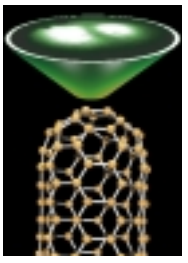
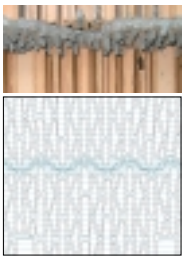
EMPA Activities 2002

Report on technical and scientific activities



Advanced Materials
and Surfaces



Materials and Systems
for Civil Engineering

Materials and Systems
for Protection
and Wellbeing of the
Human Body

Information, Simulation
Technologies, Reliability

Mobility and Environment

EMPA Academy

Swiss Federal Laboratories
for Materials Testing and Research

An institution of the ETH Domain

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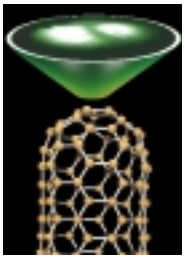

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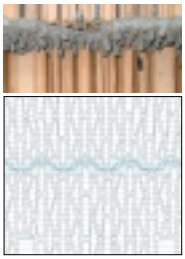

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WELCOME

2002

Welcome to the lecture of
the report EMPA Activities 2002

It is our pleasure to present you with some of the 2002 activities of EMPA, the Materials Science and Technology Institution of the ETH Domain. In the first part of our report, short descriptions of R&D projects including references to publications and patents are presented; in the second part, the scientific output 2002 is summarized with lists of general knowledge-transfer, publications, PhD theses, invited talks and conference contributions.

The year 2002 was characterized by an increase of the number of PhD students from a good dozen (average 1999–2001) to 30, an increase of the peer reviewed (SCIE) publications from 70 to 90, and an augmentation of the number of scientific collaborators from 290 to 320 Our efforts towards the goal of 60% application oriented research and development, 30% services and 10% knowledge-transfer are taking effect.

A decisive step to reinforce materials science on the micro- and nanometer scale was made by the set-up of two new research laboratories, one in the field of “nanotech@surfaces”, the other in “Functional Polymers”.

All this was achieved without the budget being increased.

In our intention to strengthen national partnerships we were invited guests of the Università della Svizzera Italiana for a workshop to focus our portfolio. In this context, we visited the Centro Svizzero di Calcolo Scientifico, of the SUPSI and of regional companies.

To maintain our collaborative R&D efforts with European partners from academia, private and public laboratories and companies, we invested considerable effort into projects of the 6th framework programme of EU.

We feel highly honoured that internationally respected scientists have accepted to be members of our Research Committee:
Prof. Teruo Kishi
Director NIMS, Japan
Prof. Herbert Einstein
MIT, USA
Prof. Robert Cahn
Cambridge University, Great Britain
Prof. Klaus Muellen
Max Planck Institute, Germany
Dr Erkki Leppavuori
Director VTT, Finland

We are grateful to all those who contributed to our achievements.

Louis Schlapbach

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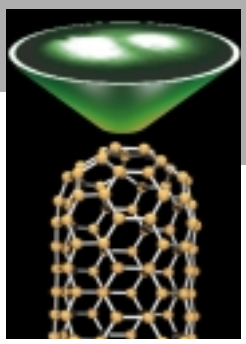

EMPA has established high competence in “Materials Science and Technology”, focusing especially on processing ceramics, composites and biomaterials. As a leading institute in surface engineering and characterization, EMPA promotes important developments with the related Swiss industry. In the frame of the innovation program “Nanotechnology”, ambitious goals have been formulated for nanoparticle synthesis, nanostructuring of materials and surfaces as well as high efficient carbon nanotubes. Novel conceptional design and service life prediction of advanced structural systems are of major concern in our polymer and metal activities, including unique testing and sophisticated joining.

EMPA

Synchrotron-radiation photoelectron diffraction at SLS: Probing molecular orientation at surfaces

X-ray photoelectron diffraction (XPD) is a powerful tool for the structural characterization of adsorbed molecular films. The use of synchrotron radiation extends its applicability to previously inaccessible systems like dilute molecular layers or low-symmetry and low-density molecular adsorbate system. We have investigated the adsorption of both enantiomers of tartaric acid ($C_4H_6O_6$) on the Cu(110) surface. First results show XPD patterns that directly reflect the chirality of the adsorbed molecules.

With the growing need to gain control over atomic scale objects in nanosciences, new characterization tools have to be developed. Because the orientation of adsorbed molecules is directly related to the interfacial interaction between the substrate and the molecules as well as to the nearest-neighbor molecule-molecule interaction, knowledge on the adsorption geometry of large molecules is of pivotal importance for the realization of functional interfaces built from molecules. For molecules larger than a few atoms, however, the determination of orientation and conformation is by no means a trivial task. Most of the traditional structural methods fail in the case of too many atoms per unit cell, and spectroscopic methods probing transition matrix elements rely on the existence of a few but well defined and separated symmetry elements.

An experimental method that has the potential to overcome these limitations is angle-scanned photoelectron diffraction (XPD), which is based on the scattering of photoelectrons emitted when the sample surface is illuminated with X-ray photons. We have previously shown that for adsorbed fullerene C_{60} molecules XPD provides rather direct structural information, allowing the determination of molecular orientation to a high degree of accuracy. Furthermore, we have successfully investigated the orientation and intramolecular relaxation due to adsorption of the chiral phenanthrene-derivative Heptahelicene, $C_{30}H_{18}$, on the Cu(111) surface.

At the newly implemented end station Near Node Photoelectron Holography (NNPEH) at the Surface and Interface Microscopy beamline of the Swiss Light Source (SLS), the sensitivity of the experiment is further enhanced by the synchrotron radiation. This might enable the application of the method to molecules with low photoelectron-emitter density and low symmetry that have previously not been accessible. We have performed photoelectron diffraction experiments at the SLS, studying the adsorption of both enantiomers of tartaric acid ($C_4H_6O_6$) on the Cu(110) surface. First results show XPD patterns that are mirror images of each other, directly reflecting the chirality of the adsorbed molecules (Fig. 1). This demonstrates that XPD has the potential to determine the handedness of adsorbed chiral molecules and to distinguish and identify the enantiomers in a rather straightforward way. Further experiments along these lines and a detailed analysis of the results shown in Fig. 1 are under way.

Roman Fasel,
Karl-Heinz Ernst,
in collaboration with
Thomas Greber,
University of Zürich,
and Joachim Wider,
SLS of PSI (CH)

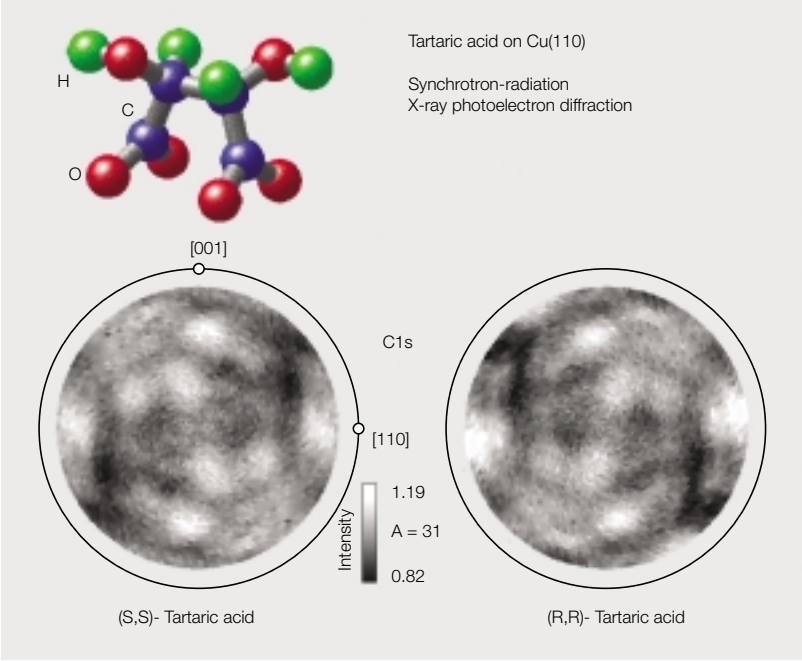

Fig. 1: *C 1s XPD patterns from the homochiral phases of tartaric acid on Cu(110). The diffraction patterns from the two enantiomers are mirror images of each other, reflecting the chirality of the adsorbed tartaric acid molecules.*

Links: www.empa.ch/abt124
> Surface technologies

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References:
R. Fasel, P. Aebi, CHIMIA 56, 566 (2002)

Carbon nanotubes for future electron emission devices

Oliver Gröning, in collaboration with Pierangelo Gröning, University of Fribourg (CH), University of Cambridge (GB), Thales Electron Devices SA (F), Mapper Lithography (NL)

Whereas a single field electron emitter can be said to be completely characterized in terms of its work function ϕ at the emission site, the field enhancement factor β, the emitting surface *A* and the resistance *R*, the description of the overall emission behavior from a carbon nanotube (*CNT*) thin film emitter with a large number of emission sites requires a statistical approach. The number of degrees of freedom with regard to geometrical alignment, orientation, length, diameter and inter-emitter distances within the thin film emitter ensemble is much larger than for a single emitter. Electrostatic screening has to be taken into account for thin film emitters, since the presence of a large number of emitters may affect the local electric field *E* at the emission sites. The emission properties can, therefore, vary considerably from one position to another on the thin film emitter.

In contrast to the well established solid state microelectronics, which relies on the scattering dominated drift of electrons (or holes) in a semiconductor, vacuum microelectronic devices make use of the collision free ballistic motion of electrons in vacuum.

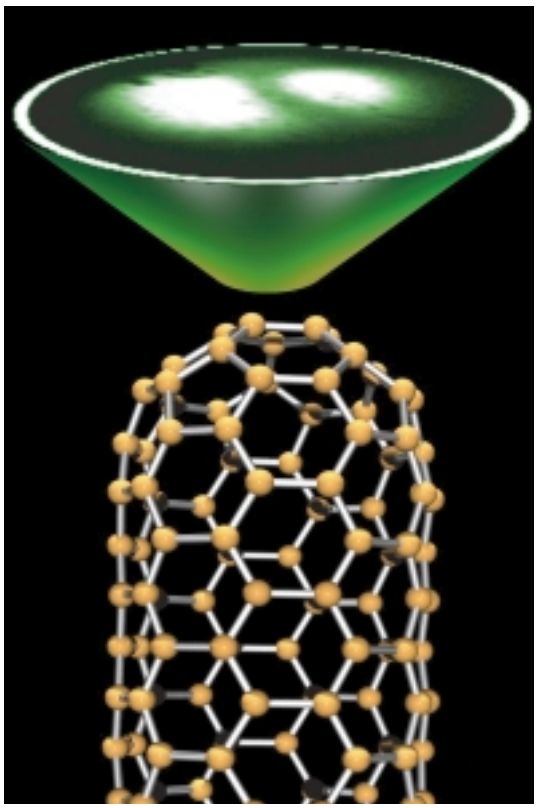

Fig. 1: *Electron emission spot on phosphorous screen from one single CNT.*

Due to the collision dominated motion of the charge carrier in solids, the drift velocities are considerably smaller than for ballistic motion in vacuum at comparable electric fields. Furthermore, power is dissipated due to the interaction of the electrons with the lattice. Especially for high power high frequency applications, this power dissipation becomes a problem.

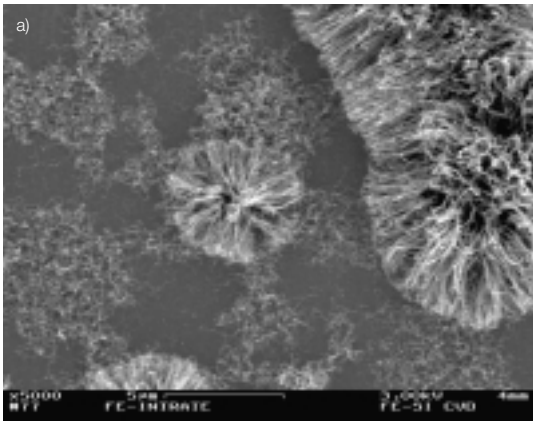

Fig. 2: *SEM image of a randomly oriented CNT thin film produced by CVD.*

This is why in the field of high power radio frequency and microwave amplifiers, vacuum electronic devices such as electron tubes, magnetrons or klystroms are still being used. Field electron emission from solids may open the door for the miniaturization of electron sources and, therefore, also for the miniaturization of vacuum microelectronic devices. However, the development of field emission electron sources has been hampered for half a century by the fact that tip like field enhancing structures are needed to create locally high electric fields for field electron emission to take place. Today, there is only one mature technology to produce field emitter arrays. This technology is the so-called Spindt type metal microtip process. The drawbacks of the Spindt type process are the expensive production, the critical lifetime in technical vacuum and the high operating voltage. Carbon nanotubes (*CNT*) can be regarded as the potential second-generation technology to the Spindt type metal microtips. The advantages of *CNT*, are above all, a potentially longer lifetime due to chemical inertness and the lower operating voltage due to higher local field enhancement.

Using field emission spectroscopy (*FES*), we have shown that the field electron emission of a single *CNT* can be accurately described by Fowler-Nordheim tunneling, and that the field enhancement factor β influences the emission properties most promi-

nently. Therefore, the field emission properties of a *CNT* thin film emitter can be understood in terms of the local field enhancement $\beta(x,y)$, which can be determined by scanning anode field emission measurements. To characterize the field emission properties of thin film emitters, we introduce the concept of the field enhancement distribution function $f(\beta)$. In this context, $f(\beta)\cdot d\beta$ gives the number of emitters per unit area with field enhancement factors within the interval $[\beta, \beta + d\beta]$. From the field enhancement distribution function $f(\beta)$ the technological relevant parameters, the emission current density and the emission site density as function of the applied field can be calculated. Therefore, the field enhancement distribution function $f(\beta)$ gives an almost complete characterization of the field emission properties of thin film emitters, contrary to the often used threshold field F_{thr}.

Scanning anode field emission microscopy (*SAFEM*) operating in the constant current mode (*CCM*) allows the investigation of the local field emission properties without current saturation or emitter degradation effects. In the *CCM*, we get a spatially resolved field emission image of the extraction voltage $V(x,y)$ at a constant current level (Fig. 3). The *CCM* is both experimentally and conceptually beautiful since $V(x,y)$ is actually an inverted image of the field enhancement landscape $\beta(x,y)$, according to:

$$\beta(x,y) = \frac{d \cdot E}{V(x,y)}$$

where d is the tip-sample distance and E the applied electric field. From the field enhancement landscape $\beta(x,y)$, the field enhancement distribution function $f(\beta)$ can be derived. For randomly oriented *CNT* films, we have shown that the $f(\beta)$ can be fitted over five orders of magnitudes according to:

$$f(\beta) = k_1 \exp(-k_2\beta)$$

where k_1 and k_2 are connected with the structural order/disorder of the field enhancing *CNT*s. By changing k_1, k_2, the field emission properties of any thin film emitters can thus be tuned. Engineering of technological relevant field emission cathodes is thus the story of how to change/manipulate the fundamental field enhancement distribution function $f(\beta)$. In order to obtain a field emission device with uniform brightness and high emission site density, stringent requirements must be placed on the permitted spatial variation of emitting sites and, therefore, the variation of β. Homogeneous emission from an ensemble of field emitting sites, defined as $dI/I < 50\%$, requires a relative variation of the field enhancement $d\beta/\beta$ smaller than 4%. This clearly shows that only a perfect control of the catalytic *CNT* growth process will result in a successful *CNT* technology for field emitters, at least for high current applications.

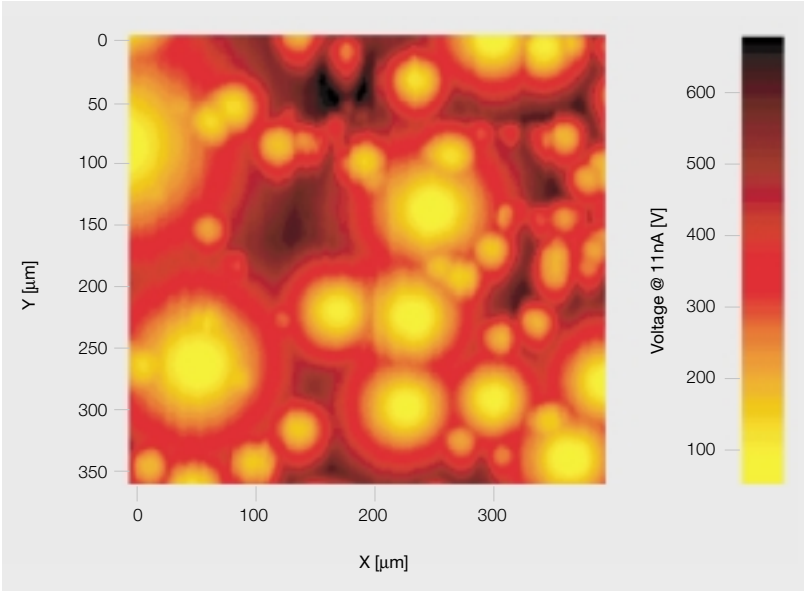

Fig. 3: *Extraction voltage map V(x,y) recorded at 11 nA emission current from the CNT thin film shown in Fig. 2. Tip-sample distance 7 µm.*

The emphasis of our current work is on providing, also for external groups in the field, experimental as well as conceptual characterization of thin film emitters and field emitter arrays not only limited to *CNT*s. Furthermore, we are interested to understand the emission degradation of *CNT* emitter, which we have identified to be on the most prominent limiting factor in the field emission performance. As an other important factor, we are seeking ways to enhance the emission homogeneity and the emission site density, namely by developing deterministic growth of *CNT*s.

Support: Top Nano 21, EU Program V

Links: www.empa.ch/abt127

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References:
O. Gröning et al., CHIMIA, 56, 553 (2002)
L. Nilsson et al., J. Vac. Sci. Technol., B 20, 326 (2002)
P. Gröning et al., Chapt. in Encyclop. of Nanosci. and Nanotechn., 2003, ed. by H.S. Nalwa, Academic Press

Determining the stress-strain behavior at micro- and nanometer scales by coupling nanoindentation to numerical simulation

Through parametric finite element calculations of the contact problem in nanoindentation we developed a series of semi-analytical functions that describe the inverse relationship between nanoindentation force-displacement data and the underlying materials stress-strain curves. We applied the method successfully to determine stress-strain curves of MEMS parts and to quantify strain hardening around fibers in metal matrix composites.

Johann Michler,
Sven Stauss,
Patrick Schwaller,
Jean-Luc Bucaille,
in collaboration with
Eric Felder, Ecole des Mines de Paris (F) and
Eberhard Blank, EPF Lausanne (CH)

The ongoing miniaturization of electronic devices and micro-electromechanical systems (MEMS), the development of new coatings and thin films, and research in materials and device development related to nanotechnology demand for new characterization tools to probe mechanical materials properties at nanometer length scales.

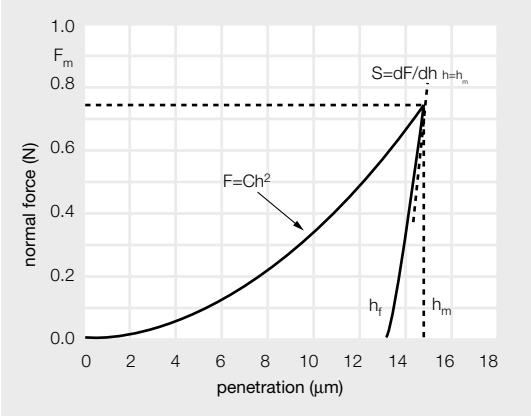

Fig 1: *Calculation of the slope of the loading curve C and Young's modulus E from the unloading curve as input data for reverse algorithm.*

Nanoindentation allows measuring nanohardness and Young's modulus. However, the fundamental materials strength parameters for materials design and device engineering, e.g. the materials stress-strain curve at nanometer scales, cannot be determined by any method up to date.

At the end of the 19th century, Heinrich Hertz studied the contact of a spherical indenter with a steel surface in order to develop a method to calculate stress-strain curves from indentation force-displacement data. Despite a major mathematical contribution to solve the contact problem (the famous Hertz equations), he was not able to estimate the stress-strain curves and, therefore, turned to electromagnetism.

Inspired by the Hertz's approach, we studied – based on a finite element analysis for a large variety of elasto-plastic metallic materials – (a) the influence of the included angle of conical indenters, and (b) the friction coefficient between the metal surface and the diamond tip on the force penetration curves in nanoindentation. For any included indenter angle, we have constructed dimensionless functions relating the characteristic parameters of the force-displacement curves measured in indentation to the elasto-plastic parameters (Fig. 1). The normalization is based on the idea that the average strain is independent from strain hardening and depends only on the indenter angle. Therefore, one point of the true stress / true strain curve can be calculated from one nanoindentation force-displacement curve per given indenter angle. We showed the great interest of using indenters with small-included angles in order to

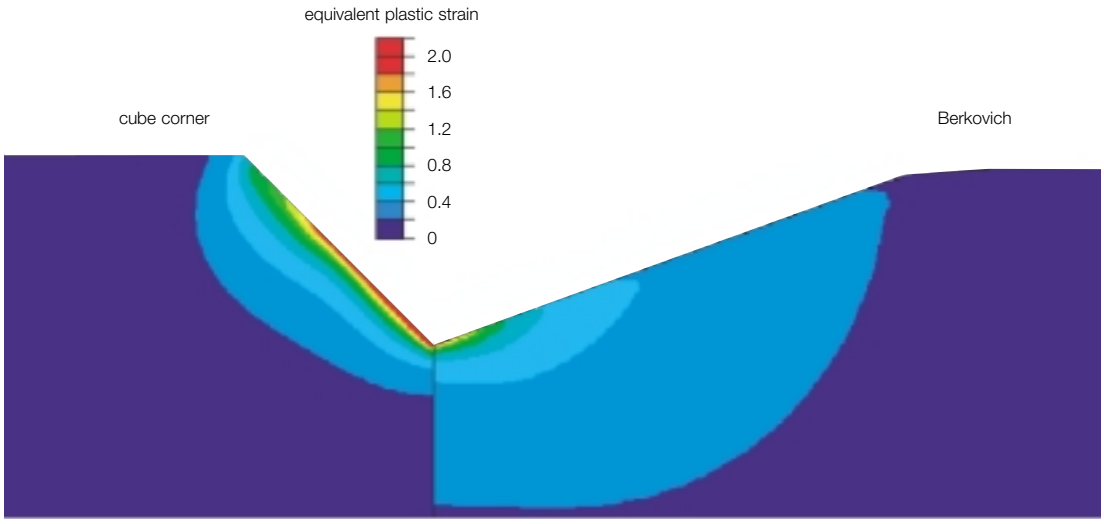

Fig 2: *Finite element simulation of distribution of equivalent plastic strains for cube corner and Berkovich indenters.*

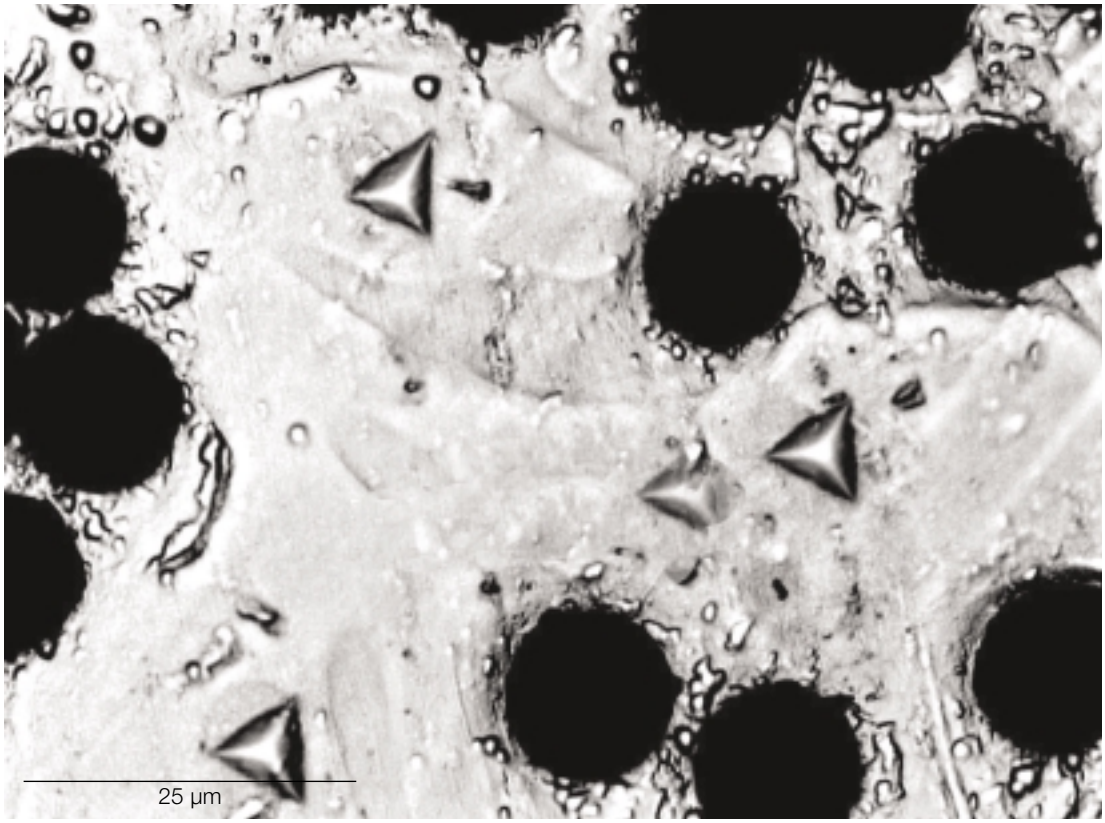

Fig. 3: *Nanoindentation of a Berkovich tip in a metal matrix of a composite for a normal load of 16 mN.*

reach large strains (Fig. 2). With this approach, only the slope of the loading curve as well as Young's modulus of the specimen calculated from the unloading curve enters the equations.

We applied the method successfully using Berkovich and cube corner tips to determine stress-strain curves of MEMS parts and to quantify strain hardening around fibers in metal matrix composites (Fig. 3). For MMC for instance, two points have been obtained and an estimation of the plastic behavior of the aluminum matrix has been plotted in Fig. 4, showing that the matrix is strain-hardened.

Current projects are related to the utilization of spherical indenters. For these tips, the deformation level increases as the penetration depth increases, allowing to determine the whole plastic behavior of the material using only one nanoindentation experiment. On the other hand, the mechanical behavior of the material during an indentation test with a spherical indenter is intricate. We are going to perform a complete coupling of numerical simulation of the contact problem to a fitting algorithm including nanoindentation force-displacement data and atomic force microscopy images of the residual imprints.

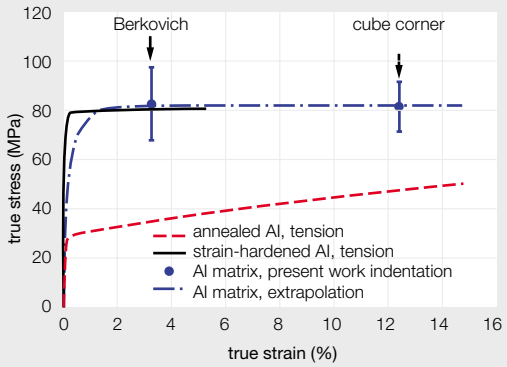

Fig. 4: *Comparison of the stress-strain curves of the aluminum matrix in the composite obtained from indentation and stress-strain curves of annealed and strain-hardened aluminum in a tensile test.*

Links: www.empa.ch/abt126
> Nanomechanics

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References:
J. L. Bucaille et al., J. Mater. Sci. 37, 3999 (2002)
J. L. Bucaille et al., Phil. Mag. 82, 2003 (2002)
J. Michler et al., Acta Materialia, in press (2002)
S. Stauss et al., Microelectronic Engineering, submitted (2002)

Chirality transfer from single molecules into self-assembled monolayers

The adsorption of enantiopure heptahelicene on Cu(111) leads to well-ordered superstructures. Depending on surface coverage, the chirality of the molecules is transferred either into handed nanoclusters consisting of six molecules or into "long-range-twisted" chiral superstructures.

Manfred Parschau,
Roman Fasel,
Karl-Heinz Ernst

The interest in helical phases composed of chiral molecules has mainly been determined by their technological applications such as in liquid crystal displays. However, the correlation of molecular chirality with the helicity of the chiral liquid crystal, i.e. the mechanism of chiral induction into the mesoscopic structure, has not yet been fully understood.

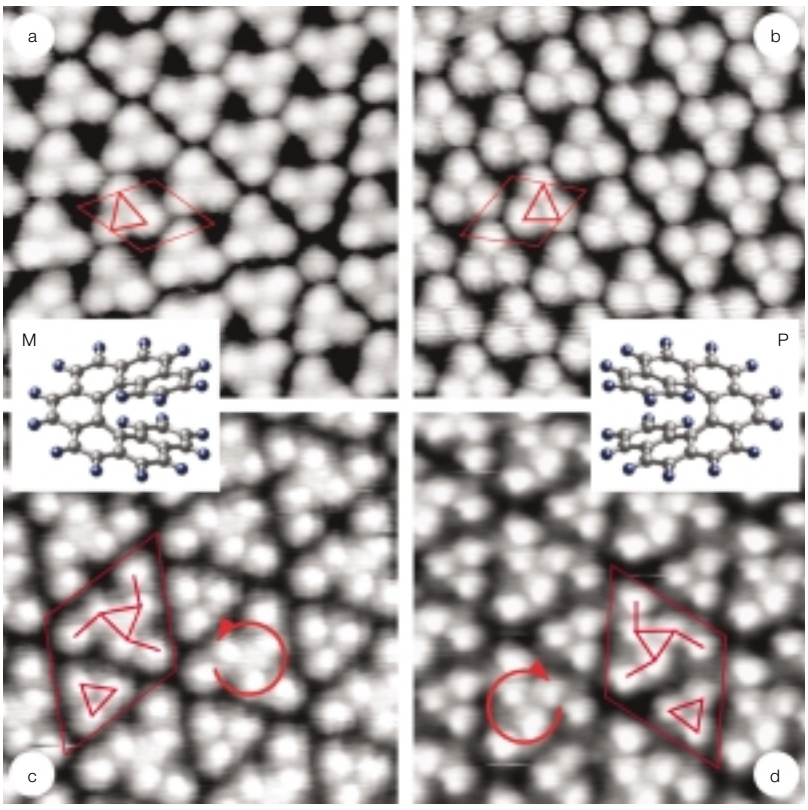

Fig. 1: *STM images acquired from superstructures of M- (left) and P-heptahelicene (right) at saturated monolayer coverage, i.e. θ_{rel} = 1, (a, b); and at 90% of the monolayer coverage, i.e. θ_{rel} = 0.9 (c, d). The unit-cells of the adsorbate lattices are indicated.*

A promising approach for getting more insights into the process of intermolecular chirality transfer is the investigation of the self-assembly of chiral molecules on surfaces where chirality transfer in two dimensions can be studied. This allows the use of scanning tunneling microscopy (STM), which is an excellent tool for studying molecular pattern formation. The adsorption of the helically shaped chiral heptahelicene $C_{30}H_{18}$ on Ni(111) and Ru(0001) showed no chiral effects, because of the low mobility of heptahelicene on these surfaces. On Cu(111), on the other hand, the molecules are highly mobile at room temperature.

In Fig. 1, four examples of ordered superstructures formed by heptahelicene on Cu(111) are shown. The adsorbate structures at a coverage of θ_{rel} = 0.9 are built up from clusters of six and three molecules, while at θ_{rel} = 1 only three-molecule clusters are observed. The structures generated by M-heptahelicene are mirror images of those formed from P-heptahelicene, and vice versa. The transfer of chirality is particularly obvious for the six-molecule cluster. The P-heptahelicene cluster forms a "clockwise spiral", while the M-heptahelicene cluster forms a "counterclockwise spiral". At θ_{rel} = 1, the supramolecular chirality is expressed by a tilt of the three-molecule clusters in opposite directions. We currently aim at developing a microscopic model for this two-dimensional chirality transfer, which is based on theoretical calculations considering the molecular orientations within the observed chiral clusters.

Links: www.empa.ch/abt124
> Surface technologies

Contact: *karl-heinz.ernst@empa.ch*
References:
K.-H. Ernst et al., in Complex Mediums III, Proceed. SPIE Vol. 4806, 248–257 (2002)
K.-H. Ernst et al., Surf. Sci., in press (2002)

Magnesium carbon, a light composite with exceptional thermal conductivity tailored for high-energy physics detectors

Sébastien Vaucher,
Olivier Beffort,
in collaboration with
Frank Lehner,
University of Zurich (CH)

A Magnesium-Carbon (Mg-C) composite combining unique physical and mechanical properties has recently been developed at EMPA in collaboration with the department of physics of the University of Zurich. The structure of the material is composed of over 60 vol.-% carbon in the form of highly conductive oriented long graphitized carbon fibers bonded by a magnesium metal matrix. In addition to a good machinability and a high Young's modulus along the fiber axis, this composite features an extremely high thermal conductivity and is transparent to radiation, which makes it a potential candidate material for application in a high energy physics detector in the Large Hadron Collider b at CERN at Geneva.

At CERN, the development of a Large Hadron Collider b (LHCb) is pursued that should allow experimental work aiming to a better understanding of the original Big Bang and in particular of a strange effect called "CP violation" (C and P: charge conjugation resp. parity operators)

As an internal part of the LHCb, the inner tracker contains silicon detectors which should be mounted on a supporting architecture that would ideally be mechanically resistant and transparent to protons while allowing a fast cooling of the silicon microchips.

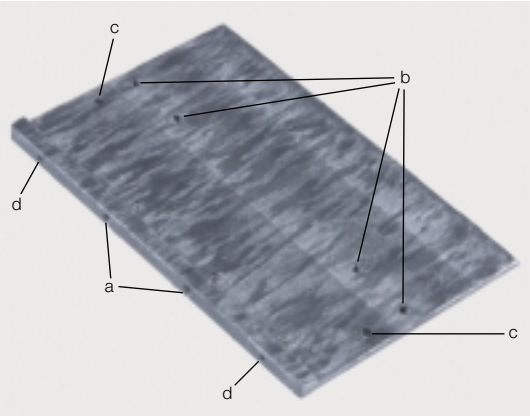

Fig. 1: *Magnesium-Carbon cooling plate 66 x 46 x 1.5 mm developed and produced at EMPA in collaboration with the University of Zurich. a: metric M2 mounting threads for the attachment to the main cooling plate, b: metric M1.5 mounting threads for the silicon chip, c: Ø 1.5 mm (P6) precision holes for positioning, d: Ø 1 mm (H7) precision holes for positioning.*

At EMPA, a carbon fiber reinforced composite material was designed to meet the requirements imposed by the specific application, i.e. proton transparency, high thermal conductivity and net shaping capability. For this purpose, carbon fibers with an exceptionally high thermal conductivity (> 800 W/mK) were selected to be embedded in a metallic magnesium matrix to provide mechanical stability and proton transparency. Composite samples were produced at EMPA by liquid metal infiltration of carbon fiber panels and were machined to the final shape (Fig. 1).

The Mg-C composite parts were then compared to other candidates such as carbon-carbon composite, carbon foams or metals. An overall comparison (Fig. 2) based on theoretical proton transparency and experimental thermal conductivity evidenced that the Mg-C material developed at EMPA in Thun is far superior to other candidate materials. Further evaluations are being performed to achieve the implementation of this composite in the LHCb.

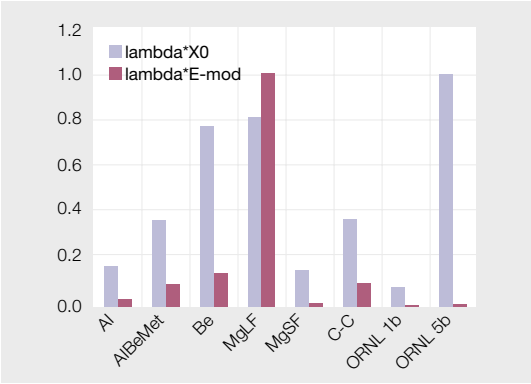

Fig. 2: *Relative comparison of thermal quantities λX_0 and λE for eight selected materials (λ thermal conductivity, X_0 radiation length, E Young's modulus; the numbers have been normalized to unity). The materials are: Aluminum, Beryllium, Magnesium-long carbon fibers composite, Magnesium-short carbon fibers composite, Carbon-Carbon composite and two graphitic foams.*

Links: www.empa.ch/abt126
> Metal matrix composites

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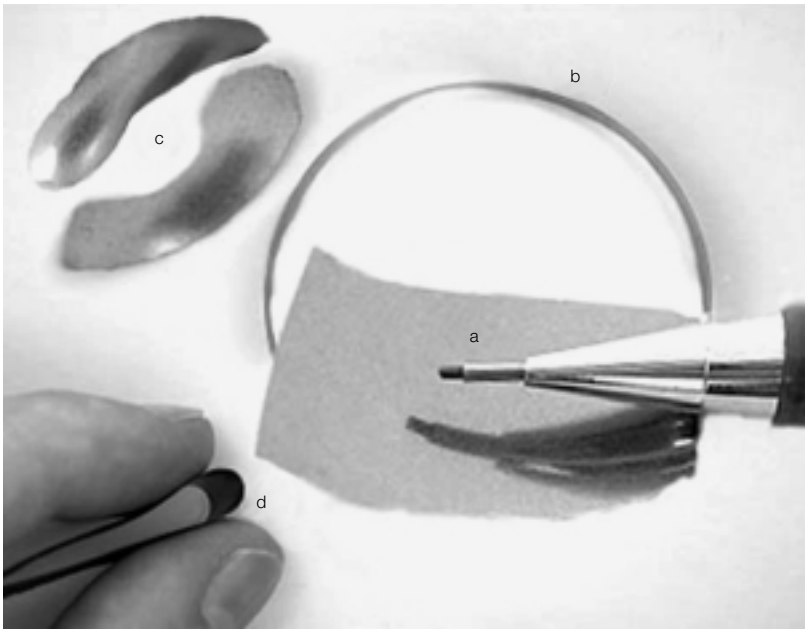
References:
K. Boesiger et al., CERN internal report LHCb 2002–061 (2002)

Thermally sprayed free-standing parts made of shape memory alloys

Stephan Siegmann,
Lukas Zysset,
in collaboration with
UAS Bern (CH),
ProMet Technologies
Inc. (USA)

Intelligent materials like shape memory alloys offer smart solutions for different technology sectors e.g. in medical and aerospace applications. Thermal spraying demonstrates a cost-effective way for the manufacturing of near-net-shape materials.

The shape memory effect (SME) is a unique property of certain alloys exhibiting martensitic transformations. Nickel-titanium alloys (NiTi) near the equiatomic concentration are the most important practical shape memory alloys (SMA). In addition to applications based on the shape memory effect (SME), these alloys have shown great potential related to high damping capacity, corrosion and wear-resistance.



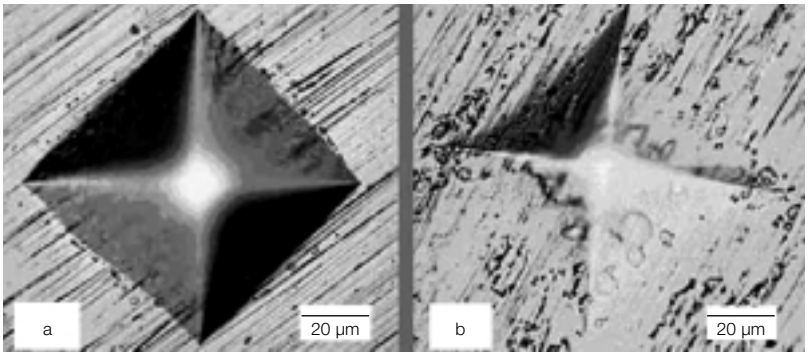


Fig. 2: *Vickers indentation (HV0.3) in a) C70 steel, b) vacuum plasma sprayed Ni55.8Ti (wt.-%) shape memory alloy showing highly elastic behavior in the as-sprayed condition.*

Nowadays, most SMA applications are realized by shaping and forming of NiTi wire, ribbon, sheet and tubing. In order to manufacture complex geometry, more sophisticated techniques such as powder metallurgy, combustion synthesis, precision casting or thin film investigations like melt spinning, vapor phase deposition, and vacuum spray processing are studied.

With regard to the excellent resistance of NiTi SMAs to corrosion and cavitation wear, investigations on thermally sprayed coatings as free-standing complex parts with the proof of a shape memory effect like in NiTi bulk material were studied. The vacuum plasma as-sprayed foil samples were investigated using the universal hardness measurement whereby also other material parameters can be determined. The elastic portion of intendation work of the as-sprayed NiTi foil shows already 75% of the SMA bulk material.

The objective of the present work was to demonstrate the capability of Vacuum Plasma Spraying (VPS) in order to produce NiTi free-standing parts exhibiting superelastic and shape memory characteristics.

Fig. 1: *Vacuum plasma as-sprayed NiTi parts: (a) mirror like surface quality of an as-sprayed foil, (b) ring-shaped part, (c) concave/convex shaped parts like membranes, (d) high flexible ribbon.*

Support: UAS Bern

Links: www.empa.ch/abt126
> Thermal sprayed coatings

www.navysbir.brtrc.com/cap/briefingsadmin/prm.asp

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References:

S. Siegmann et al., Intern. Thermal Spray Conf. ITSC, Conf. Proceed., 357 (2002)

Anode supported solid oxide fuel cells (SOFC)

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ETH-Zürich,
Augustin J. McEvoy,
EPF-Lausanne,
Kaspar Honegger,
Sulzer Innotec (CH).

In a Swiss consortium, the fabrication of anode-supported SOF cells by using simple and cheap fabrication techniques has been developed. The concept was demonstrated in a three-cell stack operated successfully at Sulzer Hexis by using reformed natural gas at around 800 °C.

Solid Oxide Fuel Cells (SOFC) operating at elevated temperatures (800–1000 °C) are – again – becoming attractive because of their ability to utilize a wide range of readily available fuels such as methane, gasoline, and heating oil. In this project, alternative techniques e.g. cold die pressing and spraying have been developed for the fabrication of anode supported SOF cells based on a metallic/ceramic composite made from Ni and the electrolyte yttria-stabilized zirconia (Ni-YSZ cermet).

The anode substrates were prepared by pressing NiO-YSZ powders (50w% each). Two different kinds of cells have been built up on these substrates: (i) cells consisting of a screen printed YSZ electrolyte layer and an $(La,Sr)(Co,Fe)O_3$ cathode and (ii) cells having an additional anode functional layer and a $Ce(Y)O_2$ buffer layer, as shown in Fig. 1. While the first cells were tested as single cells in hydrogen, the latter cells were assembled to a 3-cell short stack and tested in steam reformed natural gas at the Sulzer Hexis site.

The results of the single cell tests at 750 °C for various hydrogen flow rates point to mass transport being a limiting factor for the cell performance at low hydrogen flow rates (e.g. high fuel utilization). The short stack performance at 800 °C in steam reformed natural gas with a steam to carbon ratio of 2:1 revealed cell power densities of 0.43 W/cm^2 (Fig. 2). Electrical efficiencies exceeding 60% at high fuel utilization (90%) have been achieved, representing an excellent performance for the non sealed HEXIS stack design.

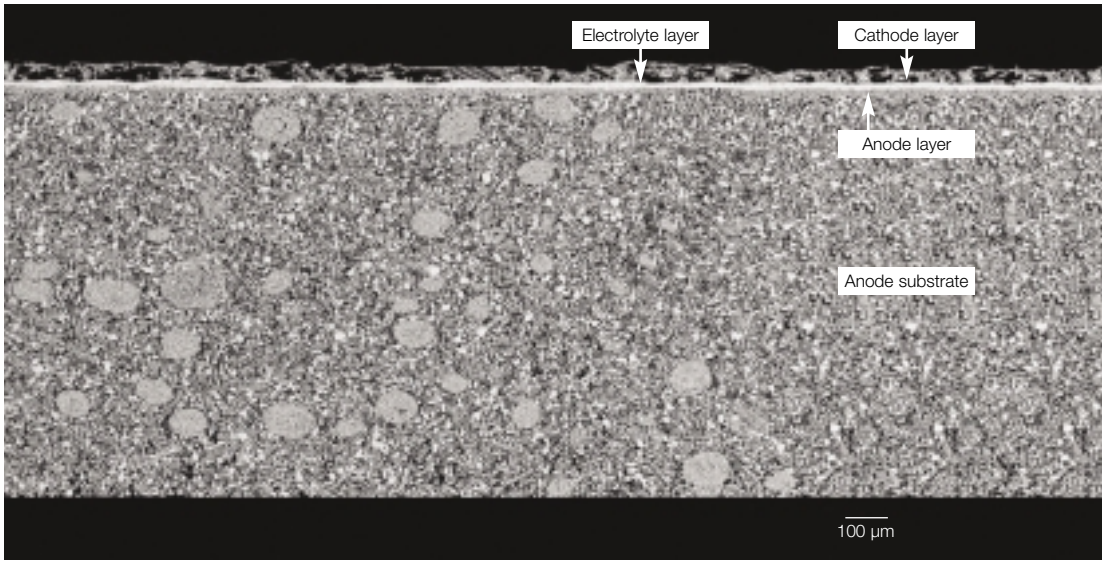

Fig. 1: *Cross sectional image of an anode supported solid oxide fuel cell.*

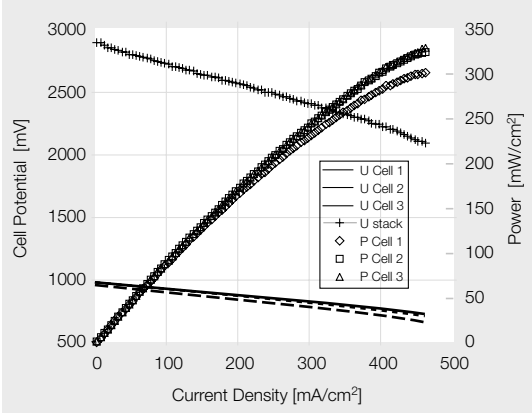

Fig. 2: *I/V-characteristics of the short stack in steam-reformed natural gas at 800 °C.*

Support: BFE

Links: www.empa.ch/ceramics
> Ceramic processing

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References:
P. Holtappels et al., 5th Europ. Forum on SOFC, Conf. Proceed. Vol. 1, 76 (2002)
P. Holtappels et al., 8th Int. Symp. on SOFC, 2003, Conf. Proceed., submitted (2002)

Multi layer laminate ceramics with ultra high fracture toughness

Multi layer silicon nitride (Si_3N_4) based ceramic laminates for structural applications such as cutting tools and roller bearings have been developed in an FP5 INCO Copernicus project. The laminate design was developed with the aid of mathematical modeling. It was possible to manufacture laminates with a three fold increase in the measured fracture toughness (K_{Ic}) over the base monolithic ceramics.

Gurdial Blugan, Jakob Kuebler, in collaboration with Nina Orlovskaya, University of Drexel (USA), Mykola Lugovy, IPMS (UA)

Over the last twenty years, there has been a continuous increase in the use of Si_3N_4 ceramics for high load applications such as bearings and cutting tools. There is a need to improve the mechanical properties of advanced ceramics to increase the component lifetimes and for use in even more demanding applications.

The laminate concept can be used to increase the apparent fracture toughness $K_{Ic_{app.}}$ and strength of a material by placing a compressive stress on any cracks on the outer surface. Thus, the compressive stress effectively closes the advancing crack tip. The production of a laminated advanced ceramic requires the use of layers of two dissimilar materials with different coefficients of thermal expansion (CTE). When cooling from the sintering temperature, the CTE mismatch induces thermal straining between the layers and the material with the higher CTE is placed under a residual tensile stress, the material with the lower CTE is placed under a residual compressive stress (Fig. 1).

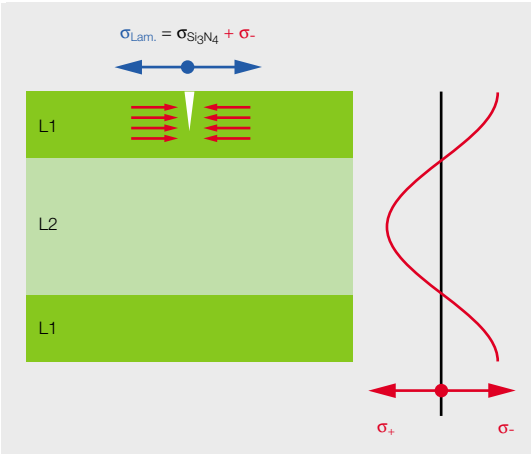

Fig. 1: *Schematic of the stress distribution in a laminate and the effect of compressive stress on a crack tip.*

The main difficulty is to produce a laminate component from advanced ceramic materials which has a high density and is also free from thermal cracking. The problem being that the residual stresses from the CTE mismatch should not crack the specimen during cooling but should still be high enough to give substantial improvements in the mechanical performance.

Titanium nitride (TiN) was homogeneously introduced into the microstructure of hot pressed Si_3N_4 to increase the CTE of the ceramic. Si_3N_4 materials with 10, 20 and 30 wt. % TiN were produced and characterized for mechanical and thermal properties. Tab. 1 shows the results. The amount of TiN additive used is directly related to the increase in the CTE. Hence it is possible to control the value of the residual stress by controlling the TiN addition. A mathematical model was developed with the parameters of CTE, Young's Modulus (E) and temperature difference from the onset of cooling. With these parameters, the thickness of the layers and the stacking sequence of the laminate can be designed to increase the $K_{Ic_{app.}}$.

Starting Material	CTE (10^{-6}/°C)	E (GPa)	K_{Ic} (MPa $m^{1/2}$)
Si_3N_4	3.18	303	4.26
Si_3N_4 + 10%TiN	3.60	311	4.47
Si_3N_4 + 20%TiN	3.99	317	4.61
Si_3N_4 + 30%TiN	4.43	330	4.71

Tab. 1: *The thermal and mechanical properties of the starting materials.*

Green sheets of approximately 300 µm thickness were produced by calendering of powder mixtures in a twin roll mill. The sheets were then trimmed to the size of the hot press dies and stacked in the sequence determined by the mathematical model before hot pressing. Ceramic laminates with layers of uniform thickness, and strong crack free interfaces were manufactured (Fig. 2a). The TiN grains were evenly distributed in the Si_3N_4 + 30%TiN layer and did not diffuse during hot pressing (Fig. 2b).

The laminates with outer compressive layers of Si_3N_4 show a significant increase in the $K_{Ic_{app.}}$ measured. Depending on the remaining thickness of the outer compressive layer after notching, $K_{Ic_{app.}}$ values of up to 17.3 MPa $m^{1/2}$ have been measured (Fig. 3a). This shows that the compressive stress on the crack tip is increasing as the crack length is increased towards the interface.

A laminate design system with outer layers under a residual tensile stress was also evaluated. It was determined that the measured $K_{Ic_{app.}}$ also increased

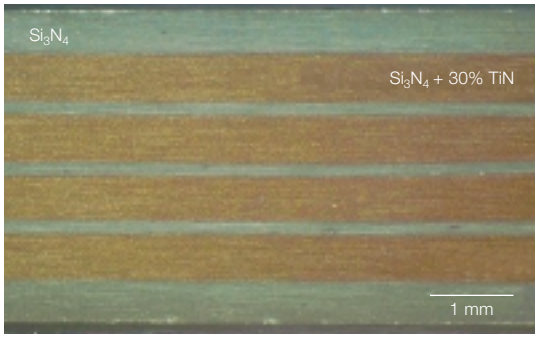

Fig. 2a: *The uniform layers in a Si_3N_4 / Si_3N_4 + 30%TiN ceramic laminate.*

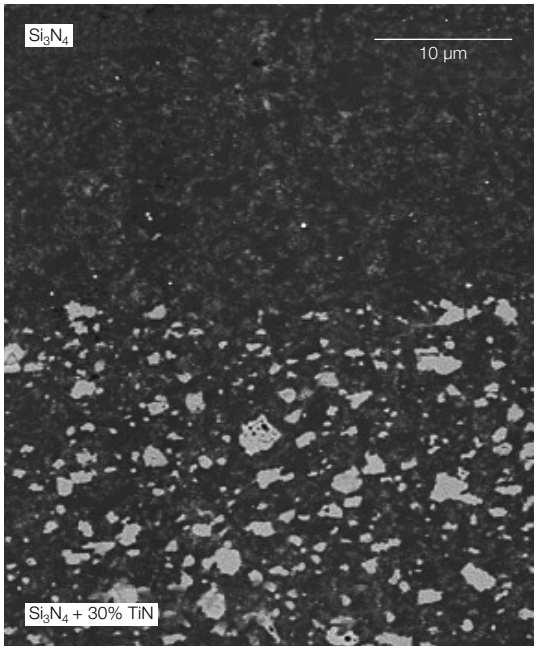

Fig. 2b: *Layer interface showing crack free boundary with even distribution of TiN grains in the Si_3N_4 + 30%TiN layers.*

with increasing notch length as the notch is extended into the first compressive layer (Fig. 3b). As the notch length is increased further into the second tensile layer, the measured $K_{Ic_{app.}}$ decreases to a value similar to that of the monolithic ceramic. In this design, crack deflection and delamination have also been observed (Fig. 4). Crack deflection and delamination are both beneficial as these effects increase the work of fracture during failure.

Si_3N_4 based ceramic laminates can be produced with a three, fold increase in $K_{Ic_{app.}}$, making them suitable for potential use in structural applications. The design of the laminates to further increase the work of fracture is being investigated, and the production of the first cutting tool samples will be manufactured by the industrial project partner KCE-FCT.

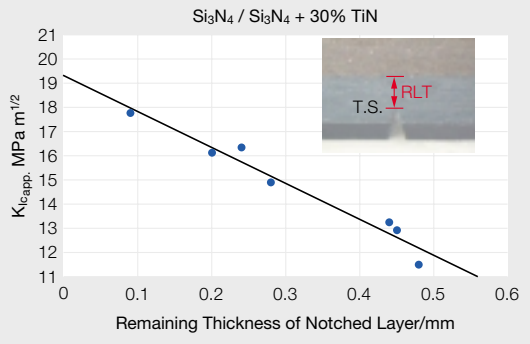

Fig. 3a: *The high $K_{Ic_{app.}}$ of the laminates is dependent on the remaining thickness in the notched compressive layer.*

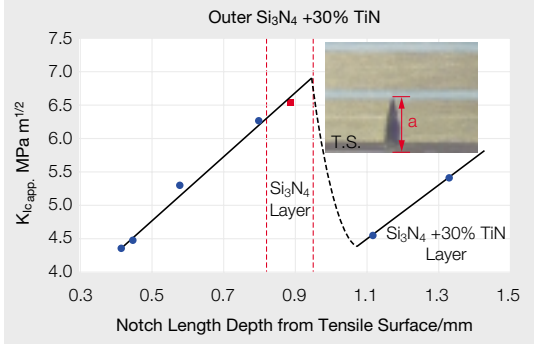

Fig. 3b: *The effect of notch length on $K_{Ic_{app.}}$ of a laminate with outer tensile layers.*

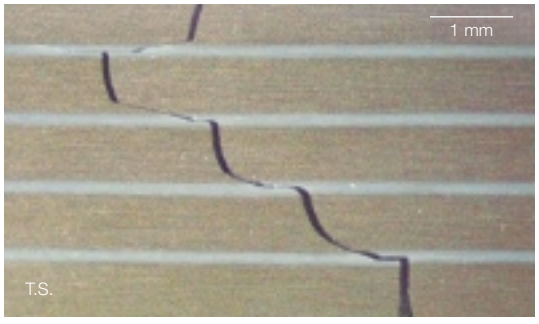

Fig. 4: *Crack deflection and delamination in laminate with outer layers under tensile stress. T.S.: Tensile Surface*

Support: BBW

Links: www.empa.ch/abt123
> Laminate

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References:
N. Orlovskaya et al., J. Am. Ceram. Soc., submitted (2002)
M. Lugovy et al., Composites Science and Technology 62 (2002)
N. Orlovskaya et al., Mat. Res. Soc. Symp., Proceed. Vol. 702 (2002)

Color tunable photoluminescent blends

Novel oligo(p-phenylene vinylene) (OPV) derivatives were synthesized by the Knoevennagel reaction. These OPVs 1–3 (Fig. 1) are highly photoluminescent (PL) dyes. The comparison of the emission spectra of the crystalline solids with those of the corresponding low-viscosity molecular solutions reveals, particularly in the case of 1, an extremely large bathochromic shift. This effect is consistent with the formation of eximers. In blends of a host polymer and a PL dye, the emission color can be readily manipulated over a wide range by controlling the extent of aggregation of e.g. 1 in an LLDPE host. This can be achieved by controlling the composition, processing conditions and temperature during the preparation of the blends. Importantly, we observed that also mechanical deformation could substantially change the emission characteristics of such blends. This effect appears to bear significant potential for technological applications, in particular the use of such dyes as internal strain sensors in polymer objects.

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University (USA)

With the goal of further development and application of functional polymer blends with unique or unusual properties, we investigated the properties of novel polymer blends of OPVs in LLDPE. OPVs serve as model compounds for the corresponding poly(p-phenylene vinylene) derivatives, which are used as the electroluminescent semiconductor in light emitting devices. In some cases, the PL emission characteristics of OPVs strongly depend on the state of matter, and bathochromic shifts up to 100 nm have been reported when comparing the PL emission of the crystalline solid with that of a dilute solution. This effect originates from the pronounced π-π interaction encountered in the crystalline lattice of these planar conjugated molecules. Intrigued by the possibility to control the emission color of a given PL dye over a wide range by merely tuning its supramolecular architecture, and with the technological potential of PL materials in mind, we chose to explore the possibility to access supramolecular structures of OPVs between the limiting states of highly crystalline solid and molecular solution in a low-molecular liquid solvent.

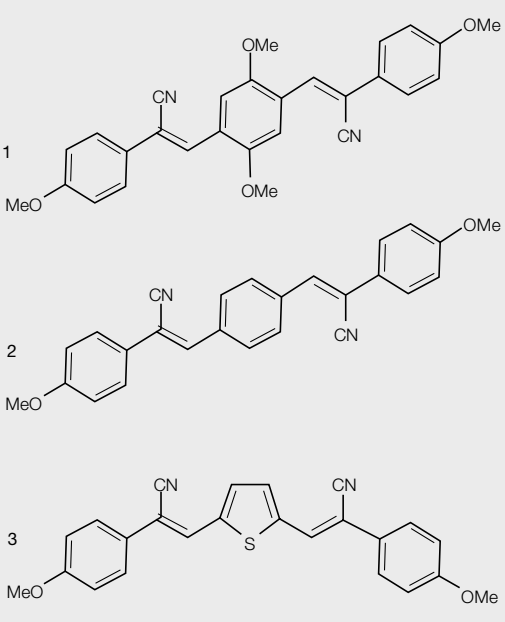

Fig. 1: *Chemical structures of 1,4-bis-(α-cyano-4-methoxystyryl)-2,5-dimethoxybenzene (**1**), 1,4-bis-(α-cyano-4-methoxystyryl)-benzene (**2**), 2,5-bis-(α-cyano-4-methoxystyryl)-thiophene (**3**).*

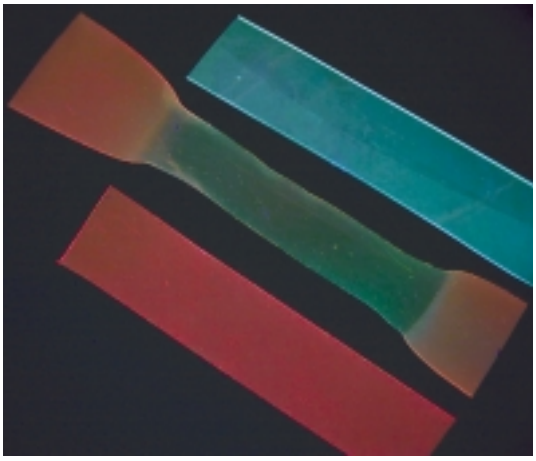

Fig. 2: *Photograph of LLDPE blend films comprising **1** in molecularly dispersed (green) and aggregated (red) form. The bi-colored sample has been mechanically deformed.*

Blends of ethylene/octene co-polymers (octene content 1.2%, LLDPE-1.2-C8 and 9.3%, LLDPE-9.3-C8 respectively) and dye **1** were prepared by swelling the LLDPE films in solutions of the dye in $CHCl_3$ and toluene at different concentrations and temperature. If dyed for a short period (~5 h) at room temperature in a low-concentration $CHCl_3$ solution of **1** (1 mg/mL), films of both LLDPE grades fluoresce green and display emission spectra that feature well-resolved vibronic structures. The spectra display a modest (~10 nm) hypsochromic shift compared to the one of a $CHCl_3$ solution of the dye, but otherwise match the latter well. The situation changes if

the concentration of the dye in the dyeing solution, the temperature, and the dyeing time are increased (Fig. 2 + 3). Fig. 3a shows with the example of LLDPE-1.2-C8/**1** that the films, in addition to the "green" monomer emission with well-resolved peaks around 496 and 531 nm, develop a broad unstructured "red" emission band around 644 nm. This band matches the one observed for the crystalline **1** and is indicative of excimer emission, which implies aggregation of multiple dye molecules. Keeping immersion time (16–18 h) and temperature (60 °C) constant, the relative intensity of the red band gradually increases with increasing dye concentration in the dyeing solution. This finding is concomitant with a higher dye concentration in the film and an increased probability for aggregation and excimer formation. Fig. 3b shows with the example of the same dye/polymer combination as used in Fig. 3a that the effect is more pronounced upon increasing the temperature to 70 °C and exchanging $CHCl_3$ for toluene. Fig. 3c and 3d demonstrate that the effect is further amplified when using LLDPE-9.3-C8 instead of LLDPE-1.2-C8, consistent with the higher solubility of LLDPE-9.3-C8. This results in an increased extent of swelling, which, in turn, leads to a higher concentration of **1** in the dyed films. The emission of highly dyed LLDPE-9.3-C8/**1** blend films is predominantly governed by excimers, while monomer emission is virtually fully suppressed.

We have investigated the influence of solid-state tensile deformation on the emission characteristics. Fig. 4 shows the PL spectra of films of LLDPE-1.2-C8 and LLDPE-9.3-C8, which were dyed with a solution of **1** (~10 mg/mL at 70 °C) in toluene, and drawn at room temperature to draw ratios $\lambda = (l-l_0)/l_0$ of up to 400%. Most interestingly, in both systems the relative intensity of the "red" excimer band is substantially reduced upon drawing. In case of the LLDPE-9.3-C8 blend film (Fig. 4b), the emission spectrum remains dominated by the broad low-energy band. By contrast, the LLDPE-1.2-C8 blend film (Fig. 4a) undergoes a most striking transformation, and the emission spectrum changes from an excimer-dominated band to an almost pure green, at a draw ratio of only 200–300%.

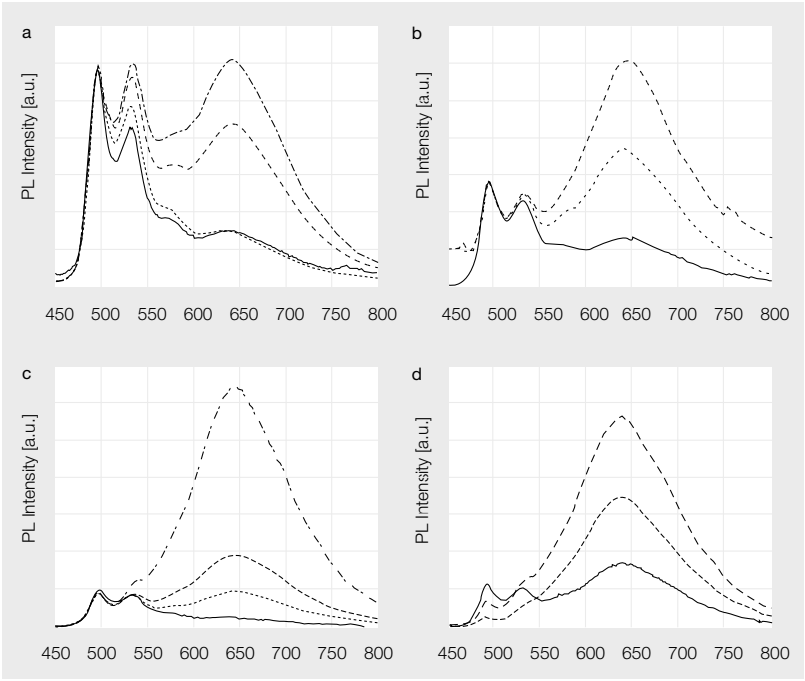

Fig. 3: *PL emission spectra of blend films of LLDPE and **1**. LLDPEs containing 1.2% (a, b) and 9.3% (c, d) of octene. Dye concentration in solution ($CHCl_3$ a,c; toluene b,d) 1 (solid line), 5 (dotted line), 10 (dashed line) and 20 (dashed dotted line) mg/mL.*

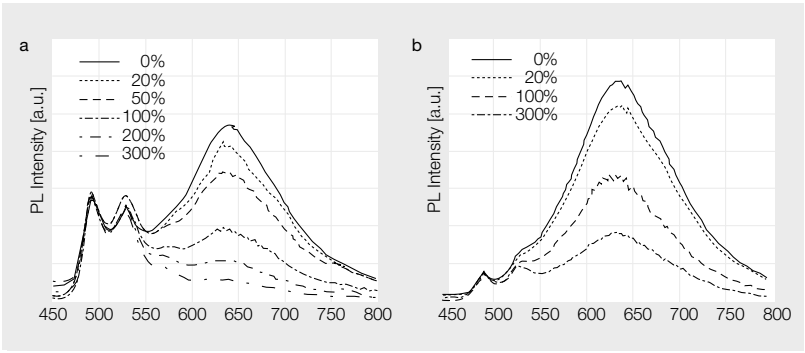

Fig. 4: *PL emission spectra of blend films of LLDPE-1.2-C8/**1** (a) and LLDPE-9.3-C8/**1** (b) as function of draw ratio.*

Support: CWRU

Links: www.empa.ch/abt140
www.case.cwru.edu/departments/

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References:
C. Löwe et. al., Synthesis, 9, 1185, (2002)
C. Löwe et al., Advanced Materials, 22, 1625 (2002)
C. Weder et al., US provisional patent, application filed (2002)

Functional Polymers from Poly[(R)-3-hydroxyalkenoates]: Protection of Surfaces from Biofouling

We produce a large amount of unsaturated biopolyesters by Pseudomonas putida in chemostat cultures. Using this unique class of thermoplastic, biodegradable polymers, we develop in this work microencapsulation processes and novel polymer-analogous reaction sequences for the construction of adaptive and environmentally friendly antifouling coatings.

Roland Hany,
Thomas Geiger,
Manfred Zinn

Some bacteria build unwanted or even pathogenic microscopic cities, called biofilms. These mats of cells form on surfaces varying from rocks to teeth to catheters. Most conventional strategies to remove a biofilm or protect a surface use toxic compounds that are aimed at killing the bacteria. For example, the most effective solution to marine biofouling is the self-polishing copolymer organotin coating; unfortunately, it is also the most toxic. Likewise, attempts to use conventional antibiotics to retard the formation of bacterial films on implanted medical devices suffer from the ubiquitous problem of emerging resistance from the most problematic bacterial strains.

The present work is aimed at protecting surfaces using a biocompatible, biodegradable polymer matrix and a non-toxic antifouling compound. The polymer is a poly[(R)-3-hydroxyalkenoate], PHA-DB, and the antifouling compound is zosteric acid (ZA), a derivative of cinnamic acid (Fig. 1). ZA is a natural product made by the seagrass *Zostera marina L.* ZA does not kill bacteria but acts as a shield preventing bacteria from attaching. This mode of action is environmentally safe and side-steps the risk of bacteria developing resistance.

Several model systems to protect surfaces from biofouling will be designed. The active (leaching) surface is a PHA-DB coating where ZA is mixed in. A constant flux of this antifoulant out of the matrix hinders cells from attaching and forming biofilms. An interactive coating consists of PHA-DB microspheres that contain ZA. Since PHA-DB is biodegradable, the surface erodes through microbial action until new globules are etched and ZA secreted. Therefore, this interactive surface represents an adaptive method that enables controlled release of agent in direct response to the presence of fouling organisms. A passive surface is a coating that contains the antifouling compound covalently bound to PHA-DB. It will find its application in systems where liquids are moved fast and protection over a long period is desired.

Pseudomonas putida (ATCC 29347) accumulates PHA-DB as an intracellular carbon and energy storage compound under nitrogen-limited growth conditions. In general, the polymer composition reflects the carbon source fed to the culture. We used this approach to produce PHA-DB with a defined portion of unsaturated side chains. A chemostat culture of *P. putida* (D = 0.1h^{-1}) was fed with a minimal medium containing octanoic acid (90 mol%), 10-undecenoic acid (10 mol%) and ammonium at a constant C/N ratio of 12 gC/gN. This resulted in a simultaneous growth limitation by carbon and nitrogen. The chemostat production unit yielded up to 10 g PHA-DB/day. PHA-DB microspheres that contained the

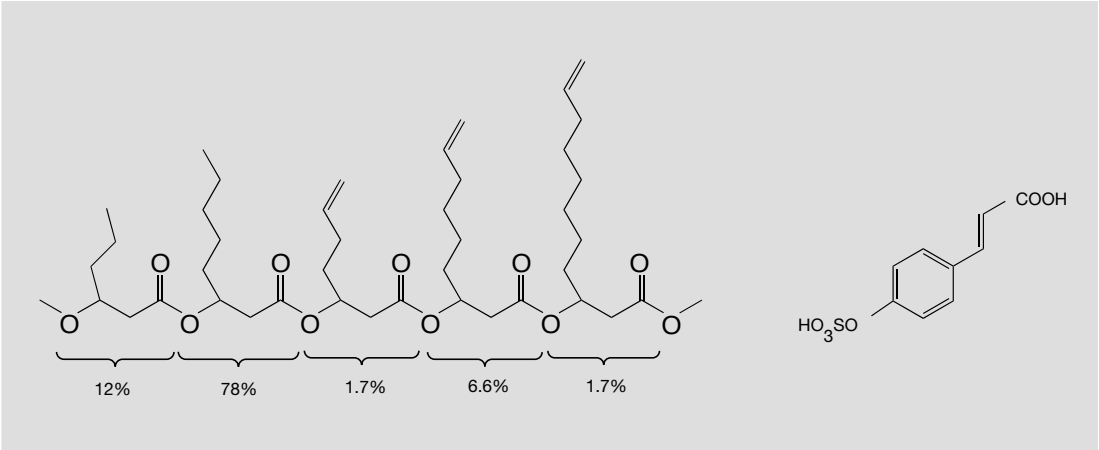

Fig. 1: *Chemical composition of the bacterial polyester poly[(R)-3-hydroxyalkenoate], and the antifouling compound zosteric acid.*

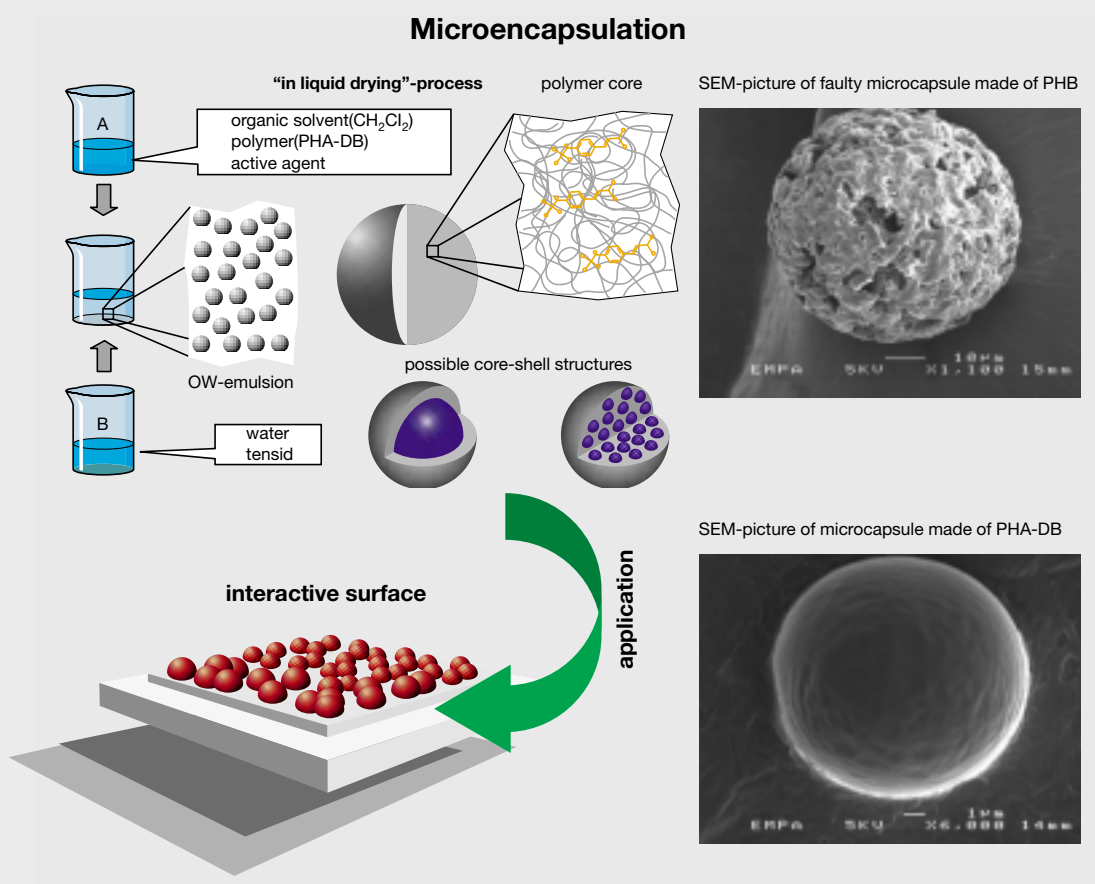

Fig. 2: *A schematic representation of the microencapsulation process.*

active component (Fig. 2) were produced. In addition, the terminal double bond was accessible for polymer-analogous reactions; the free-radical coupling with hydroxyl or carboxyl substituted thiols across the terminal double bonds of PHA-DB yielded graft copolymers which were esterified under mild conditions and in good yields (Fig. 3). Results from preliminary screening tests of antifouling coatings are encouraging and support the basic concepts.

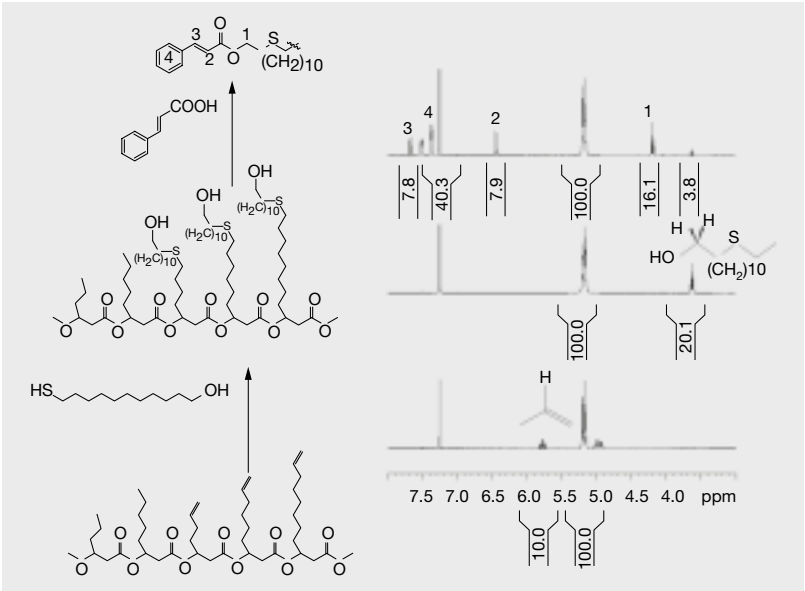

Fig. 3: *Proton NMR-Spectroscopy used to monitor the quantitative Anti-Markovnikov addition of 11-mercapto-1-undecanol to the terminal double bond of poly[(R)-3-hydroxyalkenoate], followed by the esterification with cinnamic acid.*

Links: www.empa.ch/abt140

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References:
B. Witholt, R. Hany et al., Macromol. 35, 684 (2002)
B. Witholt, R. Hany et al., Macromol. 35, 4946 (2002)
M. Zinn et al., Acta Biotech., accepted (2002)

Active fiber composites for adaptive material systems

Active fiber composites (AFC) constituted of unidirectional piezoelectric ceramic fibers sandwiched between two electrodes and embedded in a polymer matrix present major advantages over conventional piezoelectric materials like ceramics and polymers. Indeed, if their toughness and flexibility is far superior to monolithic piezoceramics, their piezoelectric properties are also greater than piezopolymers. In the framework of this project, which belongs to the EMPA innovationprogram "Adaptive Material Systems", AFCs of different geometries have been successfully manufactured and present good performances as sensors and actuators. Active vibration damping, active structural control and health monitoring systems are some of the fields of application of these new materials.

Xavier Kornmann,
Christian Huber,
Hans Rudolf Elsener

Active fiber composites are constituted of uniaxially oriented piezoceramic fibers sandwiched between two interdigitated electrodes and embedded in a polymer matrix (Fig. 1). When a high voltage is applied to the electrodes, the electric field generated

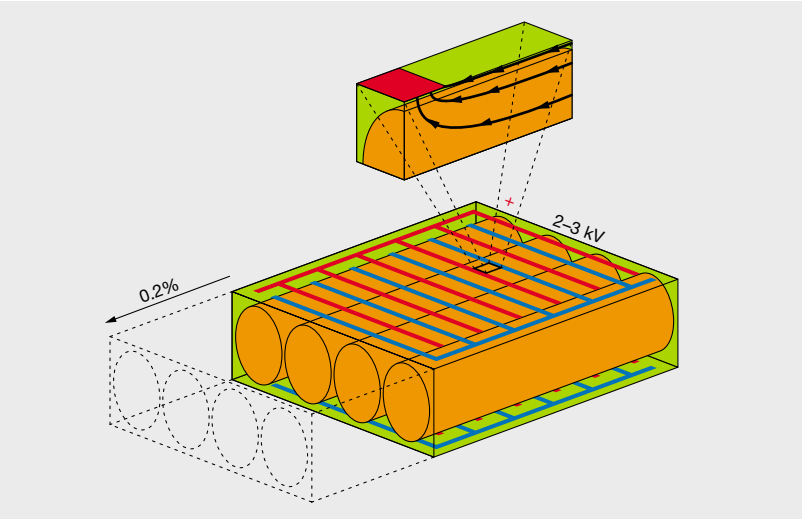

Fig. 1: *Active fiber composite concept.*

through the fibers causes an extension of these fibers in their longitudinal direction. Actuation strains up to 0.18% have been achieved with an applied voltage of 3 kV_{pp} (peak-to-peak) (Fig. 2). In order to obtain larger actuation performances, the AFC is either glued on a surface or integrated in a composite structure (bimetallic strip principle).

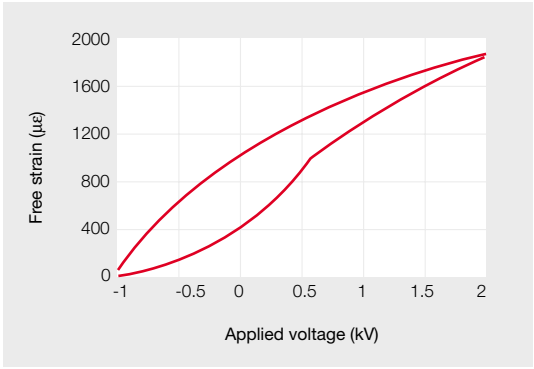

Fig. 2: *Free strain performance of our active fiber composite.*

The commercial piezoelectric fibers used in this project have a diameter of 250 µm. They are manufactured via extrusion or spinning processes and are made of lead zirconate titanate (PZT). The interdigitated electrodes are screen printed on polyimide films with a conductive silver paste, and the matrix used is an epoxy system.

The manufacturing process comprises three major steps. First, a piezoelectric fiber mat is prepared in order to organize the fibers parallel to one another. Then, the fiber mat is transferred between the interdigitated electrodes where they are laminated with an epoxy matrix. Finally, the AFC is poled. This last step consists in applying a high voltage (ca. 2.5 kV) to the AFC at 60 °C for several minutes. During the poling process, dipoles present in the piezoelectric fibers are oriented parallel to the electric field and a remnant deformation of the fibers occurs. It is only after the poling process that AFCs can be used as sensors or as actuators.

Due to their excellent performances as sensors and as actuators, AFCs are particularly suited for use in adaptive material systems. Potential applications of these new materials are intelligent rotor blades for wind power plants or active mirrors for the aerospace industry.

Links: www.empa.ch/abt114
> Adaptive material systems

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References:
X. Kornmann et al., SPIE, Proceed. of Smart Structures and Materials, San Diego, 2003, accepted (2002)

Application of the composite concept to the brazing of metals with ceramics

Jolanta Janczak-Rusch, Hans-Ruedi Elsener, Manfred Roth

Brazing technology is gaining in importance as a reliable and cost-effective joining process of dissimilar materials. However, two main problems have to be overcome when brazing metal with ceramic parts. The first one is the poor wetting of ceramics by most of the metals and alloys. The second problem is related to the differences in the physical properties of metals and ceramics. Their extremely different thermal expansion coefficients and Young's moduli lead to high residual stresses when cooling down from the brazing temperature. As a result, the strength of the metal-ceramic joint may be much lower than the strength of the joining partners.

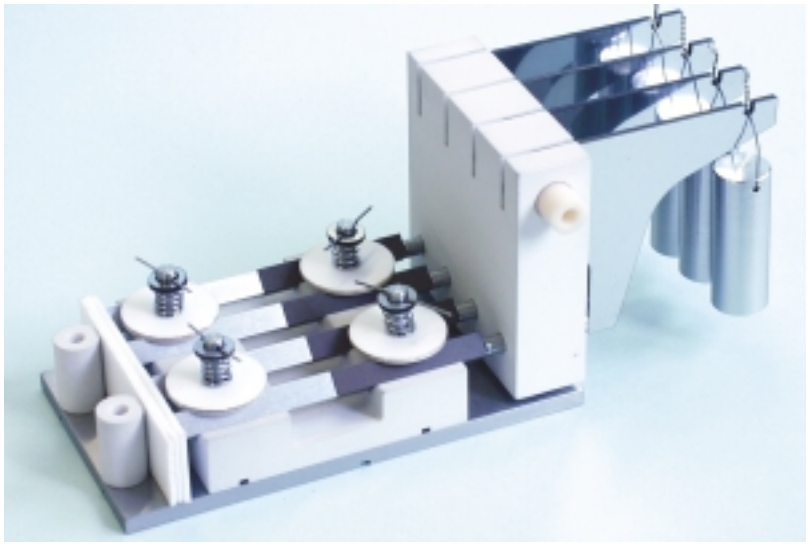

Fig. 1: *Experimental set-up for vacuum brazing of metal-ceramic specimens. Dimension of joining partners: 4 x 3 x 25 mm.*

The composite concept offers a solution to these problems by design of tailored brazing filler metals under consideration of interfaces between the components of the material system. We made use of the experience from the composite material field to develop filler systems for joining silicon nitride ceramics with steel. Different configuration of brazing filler metals based on layered and particle reinforced structures were studied. The joints were produced through vacuum brazing and mechanically characterized in a 4-point bending test. After fractographic investigations, the microstructure was studied by means of SEM, EDX and EPMA.

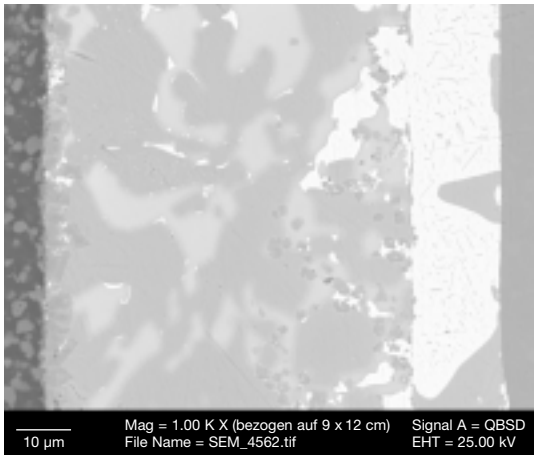

Fig. 2: *Microstructure of the 14NiCr14- Si_3N_4/TiN joint brazed using a CuSnTiZr/AgCuIn filler system.*

A layered brazing filler system (CuSnTiZr/AgCuIn[1]) was found to be well suited for joining Si_3N_4/TiN ceramic with 14NiCr14 steel. An average strength of about 400 MPa was reached, 20% higher than the strength of the same joints produced with a recommended single Ag-based brazing filler metal (AgInTi[2]). When comparing with joints brazed with a single Cu-based filler (CuSnTiZr) optimal for the ceramic joining partner, a strength improvement of about 80% was achieved. The possibilities for further joint strength increase using particle reinforcement are under investigation.

The practical application of the newly developed composite brazing materials will be demonstrated on prototype parts for use in the cutting tool industry.

[1] Incusil 15, Wesgo

[2] CB6, Degussa AG

Support: Gebert Rüf Foundation

Links: www.empa.ch/abt124
> Joining technologies

www.grstiftung.ch

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References:
J. Janczak-Rusch et al., Proceed. of 6th Int. Conf. on Joining Ceramics, Glass and Metal, 41–48 (2002)
U. Klotz et al., Proceed. of 6th Int. Conf. on Joining Ceramics, Glass and Metal, 142–149 (2202)

New high performance abrasive tools

Manfred Kiser,
Daniele Piazza,
in collaboration with
Gregor Burkhard,
ETH Zürich (CH)

A newly developed technology is presented which allows the manufacturing of single-layer abrasive tools with defined spacing between the grains and a high grain protrusion.

Most common abrasive tools are ceramic-, resin- or metal-bonded, whereby the metal-bonding is performed by sintering of a metal powder or by electroplating. All these fabrication methods have in common that the abrasive grains are randomly distributed in a high concentration and that the grit is only mechanically clamped by a matrix. Whenever small to medium-sized abrasive grains are used, the grain protrusion is very limited, thus reducing the free space. A limited free space between abrasive grains impairs both chip removal and cooling, and, especially at high cutting speeds, leads to thermal damage of the surface.

A new generation of single-layer abrasive tools has been invented by the Applied Technology and Development Group (GVE) at EMPA and the Institute of Machine Tools and Manufacturing (IWF) of ETH Zurich. The new manufacturing concept enables a defined arrangement of the abrasive grains, whereby patterns and spacing are custom-made. As bonding system the active brazing technique was selected. Here, contrary to other described binding techniques, the grains are fixed to the matrix by chemical bonding. The thickness of the matrix can, therefore, be dramatically reduced, achieving a higher grain protrusion. Nonmetallic and ceramic grain materials can be wetted directly by adding active elements like titanium, zirconium, niobium or tantalum to the brazing filler alloy, which form intermediary carbide or nitride layers when diamonds or CBN are used, respectively. The extremely high reactivity of such elements requires protective atmospheres or vacuum during the high temperature process.

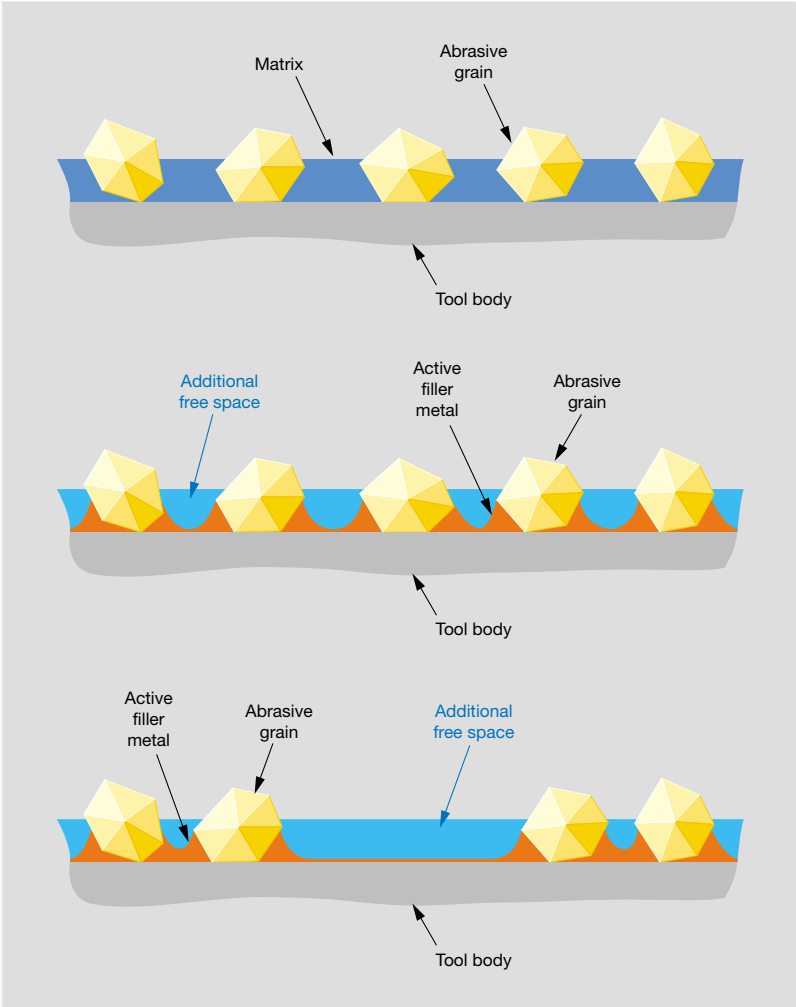

Fig. 1: *Cross-section of different single-layer abrasive tools. From top to bottom: electroplated, active brazed, active brazed with defined arranged grits. A higher grain protrusion and additional free space is achieved by active brazing. Extra free space is obtained by the defined arrangement of the abrasive grains.*

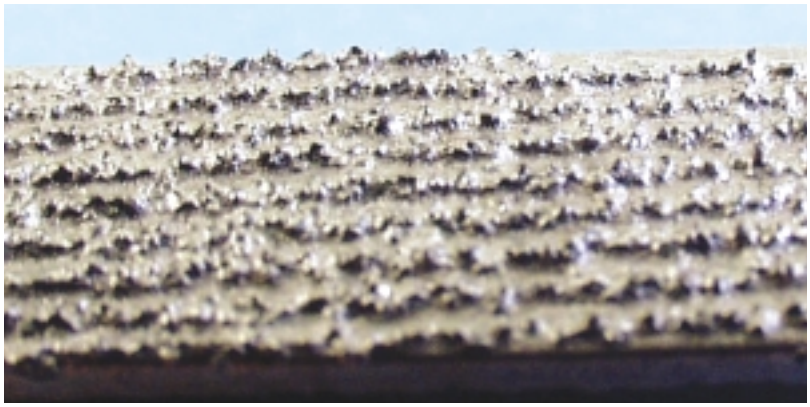

Fig. 2: *Details of an active brazed honing tool. The abrasive grains are lined up and show a high grain protrusion.*

The main invention is the application of the grains itself. The key component is a dispenser supplying micro glue droplets. These droplets can be arranged in a controlled fashion on the tool body, enabling to produce almost any kind of pattern. Afterwards the grit is sprayed or scattered over the whole tool surface, whereby one or more grains, depending on the grit and glue drop size, stick to each glue droplet. The produced abrasive structure is then permanently fixed to the tool body by applying a defined quantity of active filler alloy (e.g. as paste) and brazed.

The new technology for defined grain placement and bonding has been applied to honing tools (50 mm long x 11.6 mm in diameter) for single-stroke-honing. These tools are intended for rough and finish honing of a central bore of a fine stamped and case hardened gearwheel. On average, the diameter of the bore has to be increased by 0.09 mm.

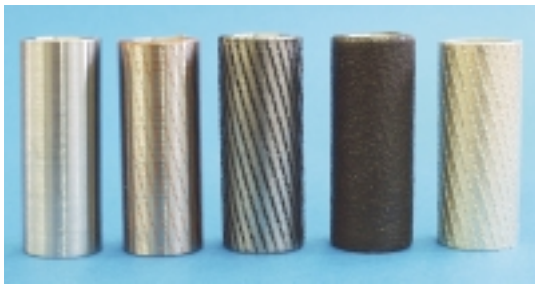

Fig. 3: *The fabrication steps of the new high abrasive tools.*

In the past, this task was performed exclusively with single-layer, electroplated honing tools (grit size B126) purchased from various suppliers. The honing process required three separate steps, removing in each of the first two 0.04 mm in diameter. The last machining step is necessary to achieve the required surface finish. With this procedure, the average tool life is 5'000 work pieces.

In an attempt to reduce machining time, the first two honing steps were combined to a single stroke with infeed of 0.08 mm in diameter. Conventional electroplated tools, however, would break down after machining 1'000 pieces at most. With a single active brazed tool, more than 12'000 parts could be machined.

As it can easily be seen, the tool life was extended strikingly and at the same time the machining time was reduced by at least 30%. Analyses of the honed surfaces showed that the roughness constantly decreased during the first 3'500 machinings and established a fairly steady value of about R_a = 0.5 µm for the rest of the tool life.

Our new procedure to manufacture abrasive tools allows the deposition of grains in a simple, fast, flexible and reproducible way, regardless of the shape of the tool body and the grain size. Hence, it is possible to create defined patterns that allow an improved coolant flow and a better chip removal.

Support: BBT-KTI 3586.1

Links: www.empa.ch/gve
> Abrasives

www.iwf.bepr.ethz.ch

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References:
G. Burkhard et al., Industrie Diamanten Revue 36, 116 (2002)
G. Burkhard et al., Annals of CIRP 51, 271 (2002)
Patent EP1208945, pending (2002)

JunFunori from red algae – a new natural polymer to consolidate matte paint

Funori is a polysaccharide from the red alga Gloiopeltis furcata and has become well-known to conservators as an exceptionally suitable product to consolidate matte paint. Because of variations in quality of the seaweed, we developed an extraction method and a purifying procedure to obtain a standardized product: an improved version of the product now called "JunFunori" (Jun = pure).

Thomas Geiger,
Françoise Michel

The consolidation of matte paint is difficult and critical because it responds very sensitively. Unfortunately, stains, tide lines, veils, darkening and gloss sometimes appear during consolidation with commonly used consolidants as gelatin, cellulose ethers or sturgeon glue.

JunFunori is a polysaccharide and its monomer units are comparable to those of agar and carrangeen. Polysaccharides from the family of Gloiopeltis contain repeating units of [→3)β-D-galactose-6-sulfate-(1→4)3,6-anhydro-L-galactose(1→], an ideal 6-sulfonated agarose, and sulfonated carrageenoide structures.

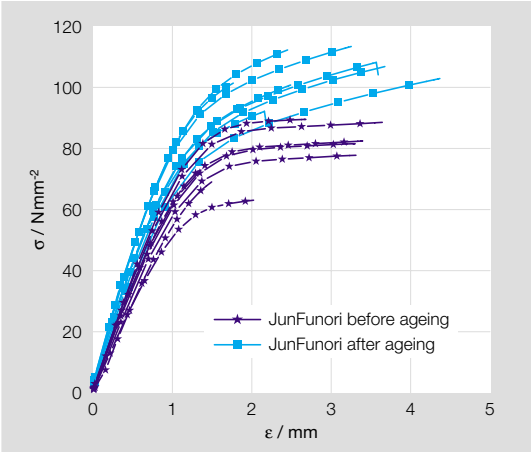

Fig. 1: *Stress-strain curves of JunFunori.*

Because of variations in quality, we purified the red algae extract and, as one consequences thereof, better consolidations have been obtained. In the developed extraction and purifying procedure, *Gloiopeltis furcata* is washed with water to remove sea salt. Afterwards, the chopped algae material is extracted with water according to special conditions and treated with charcoal in order to remove impurities. After filtration under high pressure, a colorless, odorless and clear solution is obtained, of which JunFunori precipitates after final water evaporation. A special attention has to be given to adjust the right viscosity of the solution.

Consolidations with JunFunori preserve the appearance of matte paint. Furthermore, accelerated ageing tests demonstrated the good stability of JunFunori against UV light and variations in humidity. The mechanical properties of JunFunori are determined before and after ageing by simple elongation of rectangular samples. JunFunori hardly showed any change in its mechanical property (Fig. 1). The insignificant softening at high elongations occurred because of the plasticising effect of water.

The IR-spectra from JunFunori (Fig. 2) before and after accelerated ageing show no significant changes or additional absorption bands after ageing. This leads to the conclusion that no molecular changes take place under the given ageing condition.

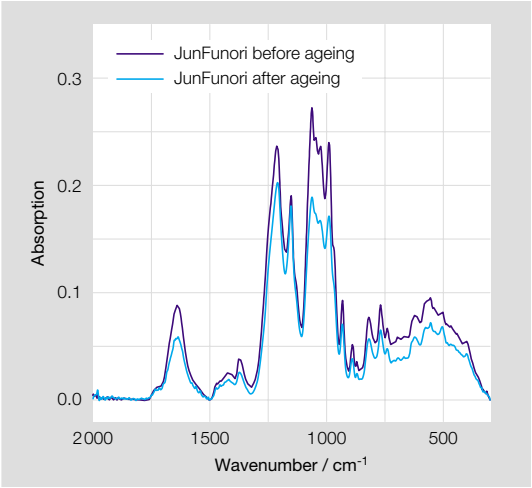

Fig. 2: *FT-IR (ATR) spectra from JunFunori.*

Finally, our experiments confirmed the usability and reliability of the new JunFunori as an effective alternative to traditional consolidants.

Support: Gebert Rüf Foundation

Links: www.empa.ch/abt140
> Funori

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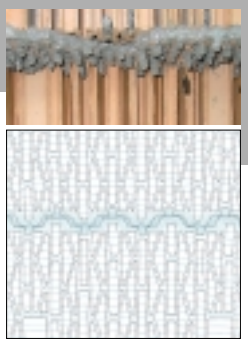
References:
G. Mörsch et al., Jahresbericht 2001 Gebert Rüf Stiftung, 31 (2002)
F. Michel et al., Zeitschrift für Kunsttechnologie und Konservierung, 2, 257–275 (2002)
Th. Geiger et al., Studies in Conservation, in press (2002)

List of abbreviations

ASTRA	Swiss Federal Roads Authority
BAG	Swiss Federal Office of Public Health
BAM	German Federal Institute for Materials Research and Testing
BBL	Swiss Federal Office for Constructions and Logistics
BBT-KTI	Swiss Federal Office for Business Formation and Technology – Commission for Technology and Innovation
BBW	Swiss Federal Office for Education and Science
BFE	Swiss Federal Office for Energy
bfu	Swiss Federal Office for Accident Prevention
BLW	Swiss Federal Office for Agriculture
BUWAL	Swiss Agency for the Environment, Forest and Landscape
BVet	Swiss Federal Veterinary Office
CERN	European Organization for Nuclear Research
CWRU	Case Western Reserve University
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EPF(L)	Swiss Federal Institute of Technology Lausanne
ESA	European Space Agency
ETH(Z)	Swiss Federal Institute of Technology Zürich
EU Program IV	European Community, 4th Framework Program
EU Program V	European Community, 5th Framework Program
FAL/FAT	Swiss Agriculture Research Institutes
FKH	Expert Commission for High Voltage Issues
GR	Swiss Defence Procurement Agency
Holz-21	Swiss Federal Stimulation Program for the Wood
IBT	Institute of Biomedical Engineering
ifra	International Newspaper Color Association
ifu	German Institute for Environmental Informatics
IKB	Institute for Nuclear Physics
IPMS	Institute for Problems of Materials Strength
ISAC-CNR	Institute of Atmospheric Sciences and Climate – National Research Council of Italy
IZT	Institute for Future Studies and Technology Assessment
PSEL	Project and Study Fund of the Electricity Industry
PSI	Paul Scherrer Institute
seco	Swiss State Secretariat for Economic Affairs
SLS	Swiss Synchrotron Light Source
SNF-NFP	Swiss National Science Foundation – National Research Progam
SUVA	Swiss National Accident Insurance Organization
TA Swiss	Swiss Center for Technology Assessment
Top Nano 21	Research Program of ETH Council
TTM	Technik Thermische Maschinen
UAS	University of Applied Sciences
UGRA	Swiss Association for the Promotion of Research in the Graphic Arts Industry
UNIZ	University of Zürich
USAID	United States Agency for International Development

EMPA Activities 2002
Materials and Systems for Civil Engineering



The R+D activities of EMPA in the field of civil engineering are focused on the reduction of the use of energy and the consumption of raw materials in the construction area. New methods are developed for health monitoring and subsequent reinforcement of large structures. From the results of physical, chemical and mechanical studies of the behavior of binding agents such as concrete and bitumen, insights in the aging process of these materials are gained and concepts for new formulations are deduced. Numerical simulation is becoming more and more important in all projects.

EMPA

Characterization and improvement of wood bonding with 1 K PUR adhesives

Klaus Richter,
Maria A. Schirle,
Anja Fischer

Analysis of timber surface properties affirm that neither surface roughness nor dynamic contact angle (DCA) parameters are suited as easy to interpret indicators for the quality of 1 K PUR bonds. Priming of the wood surface before gluing efficiently improves wet strength of 1 K PUR bonds.

For several years, one component polyurethane adhesives (1 K PUR) have been promoted successfully by Swiss adhesive manufacturers for the application of load bearing timber. However, the bonding mechanisms are still not fully understood. Occasionally unspecific bonding problems are reported, especially when gluing softwoods with higher extractive content.

In order to better understand the interaction of three softwood species (spruce, larch, Douglas fir) and a commercial 1 K PUR system, and to contribute to more reliable adhesive bonds, surface roughness parameters and adhesive properties were evaluated and their influence on the bonding strength was studied. It was found that for each surface processing (standard, and rotoles® planing; sanding) the mean roughness does not correlate with the cutting direction of the timber (rift, half rift, tangentially sawn), but that clear roughness differences exist between the machining techniques. DCA of 1 K PUR droplets on sanded samples are about 10° smaller than on planed ones, indicating that machining has a more pronounced impact on adhesive wetting than the species effect. The theory of adhesion would lead to expect higher shear strength values for the corresponding planed samples. However, this theory is supported only when dry shear strength is assessed, whereas wet shear strength after boiled water treatment showed a slightly better performance of the sanded specimen.

The unsuitability of DCA as a parameter to predict adhesion quality was even more pronounced when surfaces pre-treated with an HMR-primer were assessed. Compared to control samples, the spreading behavior of the adhesive was not changed to lower values on all primed surfaces, whereas the corresponding wet shear strength was significantly improved by the primer.

In contrast to mechanical treatments, chemical surface activation using the HMR-primer was identified as the only measure to assure a reliable bondline performance under limiting conditions. In delamination tests applying extremely tough conditioning cycles, unprimed samples of larch showed, different to spruce, unacceptable bondline delamination whereas all primed samples passed existing performance requirements.

Further research concentrates on the role of water soluble larch extractives on wood adhesion and the improvement of temperature-creep performance of 1 K PURs.

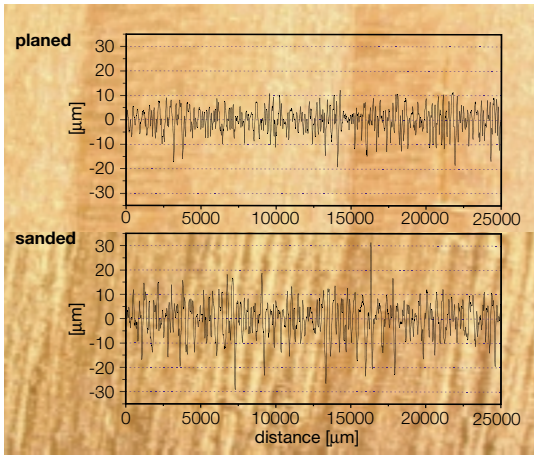


Fig. 1: *Surface roughness plot of planed Douglas-fir.*

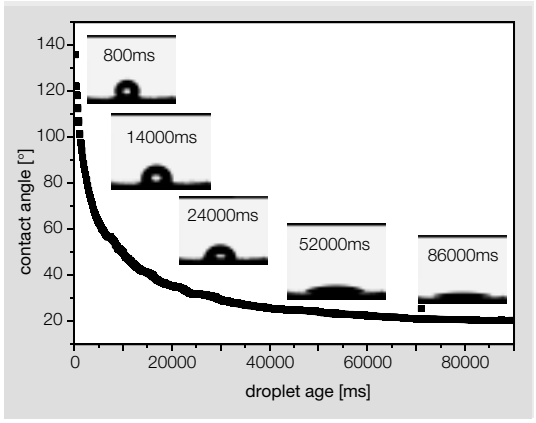


Fig. 2: *Example of DCA measurement.*

Support: BBT-KTI 4126

Links: www.empa.ch/abt115
> Wood technology

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References:
K. Richter, M. A. Schirle. Lignovisionen 4, 149–154 (2002)
M. A. Schirle, K. Richter. Lignovisionen 4, 137–148 (2002)

Actual research projects on weathering of wood and protection

Wood under exterior conditions undergoes a series of chemical, physical, and biological effects that impair its aesthetic appeal, technical functions, and durability. Several research studies in that context have recently been completed or are still running. Their objectives were to characterize the weathering mechanisms of wooden surfaces and to optimize the different protective measures, which are a prerequisite for the competitiveness of exterior wood constructions.

Jürgen Sell,
Martin Arnold

Numerous long-term weathering tests and accompanying studies have been carried out at EMPA in cooperation with several European and North American wood research institutes. The results of this comprehensive research work show that solar radiation (UV and global radiation) and moisture (precipitation and humidity) are the dominant climate factors leading to the different aging effects of wood and wood coatings. Fig. 1 schematically illustrates the main weathering mechanisms as well as potential protection measures.

UV irradiation of wood results mainly in a relatively fast degradation of the matrix substance lignin and thus in a disintegration of the wood structure which consists of reinforcing cellulose fibrils, lignin and several polyoses acting as binders. Since UV light penetrates wood to a depth of only 70 to 80 µm, the photodegradation is limited to its surface (if water does not erode the degraded substance). A current study is dealing with the effect of photodegradation on the mechanical and fractographic properties of Scots pine and Norway spruce (separately for heartwood/sapwood and earlywood/latewood). The photodegradation was monitored through the changes in microtensile strength of thin microtomed strips (thickness 50 to 80 µm) during natural and artificial UV-irradiation, and by subsequent SEM analysis of transverse-fracture surfaces of the strips. The tensile strength changes during light exposure were analyzed and were shown to be consistent with fractographic evidence of the structural changes in wood. These include the breakdown of compound middle lamella, the thinning of cell walls and the development of brittleness of cell walls (Fig. 2). The mechanism of failure is essentially different in earlywood and latewood, and the microtensile strength is predominantly determined by the latewood portions of the growth rings.

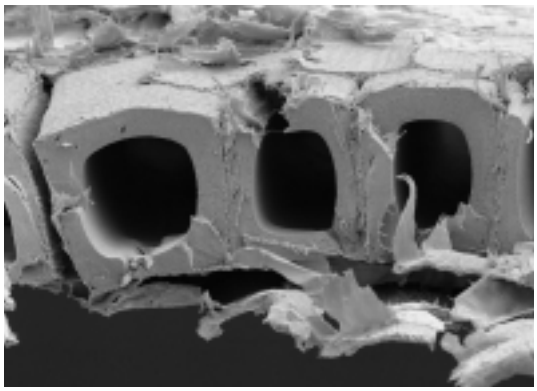

Fig. 2: *Spruce latewood tracheid cells after natural weathering for 41 days (40% retained tension strength). Thinned walls show brittle failure (characteristically smooth surfaces) in a transverse plane. 1300 : 1.*

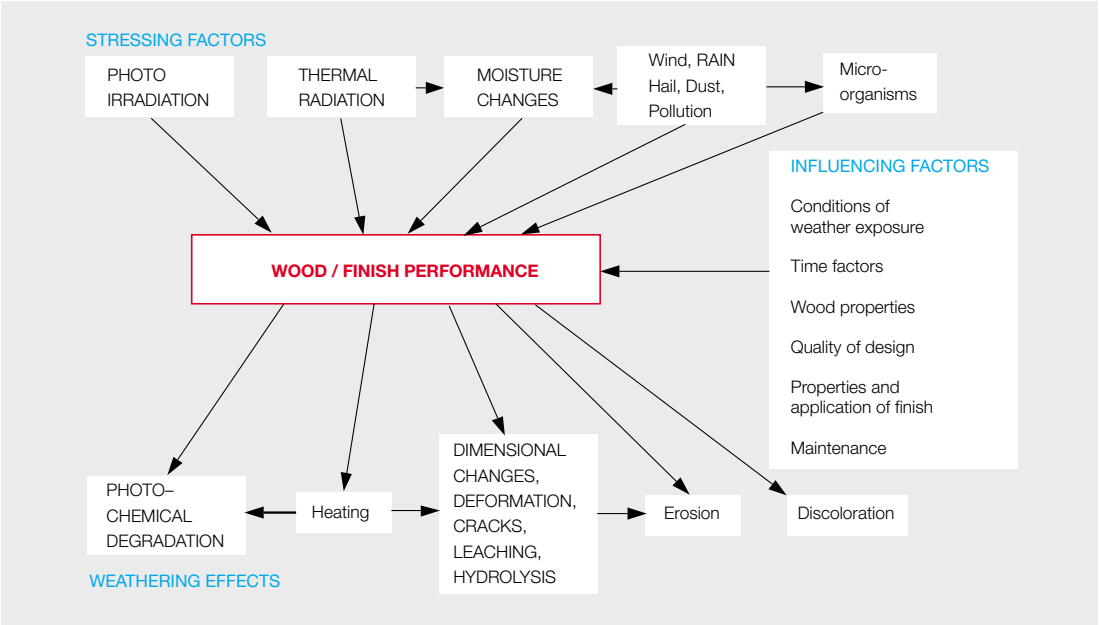

Fig. 1: *Main mechanisms and influencing factors regarding the weathering of the wood/coating system.*

To evaluate a new test method of (accelerated) natural weathering of exterior wood coatings, a round robin test was carried out on 9 different locations in Europe. Part of the evaluation consisted of investigating the relationship between the weathering results and the meteorological conditions on each site. The aim was to develop a climatic index reflecting differences in severity of climate with respect to the weathering of wood coatings. Preferably the relationship should be uniformly applicable to all coatings systems, making it possible to transfer test results from one location to another using this climatic index, in order to reduce testing expenses. From a preceding literature study in which the climate elements relevant for aging effects of exterior wood coatings have been characterized, it was concluded that a climate index relevant to this purpose should be composed of global irradiation, total precipitation and number of days with more than 0.1 mm precipitation. For all coating systems tested, the correlation between this empirical climatic index and weathering results appeared to be very poor. No unambiguous relation could be found, which was valid for all systems. Thus, transferring weathering results from one location to another, independent of the coating system, does not seem to be possible on the basis of these results. When separating the results obtained from the standardized coating "Internal Comparison Product (ICP)", the relationship was considerably better. Transferring results by means of the ICP could therefore constitute a more suitable approach. Of the climate factors involved, only global irradiation showed reasonable correlation to the weathering results.

Based on prior experience with the artificial weathering of wood using a fluorescent UV weathering device, an optimized exposure cycle for exterior coatings on a wood substrate was proposed and tested within the ARWOOD project. Considering the general limitations of artificial weathering (e.g. absence of biological degradation factors), this test method appears to be well suited to help assessing the performance of exterior wood coatings. However, the complicated interactions of a natural exposure cannot be completely simulated with a simple artificial exposure test, and therefore the "conventional" natural exposure test (Fig. 3) will likely remain the main test method also in the future. To achieve satisfactory results with this artificial weathering method, a very strict test procedure has to be observed (Fig. 4). The developed test method is currently transferred into an EN standard on the artificial weathering of wood coatings by working group 2 of CEN/TC139 (prEN 927-6). Possible further work could include the application of this method in service life prediction studies.

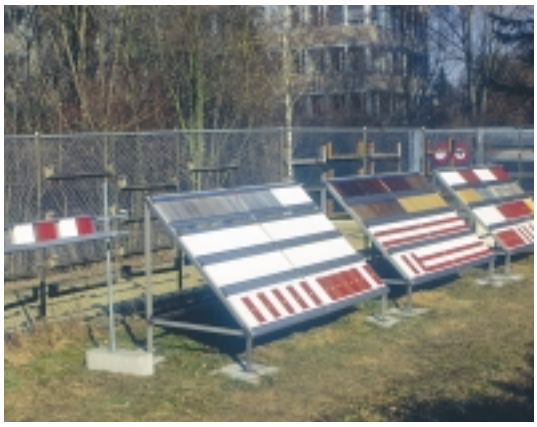

Fig. 3: *Conventional natural exposure test on a 45° plane facing South.*

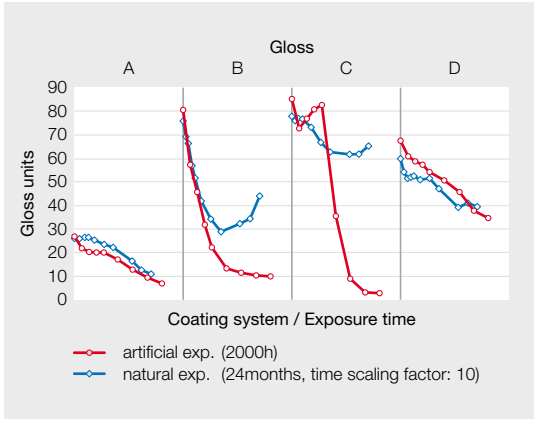

Fig. 4: *Correlation of the development of gloss during natural and artificial exposure of four different coating systems (A – D).*

Support: BBW, EU Program IV

Links: www.empa.ch/abt115
> Wood technology

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References:

J. Creemers et al., Holz als Roh- u. Werkstoff 60: in print (2002)
H. Turkulin, J. Sell, Holz als Roh- u. Werkstoff 60: 96–105 (2002)
H. Turkulin, J. Sell, Internat. Conf. Wood in Construction Industry, Zagreb, Conf. Proceed. (2002)
L. Podgorski et al., 3rd Internat. Woodcoatings Congress, Conf. Proceed. (2002)

The nature of cement hydration phases investigated by ESEM, FIB, TEM and in-situ particle separation with nanomanipulators (ISPN)

Durability qualities of portland cements are dominated by the chemical nature of the hydrate phases. In order to improve our understading of the hydrate phases, we applied a multi-method approach, including Environmental Scanning Electron Microscopy (ESEM), Energy Dispersive X-Ray Spectroscopy (EDX), Focused Ion Beam (FIB) and Transmission Electron Microscopy (TEM) (Holzer et al., in press). In addition, we have developed a method called "In-Situ Particle Separation with Nanomanipulators in the ESEM" (ISPN, Kägi and Holzer, subm.), which increases the accuracy of site specific analyses. The results document a dense but heterogeneous intergrowth at nanometer scale consisting of different hydrate phases with fix compositions formed at chemical equilibrium. This contrasts conventional models for hydrate phases with strongly variable compositions, interpreted as a result of chemical disequilibrium.

Lorenz Holzer,
Ralf Kaegi,
Philippe Gasser

The chemical nature of portland cements (PC) is related to the high pH in the pore solution, which is dominated by high concentrations of potassium and calcium hydroxide. The high pH in concrete is of major importance because this chemical environment inhibits corrosion of steel reinforcement. The "elimination" of potassium and calcium due to leaching or carbonation results in a reduction of the pH. This gives way to an accelerated corrosion and can invoke further chemical degradation of the cementitious matrix, which reduces the durability of concrete. For systematic sustainable improvements of concrete structures, it is thus crucial to understand how CaO (65 mol% of PC) is incorporated into the cement hydrate phases.

80% of the cementitious matrix in hardened portland cement is formed by calcium-silicate-hydrate (C-S-H). However, the structure of C-S-H at atomic or nanoscopic scales is still a matter of debate. To date, none of the existing models for C-S-H can explain the different analytical results: NMR studies indicate that the formation of cement hydrates is associated with an Si-O-Si-polymerisation. X-Ray Diffraction (XRD) data show that C-S-H is either amorphous or consists of crystalline domains, which are smaller than a few atom layers (crypto-cristallinity). This contrasts results from thermodynamic models which describe the C-S-H-phase as a solid solution between two crystalline endmembers (jennite and tobermorite). To date, none of these crystalline phases have been detected in ordinary cementitious materials.

Most chemical investigations of C-S-H are performed by EDX in SEM. As illustrated in Fig. 1A, the excitation volume in conventional SEM (µm-range) is larger than the size of most hydrate phases (nm-range). Thus, signals from different matrix phases contribute to the EDX spectra, which results in a wide scattering in the discrimination diagram Al/Ca vs. Si/Ca (Fig. 2, green crosses). Based on such misleading data, several authors argued that the chemical composition of C-S-H is variable, and that the chemical equilibrium is not attained.

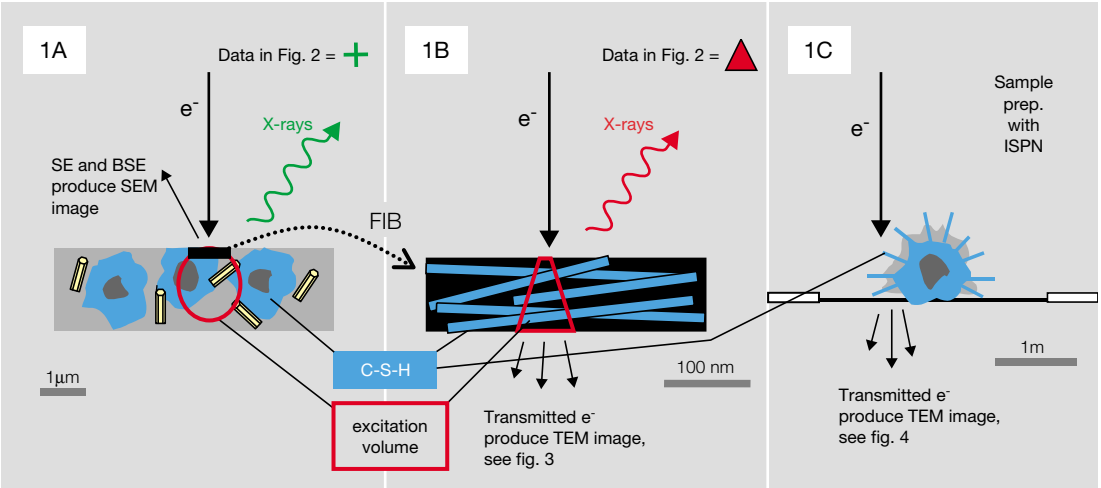

Fig. 1: *Schematic illustration of beam-sample interactions in SEM and TEM. 1A) In (E)SEM, the large interaction volume affects several matrix phases. This results in impure mix-analyses. 1B) The 100 nm thick TEM lamella contains numerous C-S-H fibers. Single C-S-H fibers can neither be resolved by TEM-imaging nor by EDX. 1C) With ISPN, µ-particles can be separated from the heterogeneous matrix. In this way, single C-S-H fibers and intrafibrous portlandite can be resolved in TEM.*

In the TEM, the lateral resolution for imaging and chemical analysis is strongly improved. However, TEM analysis requires electron transparent samples of about 100 nm thickness. Conventional TEM sample preparation methods are not site specific. The FIB offers new possibilities, as thin TEM lamellas can be cut with a high precision from a larger sample. Fig. 1B schematically illustrates that several layers of nanoscopic C-S-H fibers are contained within the lamellar cross-section. Because TEM images represent projections through the sample, single C-S-H "crystals" can hardly be resolved (Fig. 3). This is also the case for EDX-analysis because the excitation volume includes the entire cross-section. However, compared to EDX in (E)SEM, the excitation volume in TEM is reduced by a factor of 10^3, and thus a mixture of C-S-H with other matrix phases larger than 100 nm can be avoided. In the diagram Al/Ca vs. Si/Ca, the resulting EDX-analyses define a linear trend with a constant Al/Si-ratio (0.15) but with variable calcium-concentrations (Fig. 2, red triangles).

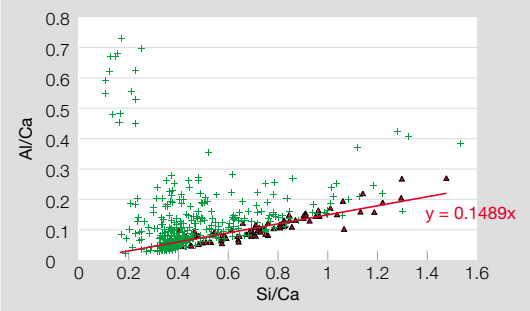

Fig. 2: *EDX spot analyses from hydrated portland cement (CEM I). Green crosses: In SEM, the scatter of EDX-data is attributed to the limited lateral resolution. Red triangles: In TEM, the analyses from C-S-H define a chemical trend with constant Al/Si-ratios.*

In order to resolve the intergrowth of different hydrate phases, we have developed a new method for "In-Situ Particle Separation with Nanomanipulators" (ISPN). This method is used to separate specific hydrated microparticles from the heterogeneous matrix. This allows us to investigate specific particles with different analytical techniques and without disturbing signals from the matrix which improves the analytical accuracy. Fig. 1C schematically shows a microparticle which was separated by ISPN from the heterogeneous cementitious matrix and transferred to a carbon coated TEM-grid. At the edge of the particle, single C-S-H fibers (20–50 nm) can be identified (Fig. 4). Between these fibers, a very thin intrafibrous phase is observed. Due to the combination of ISPN, FIB and TEM, the fibrous hydrate matrix can

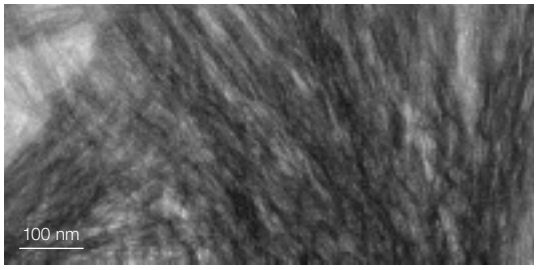

Fig. 3: *TEM brightfield imaging (FIB preparation) showing a dense intergrowth of fibrous C-S-H.*

now be identified as a nanoscale intergrowth of two phases. The phase mixture results in a chemical trend with constant Al/Si-ratios and variable calcium-concentrations. The C-S-H phase can be described as a silicate-hydrate phase with approximately 15% substitution of silica by aluminum. The extent of the incorporation of calcium into the C-S-H phase is generally overestimated because EDX spot analyses contain signal contributions from an intrafibrous phase. This phase is interpreted as portlandite ($Ca(OH)_2$), which precipitates from the saturated pore solution. The variable calcium contents can be explained by variable mix ratios in the EDX-spectra between C-S-H and intrafibrous portlandite.

The finding that considerable amounts of calcium may be trapped within intrafibrous $Ca(OH)_2$ instead of being part of the C-S-H phase questions current chemical and structural models. To improve our understanding of cementicious materials, a reevaluation of the chemical models for C-S-H is needed.

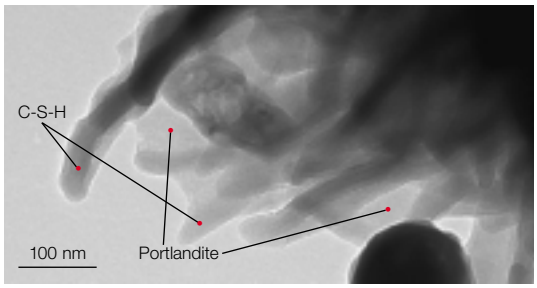

Fig. 4: *TEM brightfield imaging (ISPN preparation). Due to the gentle treatment by ISPN, intrafibrous nanoscopic portlandite can be revealed between the single C-S-H fibers (30–50 nm).*

Support: MBT (Schweiz) AG

Links: www.empa.ch/Bauchemie

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References:
F. Kreppelt et al., Cement and Concrete Research, 32, 187–198 (2002)
L. Holzer et al., GDCh, Bauchemie Bd.26, in press (2002)
L. Holzer et al., Int. Conf. ICCC 2003, Durban, South Africa, in press (2002)
R. Kaegi, L. Holzer, Atmospheric Environment, submitted (2002)

Cementitious high performance composites

The porosity of the cement matrix influences most of the properties of fiber reinforced composites. A new concept, based on microfine cement, to increase the packing density of cementitious materials was developed. The excellent rheological properties of the fresh pastes allow conventional mixing and casting at very low water/binder ratio. Very good mechanical properties and reduced shrinkage are obtained. The addition of fibers further enhances mechanical properties and reduces cracking risk. The densified paste leads to a good bond between fiber and matrix and a low porosity at their interface. High performance cementitious composites with very good mechanical and durability properties are obtained.

Josef Kaufmann,
Daniela Hesselbarth

In fiber reinforced cementitious composites, the porosity of the fiber-matrix interface is of crucial importance. High interfacial porosity leads to a poor bond between matrix and fiber and hence to a loss of strength. Additionally, high porosity may lead to connected pathways along the fibers, increasing permeability and therefore gas, water and ion transport, which may cause serious durability problems. The quality of a fiber-matrix interface can be improved either by a surface treatment of the fiber itself or by adjusting the matrix properties like rheology, shrinkage and porosity.

Porosity widely depends on the chemical composition of the raw materials, their hydration processes and the packing properties of the different components (sand, cement, filler). Packing density may be increased combining two or more components with different particle size distribution. New concrete mix designs like DSP (densified small particle) or RPC (reactive powder concrete) are based on this concept. They involve a dense granular matrix with high superplasticizer and microsilica content and additionally extremely hard aggregates (granite, calcined bauxite etc.). A further option is the reduction of porosity by polymer addition like in the MDF (macro defect free concrete) concept, where pastes with a very low water/binder ratio are impregnated with a polymer, placed by roller compactors (rubber industry) and finally thermally treated and slightly pressed. Apart from the excellent tensile properties of such MDF materials, the complicated forming process and the observed water susceptibility of the polymer are serious drawbacks of this technology.

The high performance concepts usually involve the addition of microsilica and hence the potential for shrinkage and durability problems. In the scope of an EMPA project, a new concept replacing microsilica by microfine cement and/or fine pozzolanic, latent hydraulic active or non-reactive materials was developed. Excellent results were obtained when microfine cement, mostly based on blast furnace slag, was added to ordinary Portland cement (Fig. 1). The application of superplasticizers allowed the preparation of cement slurries and mortars with very low water-binder-ratios (< 0.14) using conventional methods. Mechanical and rheological properties as well as length change of these binder systems were studied.

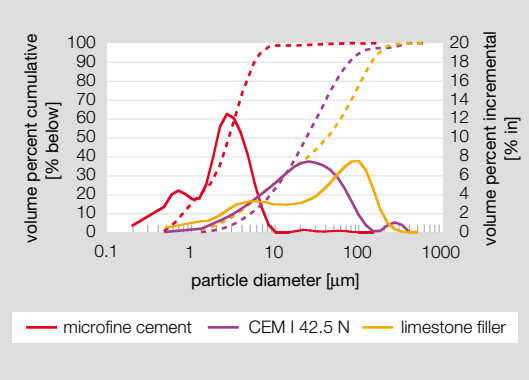

Fig. 1: *Particle size distribution of raw materials.*

As a consequence of the dense packing, the rheological properties of the fresh pastes are influenced positively (Fig. 2), leading to a much improved workability. The strong decrease of the porosity improves the mechanical properties (Fig. 3). For instance, cementitious materials with flexural strength higher than 20 MPa and compressive strength higher than 150 MPa applying conventional mixing and casting techniques are possible.

Shrinkage is reduced significantly compared to pastes containing pure Portland cement. Curing conditions were optimized to prevent early cracking, which is often a problem of dense and brittle material.

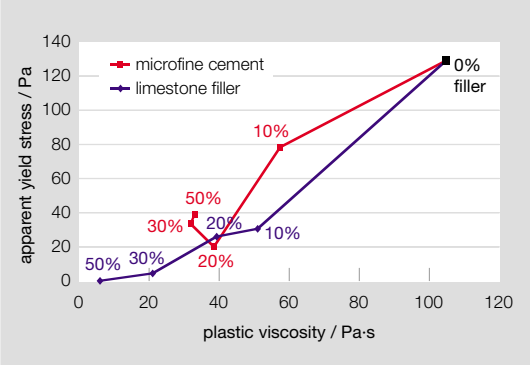

Fig. 2: *Rheological properties of cement slurries containing different amount and type of filler.*

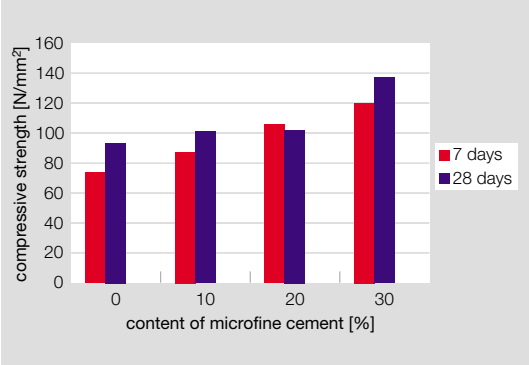

Fig. 3: *Influence of the addition of ultrafine cement on compressive strength of hardened cement pastes at an age of 7 and 28 days (curing under water).*

The addition of high performance fibers increases ductility, and further enhances strength properties. The reinforcement with fibers may also reduce cracking risk. The developed binder system provides ideal material characteristics for an application in high performance composites owing to the good bond properties between matrix and fiber. High strength, ductile and easily castable cementitious materials result (Fig. 4).

A first practical application of such materials is the replacement of conventional reinforced concrete in centrifugated tubes. Various fiber types and fiber geometries are studied currently for this application.

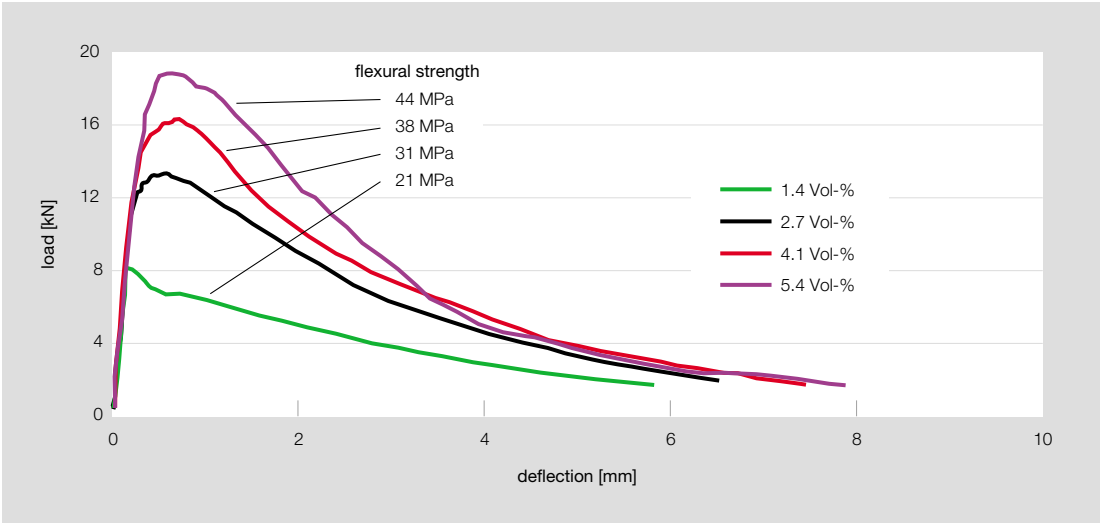

Fig. 4: *Flexural strength (3 point bending) of metal fiber composites in function of fiber content.*

Support: BBT-KTI 4600.2, SACAC AG

Links: www.empa.ch/abt135
> High performance materials

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References:
J. Kaufmann, F. Winnefeld, Int. Conf. ICCC Challenges of Concrete Construction, Dundee, Scotland, Conf.Proceed. 827–836 (2002)
J. Kaufmann, Th. Matschei, D. Hesselbarth, Int. Conference ICCC 2003, Durban, South Africa, in print (2002)

Assessment of the condition of bridges with Ground-Penetrating-Radar (GPR)

The inspection of bridge decks is a routine application of the GPR method today. Pavement thickness, concrete cover of re-bar, concrete damage and the position of tendons are some of the issues that are addressed with GPR. However in most cases, a verification of radar results is either not possible, restricted to laboratory specimens or to a few points on real objects. In order to define the accuracy and validity of radar results under realistic conditions, a research project is currently carried out. Bridges designated for demolition are inspected with EMPA's mobile GPR unit. Radar results are reported before the bridge is demolished. After the demolition, radar results are verified through a comparison with actual bridge parts.

Johannes Hugenschmidt

The ongoing research project "Assessment of the condition of bridges with GPR" started in 2001 and is sponsored by ASTRA, the Swiss Federal Roads Authority. This project aims at providing information concerning the accuracy and validity of radar results on concrete bridges. In order to achieve this goal, bridges designated for demolition are inspected with EMPA's mobile GPR unit (Fig. 1), and results are reported before the bridge is demolished. The verification of radar results is carried out after the demolition through a detailed comparison with actual bridge parts. It is planned to include six bridges in the project.

Work on the first bridge was completed in spring 2002. The structure was 53 meters long and crossed the Swiss Motorway A3 in Altendorf in the canton of Schwyz. It was called Ueberfuehrung Burggasse (Fig. 2) and had been built in 1970 from prefabricated elements that were joined on-site. This type of bridge is rather common in Switzerland. During the demolition, the bridge was sawed along and near the lines where it had been joined during the construction.

Fig. 1: *EMPA's mobile GPR unit.*

Fig. 2: *Ueberfuehrung Burggasse before demolition.*

Radar data were acquired with EMPA's mobile GPR system following the lines along which the bridge was sawed afterwards during the demolition. Radar data were processed and later interpreted with the help of three boreholes for calibration. This interpretation during which reflections within the radar data are related to physical structures such as the interface between pavement and concrete proved to be difficult. Complex reflection patterns caused by the fact that data were acquired along or near the joints, made the identification of relevant reflections difficult.

Before demolition of the concrete structure, the pavement was removed with a milling machine. During this process, pavement thickness was measured every meter along the lines where the radar inspection had taken place. After the demolition of the concrete structure, bridge parts were taken to a landfill, and the concrete cover of the top layer of re-bar was measured with a rule in distances of one meter.

A comparison between radar results and reality is shown in Fig. 3, top. The horizontal axis represents the length of the bridge. Radar results for the concrete cover of re-bar and the pavement thickness are plotted with solid blue and red lines. In some areas, no radar result was obtained due to the difficulties during the interpretation described above. Reality is shown with solid black dots. The absolute differences between radar results and reality are shown in the bottom of Fig. 3. The mean difference is 5 millimeters for the re-bar and 6 millimeters for the pavement. This is acceptable for most practical applications.

As described above, the interpretation of radar data was rather difficult. However, this bridge is still considered an important object for the project as it is expected to represent a worst case scenario as far as the complexity of the radar data is concerned.

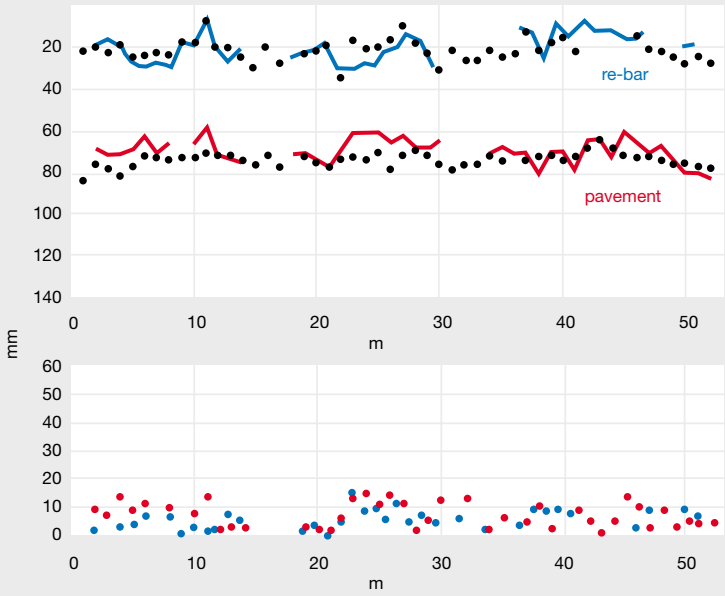

Fig. 3: *Comparison between radar results and reality (top) and absolute differences (bottom) for pavement thickness (red) and concrete (blue).*

Support: ASTRA

Links: www.empa.ch/abt113
> gpr-research

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References:
J. Hugenschmidt, 9th Int. Conf. on Ground Penetrating Radar, Conf.Proceed. 427–432 (2002)
J. Hugenschmidt, Construction and Building Materials, vol/nr 16/3, 147–154 (2002)

Cable vibration mitigation using controlled magnetorheological fluid dampers

The performance of controllable magnetorheological fluid dampers for mitigation of cable vibrations is investigated. The model-based designed LQG controller (linear regulator, quadratic cost function, Gaussian noise control algorithm) includes an inverse damper model for the compensation of the main nonlinearity of the system damper-cable. The experimental results obtained with the commercially available magnetorheological fluid damper RD-1005-3 show that the magnitude of the residual friction as well as the response time of this fluid damper have a strong impact on the vibration mitigation performance. A simulation tool was developed which allows model-based controller design and determining the optimal damper parameters for a given cable.

Felix Weber,
Glauco Feltrin

Steel cables of cable-stayed bridges are susceptible to vibrations with large amplitudes due to their inherent low damping characteristics. These vibrations may lower the lifetime of cables and anchorages. Attaching passive dampers to the cables may fail to provide satisfactory vibration mitigation because stay-cables generally vibrate with many modes in different intensities over time. Semi-active dampers offer the possibility of adjusting their damping force to the actual vibration state. Consequently, semi-active dampers are expected to exhibit a higher vibration mitigation performance than passive ones.

The goal of the project "controlled damping applying rheological materials" is to theoretically and experimentally investigate the potential of controllable magnetorheological fluid dampers (MR damper) for cable vibration mitigation. As a first step, the commercially available MR damper RD-1005-3 of LORD Corporation was chosen for this investigation (Fig. 1 left). Its damping force can be controlled by the coil current that induces a magnetic field in the MR fluid. As a result, the magnetizable particles in the fluid form chains which increase the shear resistance of the fluid. The working range of this damper is given by the residual friction at zero current level and by the maximum shear resistance at maximum current (Fig. 1 right).

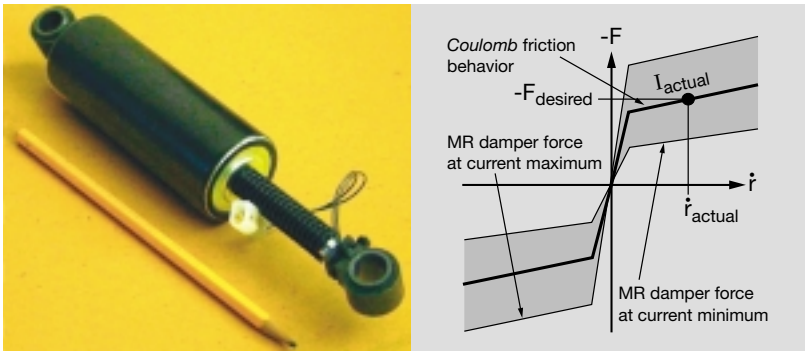

Fig. 1: *Left: MR damper RD-1005-3 (LORD). Right: Schematic damper map.*

A test set-up was built to experimentally investigate the system damper-cable with different controller strategies. The cable is 15.50 m long and was tensioned with approx. 103 kN (Fig. 2). Additional weights attached to the cable shift the eigenfrequencies to lower frequencies in order to simulate a heavier and longer cable. The damper is located after 5% of the cable length, since – on a real bridge – a damping device can only be positioned near the anchorage. The cable is excited by an electrodynamical shaker driven by a broad band stochastic process. The state of cable vibration is measured with accelerometers distributed along the cable so that the first ten modes are detected.

The control idea is to adjust the actual damping force to the actual vibration state. The state variables are the nodal displacements and velocities of the cable model. Since not all of them are measurable, an observer (linear cable model, Fig. 3) estimates those state variables. The desired damping force is the weighted state feedback (regulator) which minimizes the magnitudes of the nodal velocities. An enclosing PI (proportional, integration feedback) controller is not necessary because the cable tension forces the cable automatically into the desired displacement equilibrium point. The main nonlinearity of the closed-loop system is given by the relation between damper force and coil current. An inverse damper model compensates this nonlinearity. The optimal design parameters of the LQG controller were determined by simulation and tuned at the test set-up.

The mean value of the power spectral density of the measured node velocities (Mean-PSD) was defined as the criterion for the controller performance. Attaching the passive MR damper (0 ampere) to the cable reduced the magnitudes of the first two modes approx. 50% and 30%. The additional reduction using the controlled MR damper is shown in Fig. 4:

- The achieved vibration mitigation of the first two modes is approx. 30%. The reason for this moderate improvement is that the desired damping force was restricted by the residual friction of the MR damper RD-1005-3, i.e., the desired damping force could not always be realized.

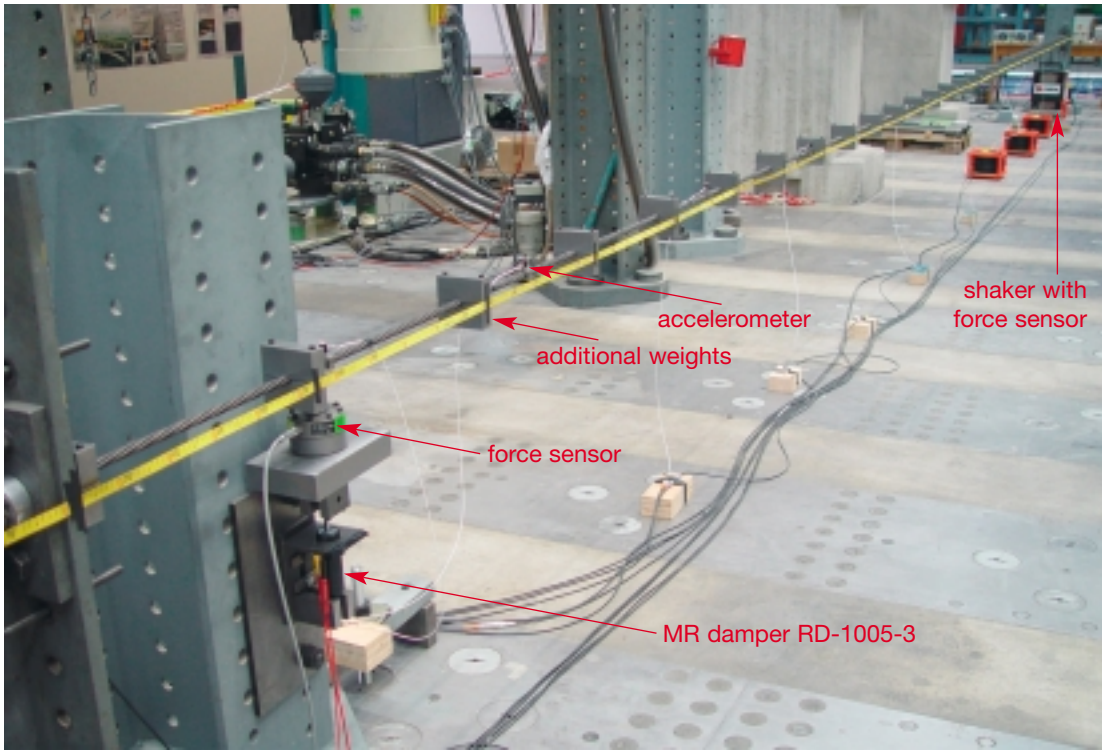

Fig. 2: *Test set-up at the Structural Engineering Research Laboratory.*

- Higher modes are amplified due to the response time of the MR damper RD-1005-3 of approx. 14 ms, which ends up in an undesired actual damping force. Assuming the frequency of adjusting the actual damping force must be at least five times higher than the frequency of the mode to be damped, the frequency limit of damping is approx. 10 Hz.

To sum up, the achieved damping improvement was limited by the operational range and the response time of the MR damper RD-1005-3. Therefore, the simulation tool developed for model-based controller design was used to specify a magnetorheological fluid damper with optimal properties with regard to the test set-up. In collaboration with an industrial partner, a new damper, which fits these properties, will be manufactured and tested in the near future.

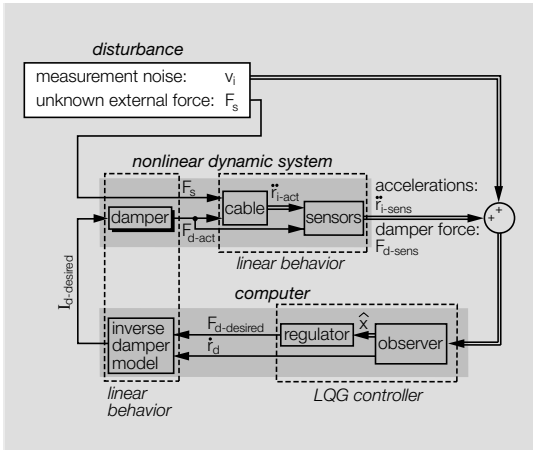

Fig. 3: *Closed-loop system.*

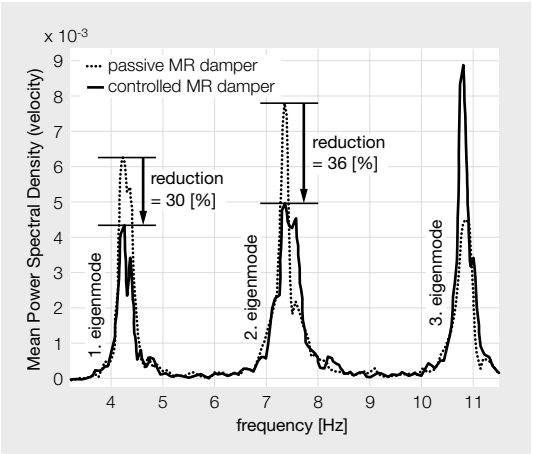

Fig. 4: *Measured vibration magnitudes of the cable with MR damper in passive (0 ampere) mode and LQG controlled.*

Links: www.empa.ch/smartstr

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References:
F. Weber, 5th Symp. on Bauwerksdynamik und Erschütterungsmessungen, EMPA, Duebendorf, Vol. 1, 1–15 (2002)
F. Weber et al., Internat. Conf. on Footbridge, Vol. 1, 1–13, AFGC-OTUA (eds.), Paris (2002)

Shear strengthening of reinforced concrete with CFRP L-shaped plates

A systematic large scale test program confirmed the feasibility of CFRP (Carbon Fiber Reinforced Plastic) L-shaped plates for shear strengthening of reinforced concrete T-beams. The interaction between CFRP L-shaped plates and reinforced concrete was studied in detail. As an important basis for the planning of retrofitting projects, a design proposal was presented.

Christoph Czaderski, in collaboration with Sika AG (CH)

Post-strengthening of reinforced concrete structures like bridges or buildings with CFRP plates, in contrast to steel plates, have the advantage of being substantially lighter. The handling on site is therefore much easier. The CFRP plates are also corrosion-resistant and exhibit excellent fatigue strength.

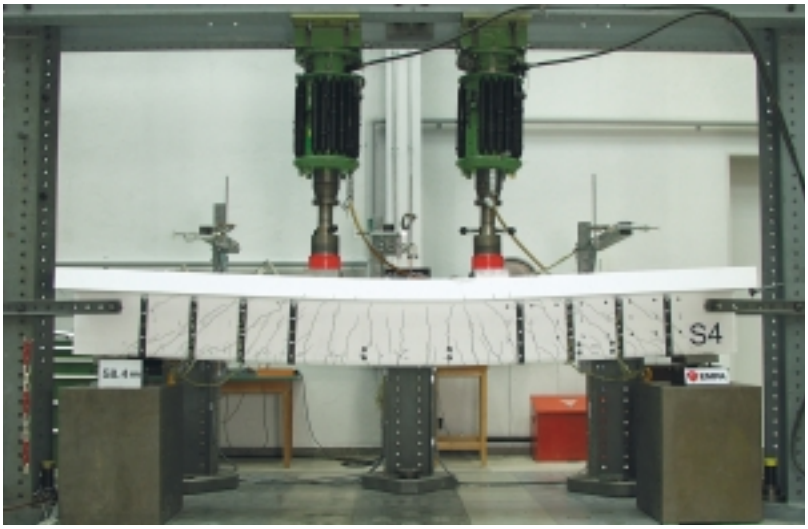

Fig. 1: *Shear strengthened test beam.*

Prefabricated "CFRP L-shaped plates" (Sika® CarboShear L®) can be used to shear strengthen reinforced concrete T-beams. In a previous test series, EMPA was able to demonstrate the feasibility of these CFRP L-shaped plates for shear strengthening. To obtain a better understanding of the load-bearing behavior of this strengthening system, a further systematic test program was performed in partnership with a Swiss industrial company (Sika AG, Zurich). A test beam specially designed for high shear stresses was tested with different arrangements of the shear reinforcement (Fig. 1). Consequently, the influence of the CFRP L-shaped plates on the shear resistance of the test beams could be shown (Fig. 2). The results were used to improve the design concept for the shear strengthening of reinforced concrete structures using CFRP L-shaped plates.

From the investigation, the following conclusions can be drawn: through the use of the CFRP L-shaped plates, the brittle failure mode "shear failure" of the beam can be changed to a ductile behavior with yielding of the internal flexural reinforcement (Fig. 2). The CFRP L-shaped plates can increase the shear failure load so that a structure can bear higher live loads. The CFRP L-shaped plates can also be used to obtain better behavior in the serviceability limit state with a reduction of the shear deformations of the beam, the strains in the internal steel stirrups and the crack width. Furthermore, important for the design, the concrete, the internal steel stirrups and the externally applied CFRP L-shaped plates act together to bear the shear load.

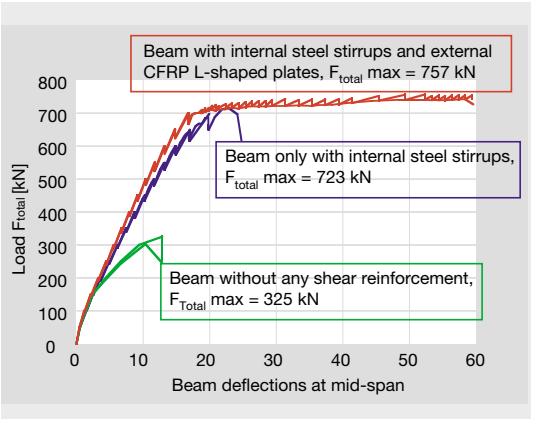

Fig. 2: *Comparison of loading tests on beams with different shear reinforcements.*

The proposed simple design concept describes the load-strain behavior of the shear reinforcement and the possible failure modes of the CFRP L-shaped plates. Design verifications were presented for ultimate limit state, serviceability limit state and accidental situation.

In order to evaluate the mechanical behavior of the strengthening system, it is intended to carry out appropriate numerical analysis.

Support: BBT-KTI 3930.1

Links: www.empa.ch/retrofitting
www.sika.ch

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References:
C. Czaderski, IABSE Symposium, Melbourne, Conf. Proceed., ISBN 3-85748-107-2 (2002)
C. Czaderski, First fib Congress, Osaka, Conf. Proceed. (2002)

Improvement of the reliability of ceramic hip joint implants

Bernhard Weisse,
Marcel Zahner,
in collaboration with
Metoxit AG (CH)

The total replacement of femoral hip joints by artificial joints has been successfully practised for many years. Such a system has to provide safety and reliability, good biocompatibility and low wear by friction. Although the probability of a failure due to material flaws in the ceramic implant is presently very low, its rate should be decreased further.

The only way to eliminate balls with invisible defects from the production line is the *proof test procedure,* a "non-destructive" test method. Thereby on every ceramic ball, a static load is applied which is higher than the maximum physiological load. The load is a superposition of water pressure (p) transferred via a plastic spigot substitute on the interior wall of the ball and an axial force applied on the punch (F). The reason to use a plastic spigot instead of a metallic one is the possibility to remove it easily after the test without damaging the ball. The magnitude of the load should not damage the ball.

The aim of the study was to optimize the proof test configuration which was developed by *Saphirwerk Industrieprodukte AG* and *Metoxit AG* in order to obtain a stress distribution which better simulates the in vivo case. The optimization consists of varying the water pressure application region on the interior wall of the ball.

The reference load case for the optimization of the proof test configuration is the "static test against a 100° cone" (*ISO 7206-5* standard), assumed here to generate a stress distribution equal to in vivo circumstances. To determine the stress distribution, a non-linear finite element (FE) analysis was performed; results were validated by measurements (Fig. 1).

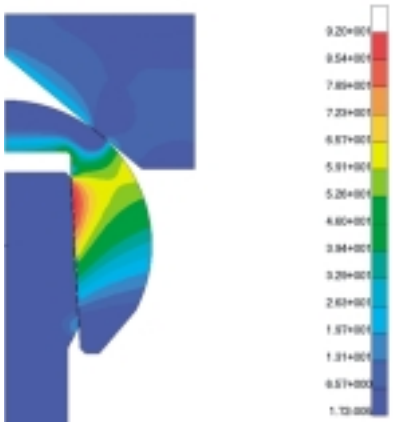

Fig. 1: *Stress distribution in the axisymmetric FE model for the load case "static test against a 100° cone".*

With an iterative approach based on finite element calculations, the pressure application region was adjusted in such a way that the stress distribution in the ball is similar to the stress distribution for the reference load case. Fig. 2 shows the stress distribution in the ball for the initial and the optimized proof test configuration. It is obvious that the latter corresponds better to the stress distribution of the reference load case.

Five arbitrarily picked balls were proof tested, thereafter a fatigue test was performed according to *ISO 7206-6* standard and the *US Food and Drug Administration* requirements. All specimens survived without rupture, which this confirms that the proof test does not damage the specimens.

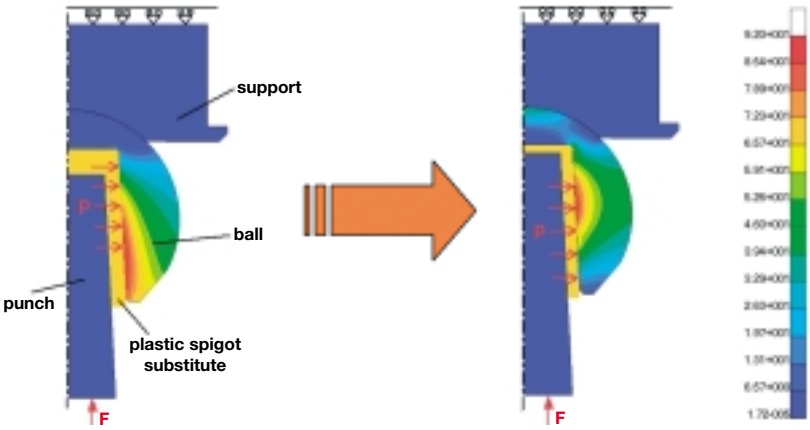

Fig. 2: *Stress distribution in the axisymmetric FE model for the initial (left) and for the optimized (right) proof test configuration.*

Although the proof test procedure is still a non-standardized test method, the procedure already has a high potential for improving the reliability of the ceramic balls used for artificial hip joints.

To further optimize the proof test procedure, the real physiological load case of a hip joint should be considered as reference load case. In the physiological load case, an asymmetric force is applied on the ball. This makes the problem three dimensional, therefore, a three dimensional FE model of the hip joint implant should be considered.

Support: BBT-KTI 4838.1 MTS

Links: www.empa.ch/abt121
> Numerical simulation

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References:
B. Weisse et al., J. of Biomechanics, submitted (2002)

A new way of modeling naturally ventilated buildings

To meet the requirements of the Kyoto protocol, more sustainable building concepts with low energy use have to be applied. Therefore, natural or hybrid ventilation systems are used in order to save electric fan power. Dimensioning of such systems is demanding because of the mutual dependence of the airflow rates and the room temperatures. Moreover, other parameters like building geometry and wind pressures influence the airflow. With the integration of a multizone airflow model into a thermal building simulation program, a new way of modeling naturally ventilated buildings has been established. To combine the two models, a numerical solver was developed, based on successive substitution enhanced with an adaptive relaxation factor.

Andreas Weber,
Markus Koschenz,
Viktor Dorer

The air flows in a building can be calculated with a multizone air flow model. Such a model idealizes the building as a network of nodes and air flow links between them (Fig. 1). The nodes represent the rooms and the building surrounding. The links depict openings, doors, cracks, window joints and shafts as well as ventilation components like air inlets, outlets, ducts and fans. The wind pressures on the facade and the indoor and outdoor air temperatures are the important boundary conditions. On the other hand, the room temperatures can be calculated with a dynamic thermal building model. The construction and the materials of the building envelope determine the character of the thermal behavior (Fig. 1). In this case, the thermal loads e.g. from persons or office equipment and the air flows in the building, are the boundary conditions. If the room temperatures and/or the air flows in a building are not controlled, a combined thermal air flow building model is necessary to take into account this mutual dependence of the air flows and air temperatures.

Meeting summer comfort criteria is one of the crucial elements in sustainable buildings. Rising internal heat loads especially in office buildings increase the cooling demand. Passive cooling by night time ventilation is a promising possibility to dissipate heat without a high energy demand. With a natural or a hybrid ventilation system, electric fan energy use can be minimized by utilizing air temperature differences and wind pressures. The mutual dependence of the airflow rates and the room air temperatures makes the design and dimensioning of such a system difficult. The size and the distribution of the ventilation openings and the size of the ventilation ducts are the design parameters of the system.

In this project, the multizone air flow model COMIS (Conjunction of Multizone Infiltration Specialists) has been fully integrated into the thermal building module of TRNSYS (TRaNsient building and SYStem simulation). COMIS has been developed in an international collaboration in the frame of the IEA Annex

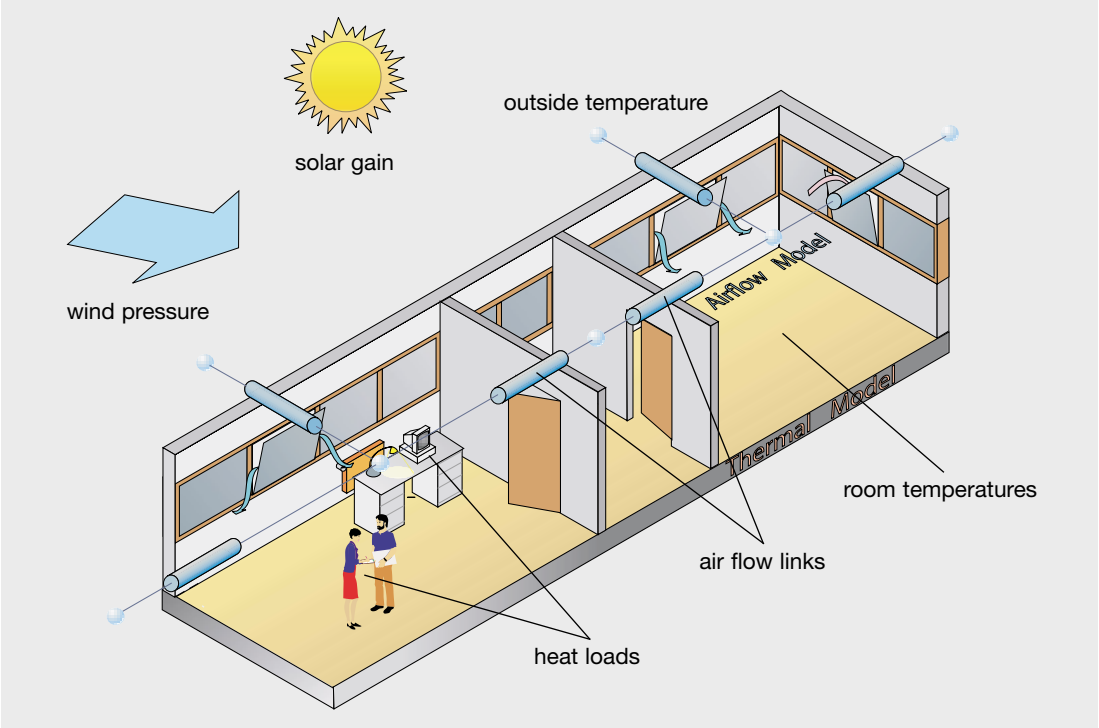

Fig. 1: *Thermal and airflow model of a naturally ventilated office building.*

23 and further improved under the lead of EMPA. TRNSYS is an internationally used thermal building and system simulation program where EMPA is one of the four main developers.

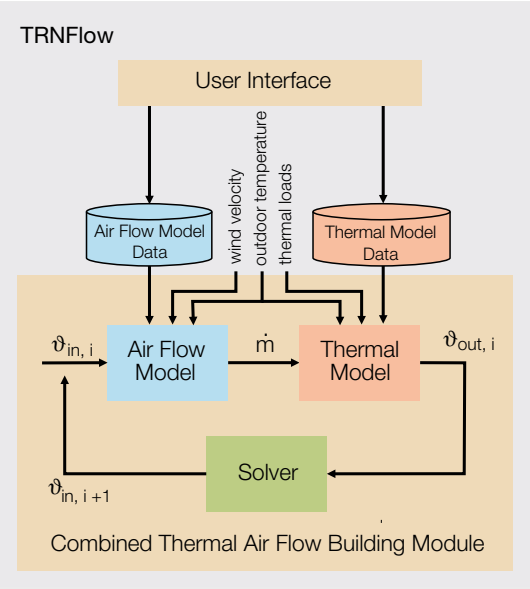

Fig. 2: *Information flow of the combined thermal air flow building module and the user interface for building data input.*

The two models COMIS and TRNSYS are linked as black boxes. For simplification, in Fig. 2 the information flow between the models is represented by one room air temperature node and one air flow variable. In fact, there are as many air temperature nodes as there are rooms in the building, and each room has at least one air flow. All these different parallel information flows influence each other. In the solution process, the air flow model starts with the input room temperatures $\vartheta_{in,1}$ and calculates the corresponding air flows $\dot{m}$ of each room. These flows are used in the thermal model, which calculates the output room temperatures $\vartheta_{out,1}$. With an iterative solver algorithm the input temperatures set is found which matches the output temperatures set. Using the successive substitution method, the output temperatures from one iteration step $\vartheta_{out,i}$ are used as input for the next step $\vartheta_{in,i+1}$. The disadvantage of this method is that it converges only if the derivatives of the functions $\vartheta_{out,i} = f(\vartheta_{in,i})$ (blue line in Fig. 3) at the solution point are in the range $-1 < d\vartheta_{out,i}/d\vartheta_{in,i} < 1$. But depending on the boundary conditions, the solution might be in a region where the derivatives are outside this range. In such a case, the successive substitution method diverges (green line in Fig. 3). To ensure convergence in each time step, it is necessary to introduce a relaxation factor ζ which reduces the alteration to the input temperatures. As the red line in Fig. 3 shows, the iteration will converge to the solution. Unfortunately, a fixed relaxation factor makes the iteration process slow in time steps where a relaxation is not necessary. Therefore, the optimum relaxation factor for each time step has to be found within the iteration. A newly developed solver algorithm adapts the relaxation factor individually for each temperature depending on the evolution of the solving process. With an oscillating evolution, the respective relaxation factor will be decreased in the next iteration step, and it will be increased if the evolution converges steadily.

The final product of the project is called TRNFlow. It consists of the building module with the combined thermal and airflow models and the user interface (Fig. 2), which can be used to input data for the two models.

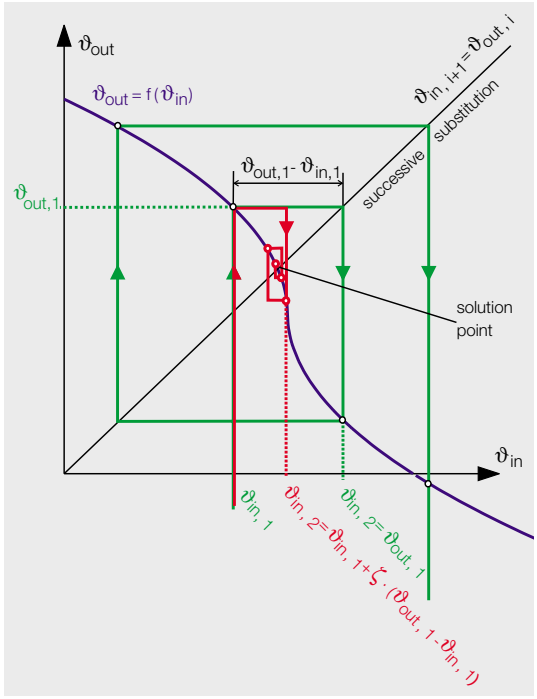

Fig. 3: *Evolution of the iterative process using the successive substitution solver method with and without a relaxation factor.*

Support: TRANSSOLAR, D-Stuttgart

Links: www.empa.ch/abt175
> Simulation

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References:
A. Haas et al., Energy and Buildings, Vol. 34, 873–882 (2002)
A. Weber et al., 3rd Europ. Conf. on Energy Performance & Indoor Climate in Buildings, Conf. Proceed., 801 (2002)

Predicting air flows inside and around buildings

Thermal comfort, personal health and safety, and efficient energy use are often closely related to the airflows inside and around buildings. As a result, computational fluid dynamics (CFD), a numerical method of predicting fluid flows, has established itself as a key technique in building physics at EMPA in a number of projects. Prior validation of the models against measured data was made.

Heinrich Manz,
Thomas Frank

Building physics deals with many aspects that are important for the people using a building and for efficient energy use. Examples include smoke movement in the event of a fire, the thermal comfort of people in rooms, the quality of the fresh air supply from natural, hybrid or mechanical ventilation, the indoor or outdoor spread of contaminants, and temperature distribution and energy flows in façades or roofs. What do all these topics have in common? Flow phenoma are important to all of them, very often in combination with heat transfer and sometimes also with contaminant transport.

Conservation of mass, momentum and energy is the basic principle for deriving a system of partial differential equations (PDEs) that governs a flow field. The term CFD generally applies to the numerical solution of these PDEs, to such an extent that the velocities, temperatures, etc. in all cells in the solution domain are predicted. In building physics, the equation solved is usually a Reynolds-averaged Navier-Stokes equation, which predicts average velocities, temperatures etc. for turbulent flows. Infrared radiation and heat conduction in solids have to be taken into account in many problems. Numerical results have to be validated by experimental data whenever possible, which the authors have already made in a number of cases (see references), in order to improve modeling techniques.

For example, an experimental investigation of a hotel bedroom fire was performed at the National Institute of Standards and Technology NIST (Lee, 1985) in the US and was used to validate a modeling approach (Fig.1). Measured initial and boundary conditions, such as ambient temperatures and heat release rate, were employed to simulate temperature stratification in the room and mass flow rate out of it

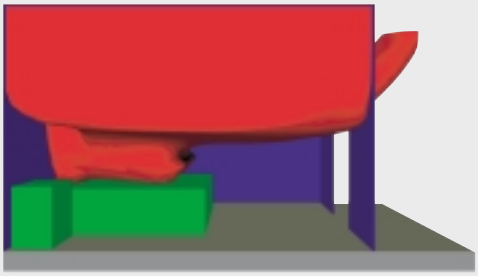

Fig. 1: *Spread of smoke in a hotel bedroom: Isosurface of 15,000 ppm carbon dioxide 150 s after ignition.*

as a function of time. A close correlation with measured data until flash-over time was obtained (Fig. 2). Such models can be used to study the spread of smoke in buildings and offer, therefore, considerable benefits for building planning.

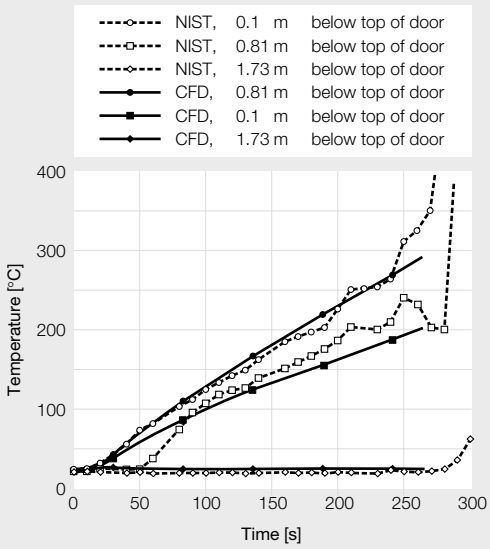

Fig. 2: *Measured and calculated temperature stratification in doorway centerline.*

Support: BFE

Links: www.empa.ch/abt176
> Numerik

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References:
H. Manz et al., Roomvent 2002, Proceed. 8th Int. Conf. on Air Distribution in Rooms, Copenhagen, Denmark, 65–68 (2002)
H. Manz, Energy and Buildings, in press (2002)
H. Manz, H. Simmler, Proceed. of 2nd Int. Building Physics Conf., Leuven, Belgium, accepted (2002)

Thermal transmittance of highly perforated porous clay bricks. Measurements versus numerical analysis

Karim Ghazi Wakili, Christoph Tanner

The brick producing industry in Europe experiences a strong competition within itself as well as with other masonry producers. The recently published European standard EN 1745, which is one of the main documents to qualify the thermal properties of all masonry type products, needs a refinement with respect to highly perforated porous clay bricks. This will ensure the consistency of measured and calculated results for this type of masonry products.

As the demands on reducing the energy consumption of buildings became tighter even for residential buildings all over Europe, the manufacturers of perforated clay bricks are trying to adapt their products to the new regulations by optimizing procedures. This has been done in two ways. First, by reducing the thickness of the perforations (air gaps) in the direction of the heat flow and hence increasing their number within fixed brick dimensions. Second, by inducing air pores into the clay material reducing its thermal conductivity.

A wall made of highly perforated porous clay bricks has been investigated by means of experimental and numerical methods according to ISO EN 8990 and EN 1745 respectively.

To provide the numerical analysis with thermal conductivity values, samples of mortar, rendering and porous clay were measured in a heat flow meter apparatus. The size of the porous clay samples (2–3 mm thickness) prevents measurements according to standardized methods and makes the EN 1745 inapplicable to masonry made of perforated clay bricks.

The results of the numerical calculations were more advantageous than the measured values. This is not in accordance with the general policy of the European standards, which require rather safety for calculated values than competition with measured ones. One possible correction of the numerical model proposed by the authors besides the inclusion of the vertical joints into the model is to take into account the mortar penetrating into the voids of the bricks. Evidence for this is given by breaking out one brick from one side of the investigated masonry wall (Fig. 1).

By such a refinement of the numerical model, the calculation method delivers values which are 3 to 5 percent higher than the measured ones (Tab. 1).

Complete wall (bricks + mortar + rendering)	measured	calculated	refined & calculated
U_{wall} [W/m^{2}K]	0.304 ± 0.010	0.291 ± 0.007	0.317 ± 0.007

Tab. 1: *Comparing measured and calculated results of the U-value.*

To sum up, it can be stated that special attention is needed regarding the nonsymmetrical shaped vertical joints without mortar, the influence of anisotropy of porous clay on the final U-value and the amount of mortar intrusion into the perforations.

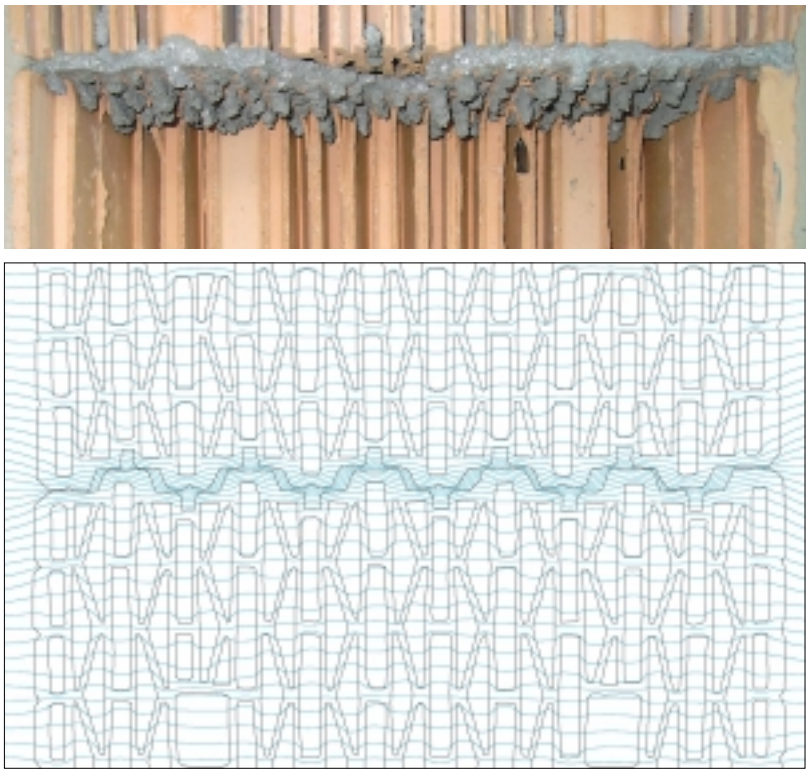

Fig. 1: *Penetration of mortar into the voids of the brick, made visible by breaking out a brick from the wall and by the calculated heat flux lines from a 2-dimensional thermal analysis.*

Support: Ziegelwerk Ott Deisendorf GmbH

Links: www.empa.ch/abt176
> Numerik

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References:
K. Ghazi Wakili et al., Energy and Buildings, in press (2002)

Failure in prestressed tendons

In many civil engineering objects prestressed tendons and anchors are used, e.g. for wide-spanning girders or to retain rock slopes. Failure of these can lead to severe damage of structures. Therefore, a feasible method for an assessment of the causes and importance of flaws is necessary to guarantee the safety of the buildings concerned [1].

Rolf Kieselbach,
Jarmila Woodtli

In modern civil engineering, high strength steel is used mainly for two applications, namely prestressing of concrete shells and slabs and for rock or soil anchors (Fig. 1). In both applications reliability is very important as numerous failure cases have shown. The risk has increased since steel with an ultimate strength of 2000 MPa and more, which is much more susceptible to cracking, has come on the market. This has led to accidents like collapses of buildings because of rupture of pretensioning strands caused mainly by stress corrosion cracking and fracture of anchors.

Fig. 1: *Example for application of anchors (retaining of rock face above tunnel) and pretensioning tendons (inside bridge deck).*

With metallography and scanning electron microscope we can determine the mechanism of crack formation and the size and shape of flaws in the material which could lead to fracture. Typical causes for cracking are stress corrosion cracking and hydrogen induced stress corrosion cracking which can easily be identified by specialists by their fracture.

The influence of a crack on the risk of brittle fracture can be assessed by fracture mechanics. Fracture mechanics combine flaw size and stress to stress intensity in the component which is compared to the fracture toughness of the material used. Contrary to other cases, the applied stress is normally well known since mostly the stress limit set down by civil engineering standards is used.

The flaw size after manufacture or caused by damaging processes can be estimated. As a consequence, the assessment of the resistance against brittle fracture can be carried out. As an example for an assessment of cracks, three different failure cases of anchors and prestressing tendons were evaluated using British Standard 7910 [2] as a modern method of fracture mechanics. Fig. 2 shows that the assessment points of the three cases correspond to the limiting curves although only approximate values for toughness were used.

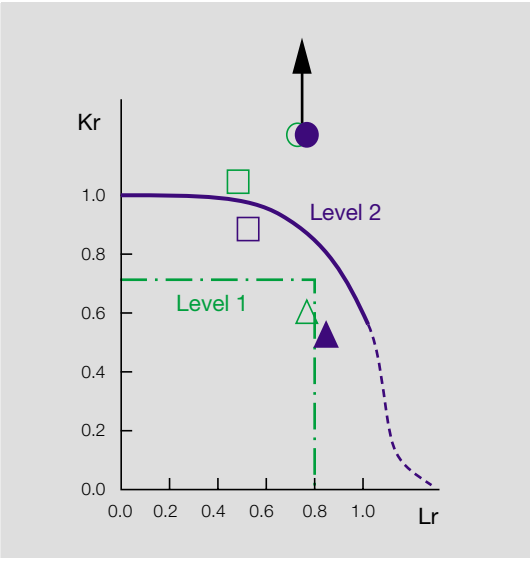

Fig. 2: *Failure assessment with fracture mechanics (Kr and Lr denote brittle and plastic failure respectively).*

As a conclusion one can say that the procedure of the BS 7910 is also suitable for safety assessment of pretensioning steels and anchors even if only approximate values for fracture toughness under stress corrosion influence are available.

[1] U. Morf: Fracture Toughness Testing Procedures for Steel and Wire Bars. EMPA-Report No. 216, Dübendorf (1988)
[2] Guide on methods for assessing the acceptability of flaws. British Standard BS 7910:1999

Links: www.empa.ch/abt121
> Failure analysis

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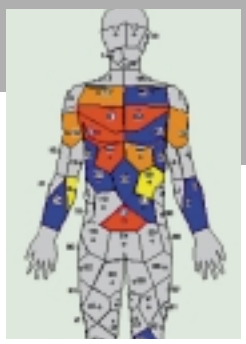
References:
J. Woodtli et al., 14th Europ. Congress on Fracture, Proceed., Cracow, Poland (2002)

List of abbreviations

ASTRA	Swiss Federal Roads Authority
BAG	Swiss Federal Office of Public Health
BAM	German Federal Institute for Materials Research and Testing
BBL	Swiss Federal Office for Constructions and Logistics
BBT-KTI	Swiss Federal Office for Business Formation and Technology – Commission for Technology and Innovation
BBW	Swiss Federal Office for Education and Science
BFE	Swiss Federal Office for Energy
bfu	Swiss Federal Office for Accident Prevention
BLW	Swiss Federal Office for Agriculture
BUWAL	Swiss Agency for the Environment, Forest and Landscape
BVet	Swiss Federal Veterinary Office
CERN	European Organization for Nuclear Research
CWRU	Case Western Reserve University
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EPF(L)	Swiss Federal Institute of Technology Lausanne
ESA	European Space Agency
ETH(Z)	Swiss Federal Institute of Technology Zürich
EU Program IV	European Community, 4th Framework Program
EU Program V	European Community, 5th Framework Program
FAL/FAT	Swiss Agriculture Research Institutes
FKH	Expert Commission for High Voltage Issues
GR	Swiss Defence Procurement Agency
Holz-21	Swiss Federal Stimulation Program for the Wood
IBT	Institute of Biomedical Engineering
ifra	International Newspaper Color Association
ifu	German Institute for Environmental Informatics
IKB	Institute for Nuclear Physics
IPMS	Institute for Problems of Materials Strength
ISAC-CNR	Institute of Atmospheric Sciences and Climate – National Research Council of Italy
IZT	Institute for Future Studies and Technology Assessment
PSEL	Project and Study Fund of the Electricity Industry
PSI	Paul Scherrer Institute
seco	Swiss State Secretariat for Economic Affairs
SLS	Swiss Synchrotron Light Source
SNF-NFP	Swiss National Science Foundation – National Research Progam
SUVA	Swiss National Accident Insurance Organization
TA Swiss	Swiss Center for Technology Assessment
Top Nano 21	Research Program of ETH Council
TTM	Technik Thermische Maschinen
UAS	University of Applied Sciences
UGRA	Swiss Association for the Promotion of Research in the Graphic Arts Industry
UNIZ	University of Zürich
USAID	United States Agency for International Development

EMPA Activities 2002

Materials and Systems for Protection and Wellbeing of the Human Body



Best possible materials and innovative solutions are being developed which guarantee the functionality and wellbeing of the body. For many protective systems, sufficient personal protection can only be achieved by reducing comfort and thereby the performance as well. The constant improvement of materials and systems helps to enlarge their field of use. Development and design are also of vital importance for biocompatible materials. Materials which stimulate the growth of tissue cells assist in the recovery of diseased or insured tissue and also help to improve the tolerance to implantations.

EMPA

Development of neuro-implants using primary neuronal cultures

Arie Bruinink,
Thomas Osterwalder,
Pius Manser,
Ursina Tobler,
Xenia Maeder

Neuroimplants need to fulfill numerous criteria. Besides supporting or replacing certain nerve functions, these implants need to be highly biocompatible. Furthermore, they should be able to steer functions of nervous cells contacting the implant. The current system was built up to verify neurobiocompatibility and to elucidate which surface properties optimally support nervous cell performance.

A relatively new branch in biomedical engineering is the development of devices that are able to replace or support the functionality of injured or diseased parts of the nervous system, or devices that promote its regeneration. Examples range from brain pace-makers (stimulating specific brain nuclei) to neural prosthesis (to functionally replace damaged areas of the central nervous system) and regeneration supports. Of these prosthesis cochlear implants are in widespread use. Others are in the stage of clinical testing or at a very preliminary stage of development. From a material point of view, all these devices share a high neuro-biocompatibility, and most of them should have the ability to steer neural and/or glial cell behavior.

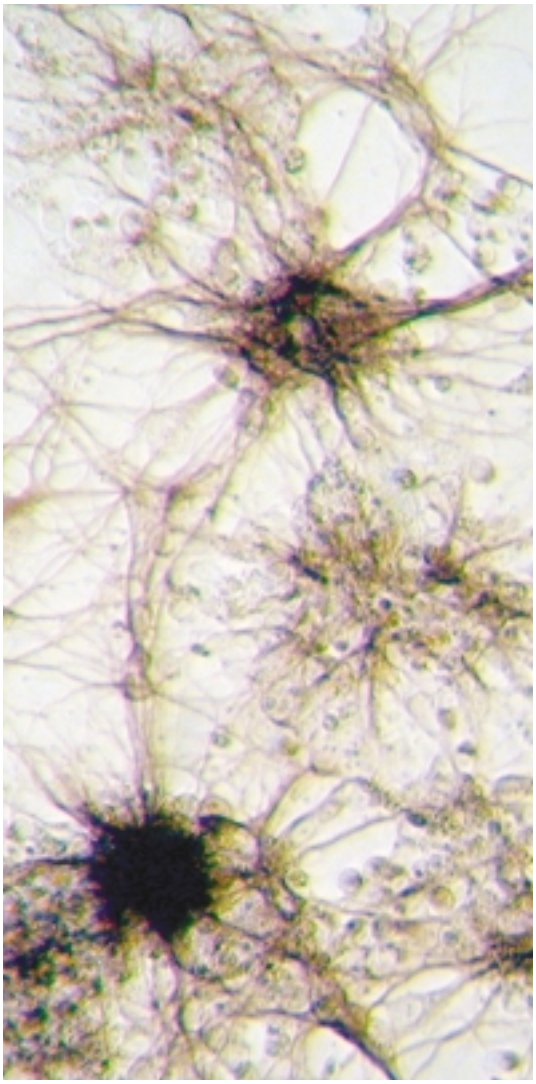


Fig. 1: *Embryonic chicken neural retina cells after 8 days in culture, stained for MAP5.*

In order to obtain information about neuro-biocompatibility of neuro-implants or of materials that will be in direct contact with the nervous system, cell cultures of the embryonic chicken brain, neuronal retina, and spinal cord have been prepared. In terms of the reaction to toxic compounds, cultured neurons and glial cells from chicken embryos have been found to closely mimic the behavior of human nervous tissue *in vivo*. Biocompatibility in the sense of neurotoxicity is assessed using viability and number of the cells as indices. Regarding neural cell function, expression of cell-type specific proteins like vimentin- and glial fibrillary acidic protein (GFAP), microtubule associated protein (MAP)-2, MAP-5, neurofilament 68kD, choline acetyltransferase and HB-9 are immunologically determined as indices for glia, neurons in general, and spinal motoneurons, respectively. In order to determine the functionality of cultured neurons it is envisioned for instance to monitor the electrical activity using the patch clamp technique.

Regenerating neurons are in constant interaction with their environment and need a supporting structure on which they can grow. Like other cells, neurons motile behavior but also neurite outgrowth are influenced by surface topography. This feature of neurons can be used to design substrates that direct growing neurites to appropriate targets, allowing them to make functional connections.

Links: www.empa.ch/abt273
> Medicine materials

www.matismed.ch

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References:
A. Bruinink et al., Toxicol. in vitro 16, 717 (2002)

Biosynthesis of tailored polyhydroxyalkanoates and their characterization by triple detection size exclusion chromatography

Due to its unique properties, biopolymers of the type PHA are promising materials for medical applications. New and tailor-made PHAs of bacterial cultures under multiple-nutrient-limited growth conditions are produced. By means of a new triple-detection-SEC technique, the molecular weight distribution of the polymers is determined in an absolute manner. This technique also allows a control of the production, purification and degradation.

Manfred Zinn,
Manfred Schmid

An important requirement for new materials is their environmental friendliness and sustainability in production. Our research is focused on the synthesis and characterization of polyhydroxyalkanoates (PHA) belonging to the class of polyester. Because of its unique physical properties and its biocompatibility and biodegradability it is a promising biopolymer for medical and some engineering applications (e.g. degradable implants). PHA is produced and accumulated in bacteria as a carbon and energy storage compound (Fig. 1). About 140 different types of PHA have been detected in more than 90 species of bacteria. To separate the polymer from the bacteria, the PHA is usually extracted with a solvent and precipitated in alcohol. Depending on the monomer composition of the PHA, the polymer is brittle, flexible or even sticky.

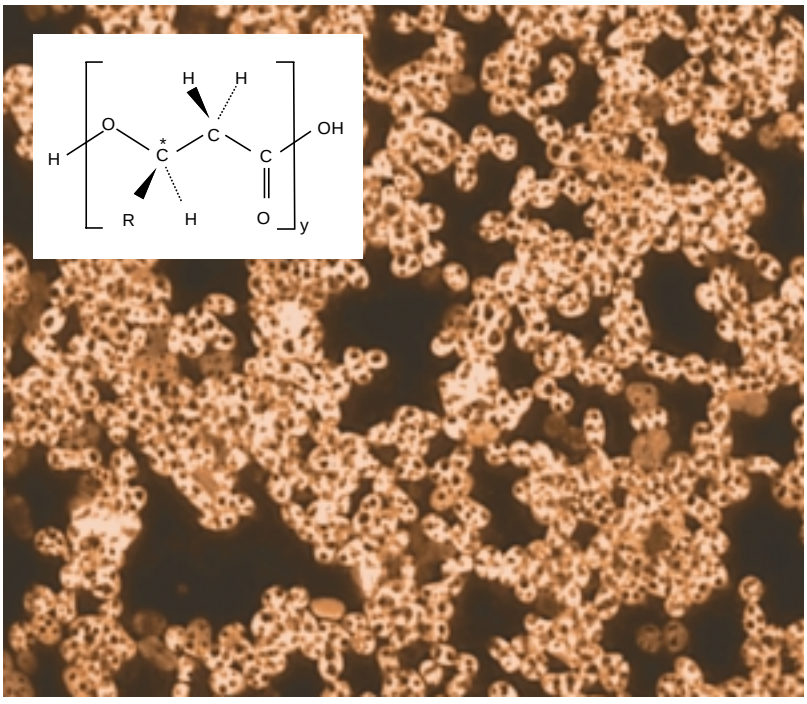

Fig. 1: *Polyhydroxyalkanoate is accumulated inside of bacteria (red) in discrete granules (black) and serves as carbon and energy storage polymer.*

Best PHA biosynthesis has been observed when cell growth was limited by a nitrogen source and a suitable carbon source (e.g. a fatty acid) in excess. However, under such growth conditions the polymer composition could not be controlled accurately. Recently, we proposed that a simultaneous growth limitation by nitrogen and carbon in a continuous culture of bacteria (Fig. 2) could allow the tailored synthesis of PHA. We proved this concept for two types of PHAs, namely poly(*[R]*-3-hydroxybutyrate-*co*-3-hydroxyvalerate) (PHB/HV) and poly(*[R]*-3-hydroxyoctanoate-*co*-3-hydroxy-10-undecenoate) (PHA-DB). PHB/HV and PHA-DB are both thermoplastic materials. PHA-DB could easily be cross-linked to form an elastomer (rubber-like material) due to the terminal double-bonds in the side chain. We found that the composition on the monomeric level could be controlled reproducibly as confirmed by ^{1}H- and ^{13}C-NMR spectroscopy.

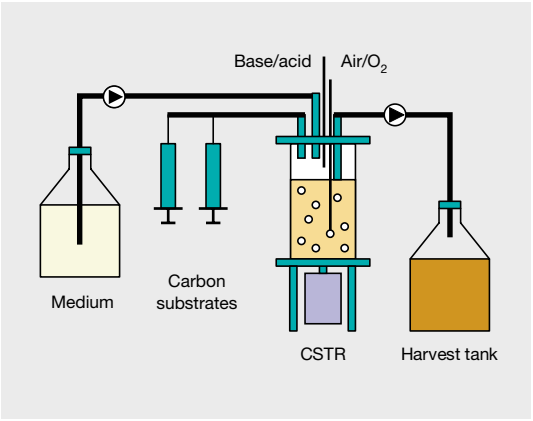

Fig. 2: *Synthesis of polyhydroxyalkanoate is performed in a continuously stirred tank reactor (CSTR) containing a cell culture which is continuously supplied with growth medium. The culture broth leaving the bioreactor is collected and stored at 4 °C until further processing.*

In addition to the molecular composition, the molecular weight distribution of PHA is an important factor regarding its biodegradability. Thus, the exact knowledge of the molecular weight (M_w) is essential for the understanding of the polymeric system and especially its biodegradation behavior.

The determination of the molecular weight distribution of a polymer is usually done by size exclusion chromatography (SEC). This technique is quite common in polymer analysis. The polymers were usually detected by refractive index (RI)- or UV-measure-

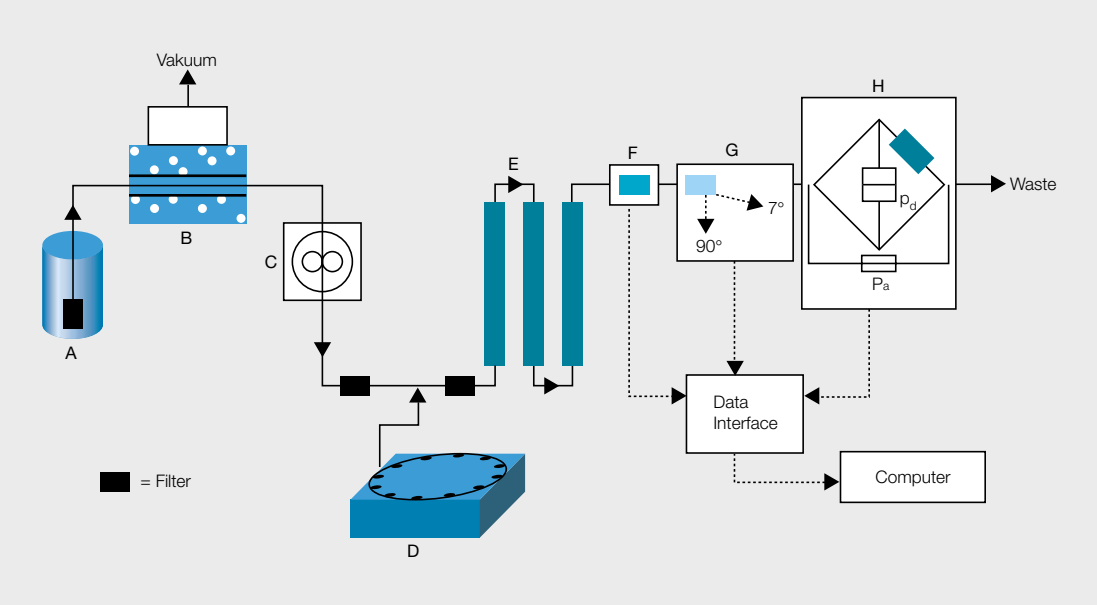

Fig. 3: Assembly of a SEC³ in principle (A = solvent; B = degasser; C = pump; D = auto sampler; E = GPC columns; F = RI detector; G = light scattering detector (scattering angle 90° and 7°); H = viscosity detector).

ments. However, these detection systems only allow an indirect estimation of the molecular weights based on a calibration with polystyrene standards as references. Therefore, polymer samples of another type can be compared only qualitatively to the standards, and the designation of absolute (true) M_w values is not possible. This limitation has been overcome by a new SEC detection technique. The "triple-detection-SEC (SEC³)" combines the classical RI detection with viscosimetry and light scattering measurements under two different scattering angles (90° (RALS)/7° (LALS)). Fig. 3 shows the assembly of a triple-SEC in principle. Due to this combination of different detectors, not only absolute M_w-values are accessible, also size (radius of gyration (R_g)) and structure information of the polymer (branching) could be obtained.

A first application of SEC³ in PHA research was realized in our laboratory. We could exactly determine the molecular weight distributions of the formerly described PHA-DB systems. The molecular weights of these copolymers range in the region between 250'000 g/mol and 300'000 g/mol. The purification of PHA-DB samples, which is done in several steps, was also accompanied by SEC³ measurements, and the influence of different purification times and/or solvents on the material was revealed. In Fig. 4, the influence can be seen as a shift of the curves of the different samples towards lower retention volumes or higher molecular weights, respectively.

As a next step, the resorption and degradation of PHA in a physiological environment will be investigated. The new material is applied in other EMPA projects.

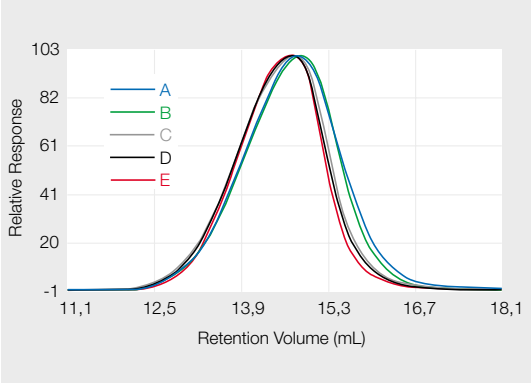

Fig. 4: SEC chromatograms of PHAs; different times of purification shifts the M_w to higher values (A → E means 1 → 5 days' extraction of the same PHA sample with hexane).

Links: www.empa.ch/abt273
> Biopolymers

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References:
M. Zinn et al., Acta Biotechnologica, accepted (2002)
M. Zinn, invited lectures at
– Internat. Symp. on Biodegr. Polyesters (ISBP02), Münster (2002)
– 2nd Czech-Swiss Symp. on Adv. Biotechnology, Prague (2002)

Down-mattress for outdoor use at very low temperature

At very low temperatures, even for well-insulated sleeping bags, a large fraction of the available thermal energy is lost to the ground through the underlying mattress due to conduction of heat. With the development of a down-filled, inflatable mattress, the thermal insulation has been radically improved, allowing the sleeping bag system to be used at lower temperatures.

Markus Weder,
Martin Camenzind,
in collaboration with
Andreas Brun,
Exped Ltd. (CH)

The Outdoors industry has seen a steady growth in recent years. Even though clothing based on the latest developments are beyond the needs of most wearers, such products are essential for the profile of the brand concerned. Mattresses should have the lowest weight and the highest thermal insulation as possible. In addition, the volume when stored must be small. Until now, self-inflating mattresses have dominated the Outdoors market (brand leader: Therm a Rest). These mattresses are sufficient for standard use; however at very low temperatures, too much energy is lost to the ground.

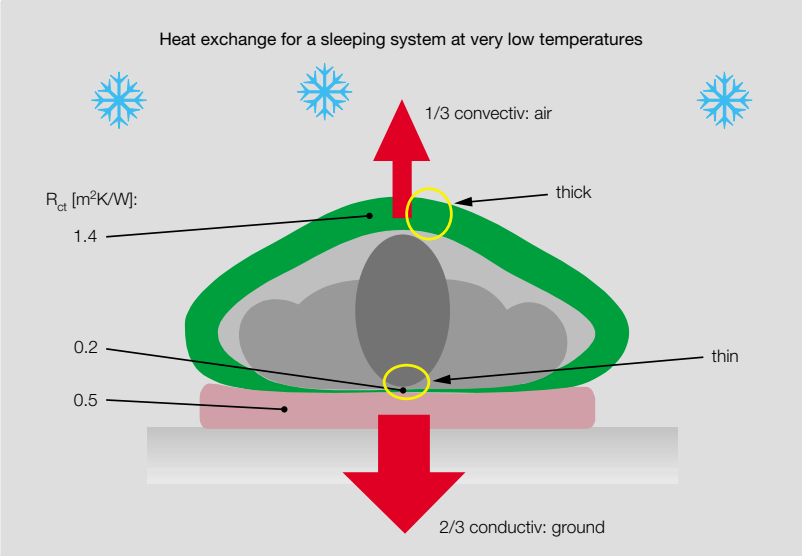

Fig. 1: *Schematic: Heat transport in a sleeping bag system.*

During practice tests in the EMPA arctic climate chamber at –20 °C, it was established that the heat insulation was insufficient when using a standard mattress, even for the best sleeping bag (specified for use at –35 °C). The underlying portion of a sleeping bag, whether down- or synthetic-filled, will be greatly compressed by the weight of the user, reducing the insulation for example for the upper part from 1.4 m^2K/W to the lower part of the bag to an R_{ct} of app. 0.2 m^2K/W (Fig. 1). Compressed in such a manner, the total thermal insulation of a down sleeping bag is reduced to 20% of the uncompressed state. To compensate for this effect, a new system with a high thermal insulation was developed, the thickness of which stays as constant as possible under a person's weight. Furthermore, a normal air mattress with a largely hollow interior insulates very poorly, since heat is quickly removed via convection and radiation. By filling the hollow regions with an appropriate material, these loss mechanisms were largely suppressed without increasing the weight or storage space considerably. The almost linear correlation between mattress thickness and thermal resistance as well as the high insulation value of the low-weighted, down-filled, inflatable underlay developed in this project prove this theory (Fig. 2). Appropriate fillers are very light materials with high springiness and thermal insulation. As seen in Fig. 2, measurements using the in-house flat plate calorimeter Kalcos show a fivefold improvement when using the down-filled mattress as opposed to a standard air mattress, and a threefold improvement compared to the commercially available alternative "Isomatte".

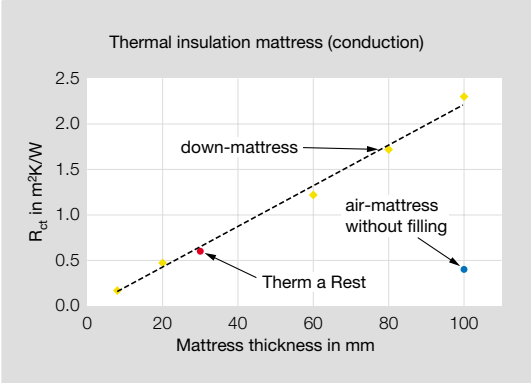

Fig. 2: *Thermal insulation measured on a plate calorimeter.*

This product received the well-sought Outdoor Award 2002 at the Outdoor Trade Fair in Friedrichshafen.

Links: www.empa.ch/abt271
> Clothing physiology

www.exped.com

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References:
Patent DE 201 12 764.4 (pending)

Water vapor transfer and condensation effects in multilayer textile combinations

René Rossi,
René Gross,
in collaboration with
Hans May, GR (CH)

In cold environments, the moisture produced by the human body will partly condense within the layers of an ensemble. Measurements of different 4-layer combinations with the sweating arm showed that the water vapor permeability of the samples and the condensation rates strongly depended on the outside climate and on the hydrophilicity of the outer layers.

In winter clothing, the moisture produced by the human body should escape the fabric layers to avoid wetting the textiles, which would reduce their thermal insulation. The water vapor resistance of a fabric depends on the water vapor pressure gradient between both sides, and is usually assessed under isothermal conditions in different standards. However, the water vapor transmission through fabrics is also dependent on the temperature gradient through the samples. Our study aimed at examining the amount and the location of moisture condensed in the different textile layers of ensembles depending on the hydrophilic properties of the materials. The combinations used incorporated different hydrophilic and hydrophobic materials. The outermost layer consisted of breathable membrane laminates with different hydrophilic and microporous components.

The sweating arm was used for this study. This apparatus simulates a human arm; it is heated up to 35 °C and releases humidity in two segments (upper arm and forearm). The measurements were made for five different climatic conditions, 20 °C and 65% RH, 10 °C and 50% RH, 5 °C, 2 °C and 1 °C, with a wind speed of 2 m/s for all the tests.

In Fig. 1 and 2, the water vapor resistance and the moisture accumulation rate of three samples are plotted against the temperature. MG was a sample with a microporous membrane; PG and HG had a hydrophilic membrane. Additionally, HG was laminated on a hydrophilic back fabric. The resistances as well as the moisture accumulation in the layers show an almost exponential decrease with the temperature. MG had higher resistance and condensation rates than the two other samples, although the water vapor resistance measured on the standardized sweating guarded hotplate was comparable to the others. The hydrophilic inner fabric laminated to a hydrophilic membrane (sample HG) reduced the water vapor resistance of the whole system probably because, when condensation forms in this layer, it will be distributed laterally over a large surface, and will produce a larger moisture flow through the membrane. Therefore, the amount of condensation measured was always lower for this sample than for the others.

At present, it is not clear if liquid transport of the condensation occurred between the different layers of a system. Condensation formed in outer layers may flow back towards the inner layers if these are more hydrophilic than the outer layers. Further research as well as theoretical models will be required to analyze these effects thoroughly.

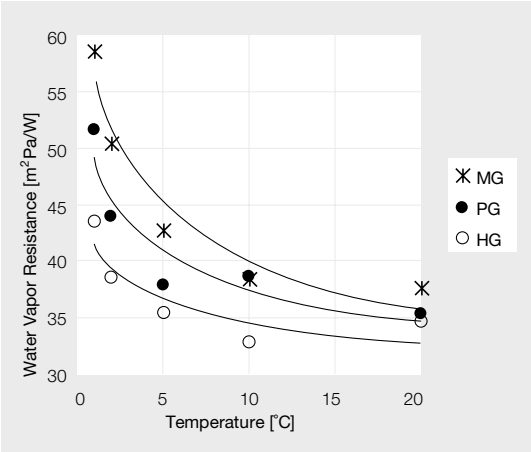

Fig. 1: *Water vapor resistance at different temperatures.*

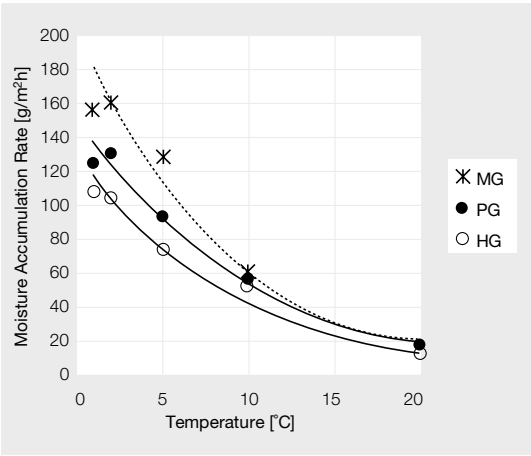

Fig. 2: *Moisture accumulation rate in the different layers of the samples.*

Support: GR

Links: www.empa.ch/abt271
> Clothing physiology

www.approved.ch

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References:
R. Rossi et al., Textile Res. J., submitted (2002)

Materials and Systems for Protection and Wellbeing of the Human Body

SMOG – a method to measure the anti-smell properties of textile finishings

Textiles with "anti-smell" properties claim to prevent unpleasant smells resulting from adsorbed substances. The first products for textile finishing which claim to improve the odor characteristics of textiles have been introduced on the market. The "SMOG" method is a rapid screening method and allows measuring the anti-smell effectiveness of such products with common laboratory techniques.

Felix A. Reifler,
Axel Ritter

Textiles can attract and store gaseous or volatile substances from the surrounding atmosphere. Desorption of unpleasant smelling substances can have a negative impact on their comfort properties. Textiles with "anti-smell" properties claim to prevent such unpleasant smells but, up to now, the effect levels cannot be measured in a sufficient way. Therefore, the project SMOG (Systematic Measurement of Odor Gradation) was initiated with the objective to measure the anti-smell effectiveness of textile finishing products with common laboratory techniques. The SMOG principle imitates the real life odor cycle of textiles and is very simple (Fig. 1). The main improvement towards conventional testing consists in a quantitative and automated analytical measurement. It is based on GC measurements and replaces the sensory odor evaluation by test persons. To assess the anti-smell effectiveness, the measured amount of volatiles is used to calculate the "Relative Odor Index" ROI, i.e. the quotient of the values for the treated and the untreated fabric. The ROI is calculated for each of the volatiles A, B, C,…, respectively.

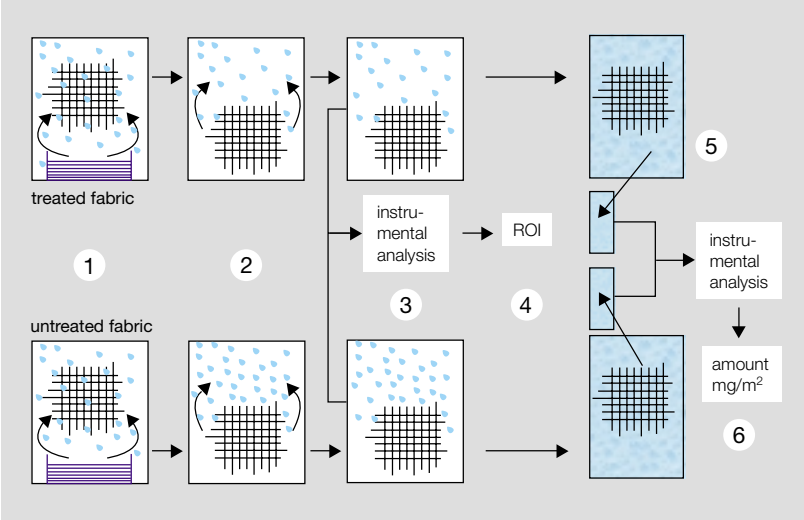

Fig. 1: *Principle of the SMOG method:*
1: adsorption (exposition to odor).
2: desorption.
3: analytical detection (analysis of the gas phases).
4: comparison 1 (Relative Odor Index ROI is calculated).
5: extraction (absolute amount of volatiles A, B, C,… on the fabric is measured).
6: comparison 2 (absolute amounts are compared).

For screening test purposes, a mixture of volatiles to simulate the impact of human sweat, cigarette smoke and perfumes simultaneously on one textile sample was developed. This mixture was used to evaluate the textile samples shown in Fig. 2. In these examples, the SMOG method clearly shows the influence of adsorbent type, textile finish and type of volatile on the odor control properties. In addition, parameters like surface structure, exposure time, temperature and humidity affect the measured properties. Therefore, all "SMOG"-results are specific for each combination of fabric, textile finish, type of volatiles and analytical procedure and cannot be generalized.

Method development is going on in order to classify future test results in an absolute scale.

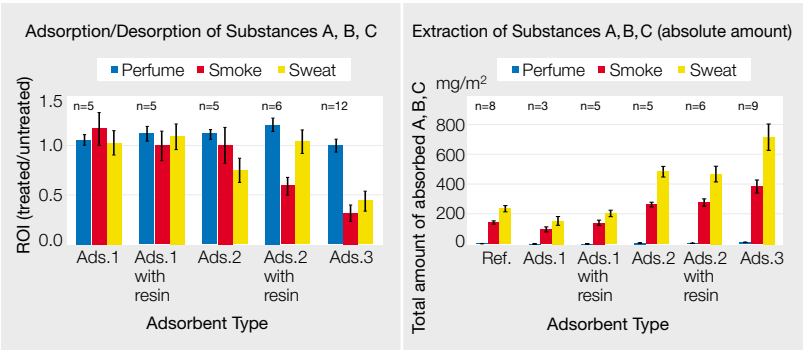

Fig. 2: *Left: ROI of treated fabrics; compared to the same reference (examples). Right: Total amount of volatiles.*

Support: Ciba Spezialitätenchemie Pfersee GmbH, D-Langweid a/Lech

Links: www.empa.ch/abt272
> Finishing

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References:
F. A. Reifler et al., Textilveredlung 37, 11/12, 5–9 (2002)
F. A. Reifler et al., Avantex 2002, Conf. Proceed. (CD-ROM)
Patent PCT/EP 02/14029 (pending)

Systematic patterns and random fluctuations in time series of coefficients of friction measured on floor surfaces

Siegfried Derler,
Friedrich Kausch,
Roman Huber

The changes in the frictional characteristics of different floor coverings in use were investigated over a period of 30 months. Considerable systematic trends as well as random variations were observed in the measured coefficients of friction, indicating strong surface wear and modification due to foot traffic and maintenance.

Slip and fall accidents can be prevented by slip-resistant floor coverings. In practice, however, it is often a problem to maintain a sufficient and durable slip resistance, because floor coverings are subject to mechanical wear, ageing, soiling and maintenance. The objectives of this project were to gain new insights in the interplay of the involved mechanisms and to analyse their influences on slip resistance.

On the surfaces of five types of floor coverings in a new sport complex, coefficients of friction were measured at intervals of one month. The resulting time series were analysed with regard to systematic and random short- and long-term variations. For each floor covering, two spots with different levels of pedestrian traffic were investigated, so that contrasting cases could be compared. The measured coefficients of friction were interpreted in combination with the results of surface roughness measurements, which provided additional information about the surface wear effects.

Mechanical abrasions turned out to be the most important wear mechanisms for floor coverings in use. In several cases, the floor surfaces were coated by residuals of cleaning products.

Fig. 1 shows the time-dependence of average coefficients of friction for a PUR-flooring. The decreasing trend is associated with the continuous polishing of the floor surface through mechanical wear, the seasonal variations with temperature and humidity effects.

Results for two different test sites on a xylolith flooring are shown in Fig. 2. After an initial reduction, relatively stable coefficients of friction are found at a protected spot in a corner, whereas the results for a heavily trafficked spot in the entrance area show an increasing trend due to surface roughening. The higher data scatter for the latter test spot indicates that the surface homogeneity is strongly reduced by mechanical abrasion.

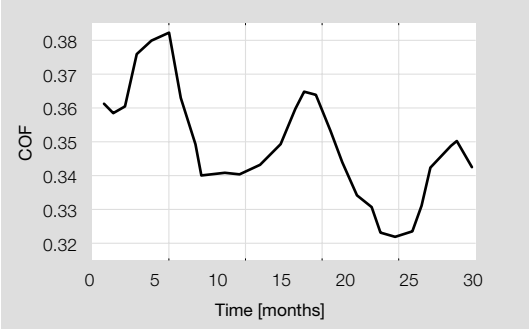

Fig. 1: *Decreasing trend and seasonal variations in mean coefficients of friction measured on a PUR-flooring using different elastomer materials.*

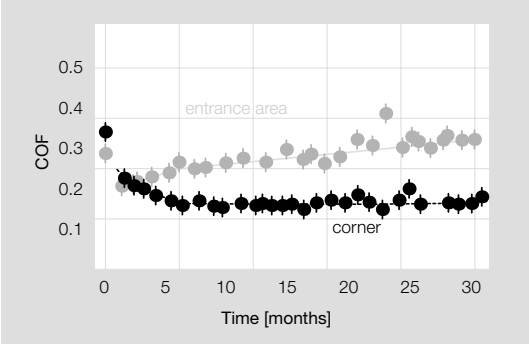

Fig. 2: *Time-development of mean coefficients of friction for two test sites on a xylolith flooring, measured with a plastic slider under wet conditions.*

The random fluctuations in the time series of coefficients of friction are determined by variations in the surface conditions of both slider material and floor covering; they depend on the specific material combination. A detailed analysis exhibits great differences in the uncertainty of friction measurements when using different slider materials. Not all currently used standard materials – elastomers of the shoe industry – seem appropriate for friction measurements. Alternative slider materials providing improved repeatability and reproducibility should therefore be developed.

Support: bfu, Suva

Links: www.empa.ch/abt271
> Slip resistance

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References:
S. Derler et al., Safety Science, submitted (2002)

Strength reduction factors due to installation of geosynthetics for soil reinforcement

Soil structures reinforced with geosynthetics are expected to have a service life of up to 100 years. This implies that the corresponding reinforcement will last accordingly. Regarding geosynthetics for reinforcement, mainly long-term strength and elongation properties, installation survivability and resistance against environmental influences are relevant.

Rudolf Hufenus,
in collaboration with
Rüegger Systeme AG
and ETH Zürich (CH)

In most conventional reinforced soil applications, geosynthetics are exposed to the highest mechanical stress during construction. Field tests have shown that the level of installation damage depends on the type of geosynthetics, the graduation and angularity of the backfill, the lift thickness and the weight, type and number of passes of the construction and compaction equipment.

The aim of the study was to find the corresponding strength reduction factors for most relevant types of geosynthetics. The comparison of the tensile strength of the geosynthetics, before and after installation, allows the reduction factor due to installation and compaction to be defined (Tab. 1). A low compaction energy – which is quite common for reinforced fill constructions – results in comparably small installation damage reduction factors.

	type of soil		
type of geosynthetics	fine–grained	rounded, coarse–grained	angular, coarse–grained
biaxial PP grids	**1.3**	**1.4**	**1.6**
uniaxial HDPE grids	**1.2**	**1.3**	**1.5**
PET/PP flat rib grids	**1.2**	**1.2**	**1.3**
PP slit tape wovens	**1.3**	**1.5**	**1.6**
coated PET grids	**1.2**	**1.3**	**1.4**
PET wovens	**1.2**	**1.3**	**1.5**
PP/PET nonwovens	**1.2**	**1.4**	**1.5**

Tab. 1: *Proposed minimum reduction factor for installation damage.*

The geosynthetics have been submitted to a laboratory simulation of the damage during installation, in which a first soil layer is compacted, a geosynthetic is placed and covered by a second layer and exposed to cyclic loading (Fig. 1). The laboratory simulation results show a clear dependency of the loss of tensile strength on the type of geosynthetics, the dynamic load and the soil material.

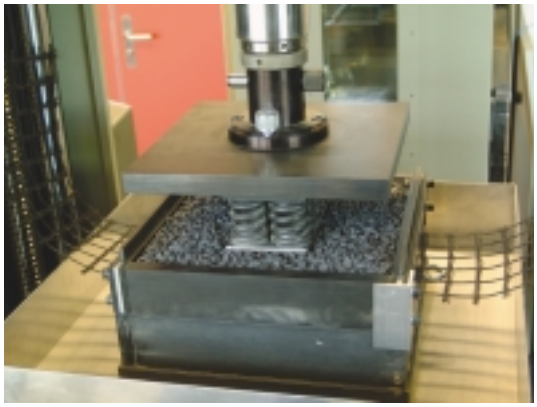

Fig. 1: *Test equipment for simulating damage during installation.*

Using the same soil material, the loss of tensile strength shows a considerably good correlation between field and laboratory (Fig. 2), where the slit tape wovens (S) are more susceptible to damage in the laboratory than in the real site. This might be explained by the sensitivity of these products to abrasion, which is more likely to occur in the laboratory test.

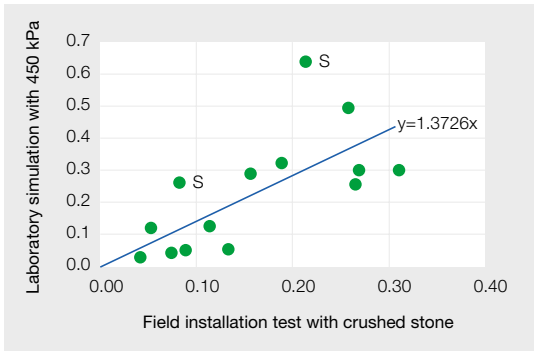

Fig. 2: *Loss of tensile strength: correlation between field and laboratory results.*

Support: ASTRA

Links: www.empa.ch/abt272
> Technical textiles

www.geotex.ch

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References:
R. Hufenus, Technical Textiles, No 1, E26–E30 (2002)
R. Hufenus et al., ASTRA research report No 1004 (2002)
R. Hufenus et al., Proceedings 7th Int. Conf. on Geosynthetics, Nice, 1387–1390 (2002)
R. Hufenus, strasse und verkehr, No 10, 388–399 (2002)

Development and application of an inverted cylindrical magnetron

Martin Amberg,
Michael Keller,
in collaboration with
Jochen Geerk,
Forschungszentrum
Karlsruhe (D)

For certain textile applications, electrically conductive fibers such as metal or carbon fibers are processed into textile goods to achieve the dissipation of unwanted electrical charges. Unfortunately, such fibers are expensive and their processing is problematic. Additionally, the high mechanical and chemical stress towards such fibers during wearing, washing, sterilization and dying leads to partial damaging. Therefore, the aim of this KTI-funded project is the substitution of such fibers with flexible, colorfast, wash permanent, competitive and metallized synthetic and henced electrically conductive fibers.

As a well-established method, metallization can be achieved with a physical vapor deposition process (PVD) using magnetrons. In a first step, the tubular form of the fiber used has led to prototyping a non-complex inverted cylindrical magnetron (Fig. 1). The cylindrical shape enables the radial and homogeneous sputtering of the metallic atoms on the fiber surfaces. The second step involved an investigation of the influence of plasma process parameters such as pressure, power, magnetic-field, gas-flow and pulse-frequency on the deposition rate, adhesion and homogeneity of the metal coatings.

The inverted cylindrical magnetron construction contains a cylindrical cathode of a large diameter of 200 mm with integrated water cooling, anode and adjustable magnetic field. To provide a wide range of sputter rates, the cathode can be driven up to 22 W/cm^2. Investigations on pulsed plasmas were made. Pulsing can be used to sputter non-conductive material and to generate high-energy species, and has an influence on the adhesion of the coating. It shows no benefit to the deposition rate and to the substrate-temperature. The substrate temperature is mainly influenced by the power and target substrate distance. Working points were defined within the temperature range of the substrate used. To illustrate the homogeneity of the layer, scanning electron microscopy (SEM) has been performed on a silver coated nickel wire (Fig. 2). The coating shows good homogeneity and no cracks or blowholes.

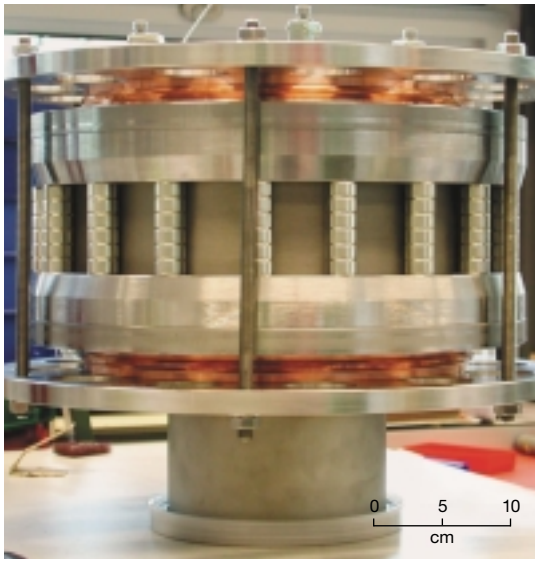

Fig. 1: *Inverted cylindrical magnetron shown vertically.*

We have successfully developed an inverted cylindrical magnetron and proven its stable operation to produce metallic films on synthetic fibers. Furthermore, the deposited Ag coating shows good homogeneity on cylindrical substrates. With the inverted cylindrical magnetron, a tool is given to develop coatings on various cylindrical substrates.

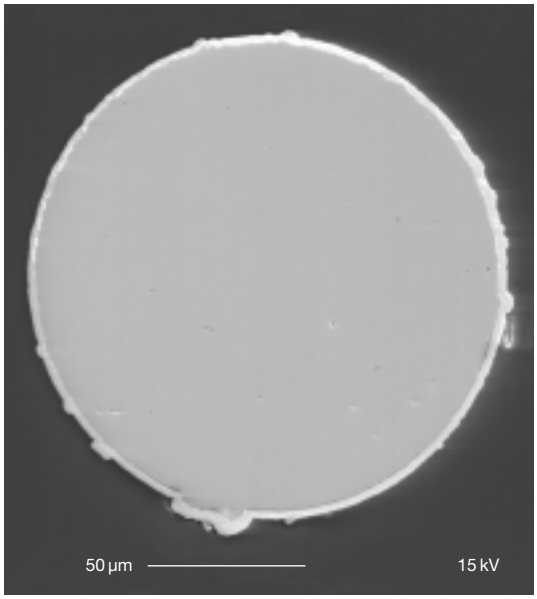

Fig. 2: *SEM picture of a 3 µm Ag-deposited film on a Ni-wire (ø 0.15 mm).*

Support: BBT-KTI 4969.1

Links: www.empa.ch/abt272
> Plasma technology

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Synthesis and characterization of piezoelectric PZT-thin films prepared by single-target pulsed DC-magnetron reactive sputtering technique

Within a TOP NANO 21 project, we are developing the technology for depositing thin piezoelectric PZT films on industrial level with a DC-sputtering process using a single ceramic PZT target.

Armin Fischer, Patrick Schwaller, in collaboration with Unaxis Balzers AG and Umicore Materials AG (FL)

Lead zirconate-titanate ($PbZr_xTi_{1-x}O_3$, PZT) thin films can be utilized as sensors, actuators and transducers and have an enormous future potential in the field of micro-electromechanical systems (MEMS) and ferroelectric random access memory (FRAM) devices. Furthermore, sandwiched PZT thin films deposited on optical fibers could have a potential use for textile applications. So far, not the pulsed DC-mode nor the targets are available for an industrial mass production process in a wide process window. In this collaboration, we develop a physical vapor deposition process of PZT thin films at low substrate temperatures (low energy input, low Pb-volatility) by applying a DC-pulsed sputtering mode to a single ceramic PZT target. We study a series of candidate targets and wafers provided by our industrial partners and evaluate the chemical, structural, electrical and mechanical properties of as-deposited and annealed PZT-thin films.

Deposition experiments on non-heated and heated substrates (in situ-thermal annealing, post annealing; layer sequence: $Si/SiO_2/Ti/Pt$ (111)) reveal that low roughness film deposition under stable DC-pulsed sputter conditions is possible. The film roughness is determined by Atomic force microscopy AFM (Fig. 1). In addition, Nanoscratch tests on as-deposited films have been performed. AFM measurements of the residual scratch reveal no brittle failure of the coating but strong pile-up formation (Fig. 2). In order to determine the crystallinity of the samples, grazing incidence X-ray diffraction (XRD) measurements are being made. We found no indication of the needed perovskite modification, probably due to the non-sufficient Pb concentration investigated by means of X-ray photoelectron spectroscopy measurements. Therefore, further deposition processes will include the use of targets with high Pb contents (>50 at%).

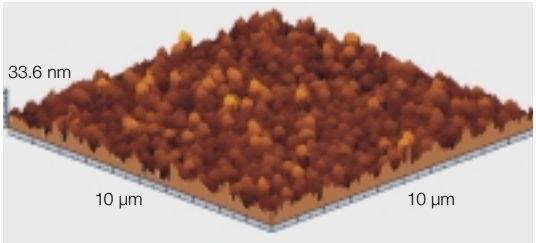

Fig. 1: *Topography of a 500 nm thin PZT film deposited on Si as measured by AFM. The roughness S_a is 3.1 nm for this sample.*

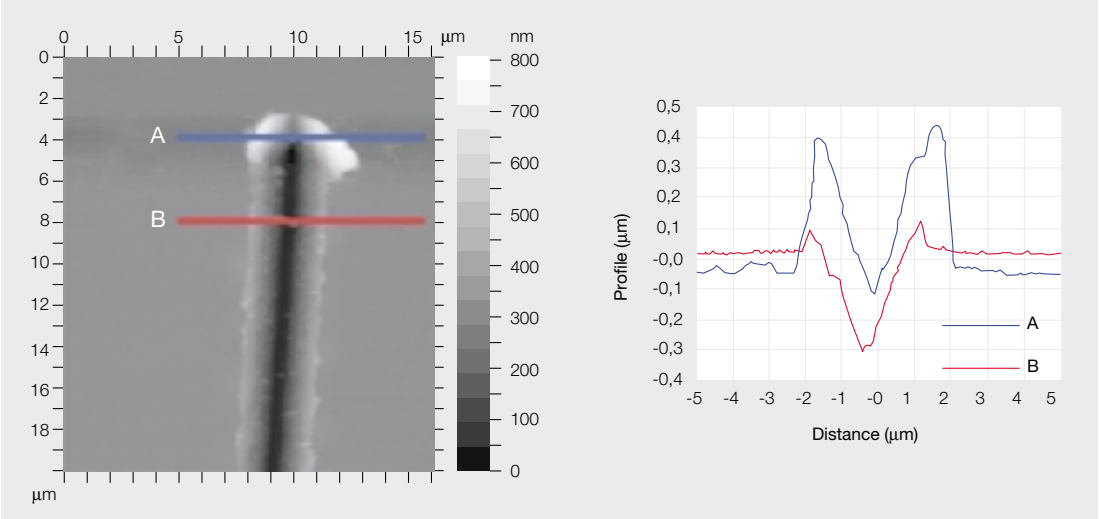

Fig. 2: *AFM measurement of the residual scratch of Nanoscratch experiment (maximum load 40 mN). No brittle failure of the coating is observed.*

Support: TOP NANO 21

Links: www.empa.ch/abt126
> Micro-/Nanomechanics
www.empa.ch/abt272
> Plasma technology

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MUSAC, an Eureka project on new models for simulating the effect of influence quantities

Matthias Rösslein, Roman Hedinger, Sergio Rezzonico, Erwin Achermann, in collaboration with ETH Zürich (CH), Universität Leoben (A), BAM (D), Nestlé, Metrohm, Mettler-Toledo, Precisa, Labor Spiez (CH), Varian (USA), Altana (D)

Many important decisions are based on results of chemical quantitative analysis. Such results are used for example to check materials against specifications. A tool to obtain comparable results with a reasonable effort for bench chemists was developed during Eureka project MUSAC.

Measurement uncertainty and traceability permit comparing results. Until now it has not been possible to calculate the measurement uncertainty for the entire concentration range of an analytical procedure with reasonable effort. Therefore, EMPA initiated and led the Eureka project MUSAC in collaboration with 15 national and international partners. Within this project, new physical-chemical models have been developed to describe the influence quantities of analytical measurements. Based on these models, a new tool has been engineered. This tool enables the bench chemist for the first time to simulate the effect of influence quantities over the entire scope of an analytical procedure. This allows to obtain a much better understanding of the measurement process, which is essential for the correct determination of a quantity.

The tool is a computer program composed of two parts. The kernel was built during an ETHZ-thesis constituting a general measurement simulation tool. The user interface was adopted to the real needs of the bench chemists. It covers the most often applied analytical techniques like titration, HPLC, ICP-OES as well as sample preparation.

As an example, Fig. 1 shows the combined standard uncertainty and its relative value in relation to the obtained concentration of an acid/base titration. The different effects of the influence quantities, which have been calculated for both ends of the concentration range of the above example, are collected in Fig. 2. The effects of repeatability, concentration of the titration solution, volume of the sample and titration volume change considerably within the scope of the analytical procedure. The different shapes of the distribution function of the results confirm this behavior. The distributions have been generated using Monte-Carlo simulation. They are sometimes considerably different compared to the expected normal distributions. This points to a partial failure of the central limiting theorem.

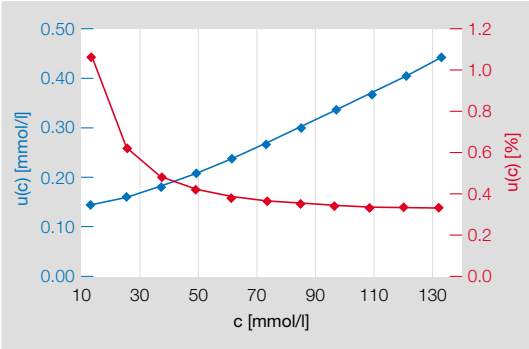

Fig. 1: *Combined standard uncertainty (u(c)) and its relative value in relation to the results (c) of an acid/base titration.*

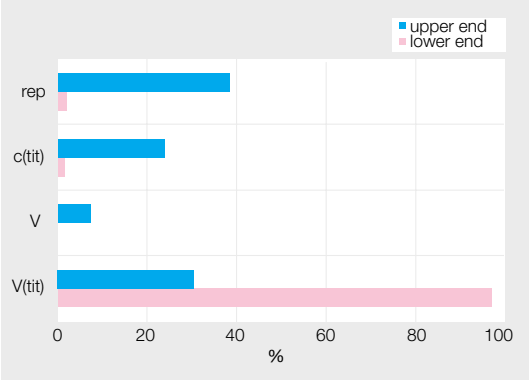

Fig. 2: *Influence quantities of repeatability (rep), concentration of the standard (c(tit)), volume of sample (V) and titration volume (V(tit)) calculated for both ends of the concentration range.*

Support: BBT-KTI 3873.1

Links: www.empa.ch/abt273
> Measurement uncertainty

www.uncertainty-manager.com

Contact: *matthias.roesslein@empa.ch*

References:
E. Achermann, MUSAC – a Tool for Evaluating Measurement Uncertainty. Ph.D. Thesis ETHZ 14573, ISBN-3-8300-0679-9 (2002)
M. Rösslein et al., Eurachem/CITAC guide: Traceability in Chemical Measurement, 37 pages (2002)
M. Rösslein, invited lect. at Pittsburgh Conf. for Analyt. Chem. and Appl. Spectr. (PITTCON), New Orleans (2002)

Purity of laboratory chemicals and measurement uncertainty

Analytical chemists who need to work in accordance to the norm ISO 17025 must know the measurement uncertainty of their analyses. One of the important influence parameters is the purity of the reference material and its uncertainty. Our study proposes how this problem can be handled.

Veronika Meyer,
in collaboration with
Gert van Look of
Fluka GmbH (CH)

The ISO "Guide to the Expression of Uncertainty in Measurement" is a widely accepted code how the uncertainty of a measurement can be determined. Data which are not statistically evaluable must be characterized by symmetrical triangular or rectangular distributions. However, this is not always the best approach.

It is a characteristic of most chemical analyses that a pure chemical compound, i.e. a reference material, is needed for calibration purposes. The uncertainty of its purity u_P must be considered for the determination of the total uncertainty u_{tot} of the result. In its simplest form the calculation is as follows:

$$u_{tot} = \sqrt{s_{rep}^2 + u_P^2}$$

In addition to u_P, it is also necessary to estimate a reasonable number for the purity of the reference material. This is especially difficult for the frequent cases where the vendor of a compound declares only the lower guaranteed purity in the form of e.g. ≥ 97%.

We investigated the data of two randomly chosen sets of 20 laboratory chemicals each with a declared purity of ≥ 97% or ≥ 99%, respectively (a total of 340 batches). It became obvious that "purity" can have different meanings: content, functionality or a purity in the sense of "100% minus impurities".

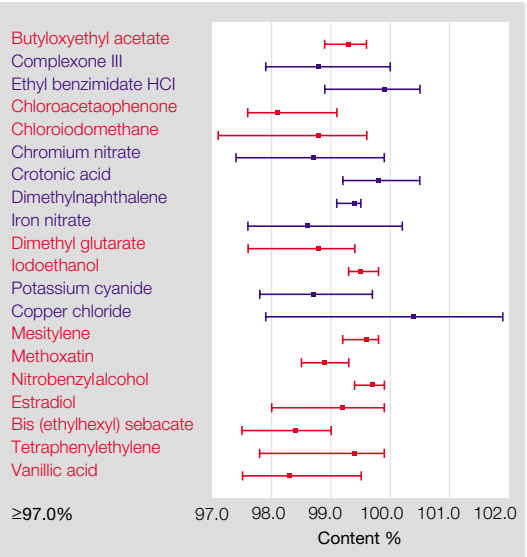

Fig. 1: *20 compounds with declaration ≥ 97%. Squares indicate the mean purity of the investigated batches, bars expand to the lowest and highest values found. Compounds in red were analyzed by chromatography (GC or HPLC), the others by titration.*

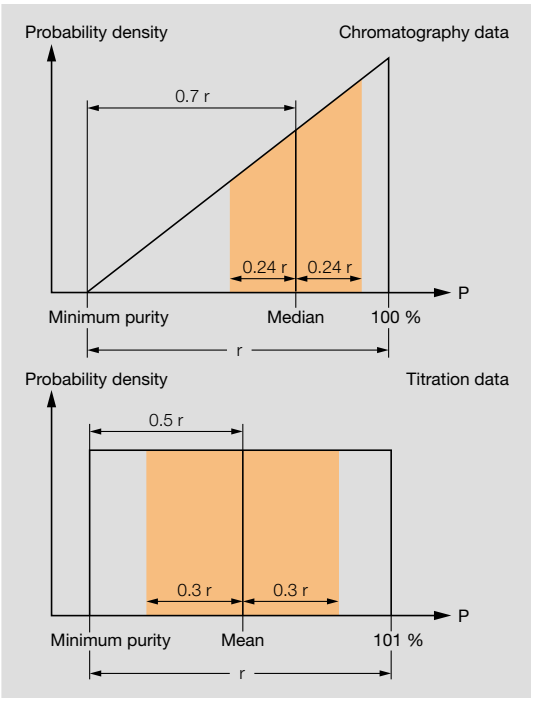

Fig. 2: *Triangular and rectangular distributions for the description of the "purity" of laboratory chemicals.*

In most cases, the "purity" is closer to 100% than to the lower guaranteed limit. However, the data depend on the analytical technique used. Values determined by chromatography do not exceed 100% because in the quality control laboratory of the vendor the sum of all peak areas is taken as 100%. Impurities with low detector activity will be underestimated and vice versa. Values obtained by titration can exceed 100% because the functionality is determined.

It could be shown that chromatography data can be better described by a non-symmetrical triangle with the right angle at 100% and the left end of its base at the minimum guaranteed value. Titration data can be best described by a rectangular function with a range from the lower guaranteed value up to 101% (instead of up to 100%).

Links: www.empa.ch/abt273
> Measurement uncertainty

Contact: *veronika.meyer@empa.ch*
Reference:
G. van Look et al., Analyst 127, 825 (2002)

List of abbreviations

ASTRA	Swiss Federal Roads Authority
BAG	Swiss Federal Office of Public Health
BAM	German Federal Institute for Materials Research and Testing
BBL	Swiss Federal Office for Constructions and Logistics
BBT-KTI	Swiss Federal Office for Business Formation and Technology – Commission for Technology and Innovation
BBW	Swiss Federal Office for Education and Science
BFE	Swiss Federal Office for Energy
bfu	Swiss Federal Office for Accident Prevention
BLW	Swiss Federal Office for Agriculture
BUWAL	Swiss Agency for the Environment, Forest and Landscape
BVet	Swiss Federal Veterinary Office
CERN	European Organization for Nuclear Research
CWRU	Case Western Reserve University
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EPF(L)	Swiss Federal Institute of Technology Lausanne
ESA	European Space Agency
ETH(Z)	Swiss Federal Institute of Technology Zürich
EU Program IV	European Community, 4th Framework Program
EU Program V	European Community, 5th Framework Program
FAL/FAT	Swiss Agriculture Research Institutes
FKH	Expert Commission for High Voltage Issues
GR	Swiss Defence Procurement Agency
Holz-21	Swiss Federal Stimulation Program for the Wood
IBT	Institute of Biomedical Engineering
ifra	International Newspaper Color Association
ifu	German Institute for Environmental Informatics
IKB	Institute for Nuclear Physics
IPMS	Institute for Problems of Materials Strength
ISAC-CNR	Institute of Atmospheric Sciences and Climate – National Research Council of Italy
IZT	Institute for Future Studies and Technology Assessment
PSEL	Project and Study Fund of the Electricity Industry
PSI	Paul Scherrer Institute
seco	Swiss State Secretariat for Economic Affairs
SLS	Swiss Synchrotron Light Source
SNF-NFP	Swiss National Science Foundation – National Research Progam
SUVA	Swiss National Accident Insurance Organization
TA Swiss	Swiss Center for Technology Assessment
Top Nano 21	Research Program of ETH Council
TTM	Technik Thermische Maschinen
UAS	University of Applied Sciences
UGRA	Swiss Association for the Promotion of Research in the Graphic Arts Industry
UNIZ	University of Zürich
USAID	United States Agency for International Development

EMPA Activities 2002

Information, Simulation Technologies, Reliability

Development of advanced materials and systems requires novel measuring simulation, modeling and information technologies. Non-destructive and imaging techniques ensure adequate reliability and safety of systems and structures from the macro to the nanoscale dimension. Noise emission of components and systems is an important environmental impact reduced by modeling, simulation and application of adaptive materials. Information technologies can minimize material flows, contributing thus to sustainable use of resources. Data and image processing are of importance in acquisition, transfer and presentation of data.

EMPA

NANOXID: Reliability limits of ultra-thin semiconductor oxides

Joachim Reiner,
Urs Sennhauser

As industry keeps scaling IC technology, thickness of the dielectric layers used in field effect transistors will reach the basic reliability limits. We investigate basic, yet unexplained new failure mechanisms as soft breakdown in extremely thin SiO_2 layers (2–5 nm).

CMOS technology is expected to reach the basic reliability limits of SiO_2 layers in the near future, and strong activities are ongoing to find suitable alternative dielectric materials. The new breakdown mechanism called soft breakdown occurs in very thin SiO_2 layers and is not yet completely understood. This effect, which might also affect new dielectric materials, is investigated in the project NANOXID.

The degradation kinetics is observed by a sequence of characterization – stress – characterization etc., for which a PC based automatic software control has been implemented. Reliable long-term testing with sub-pico-Ampere resolution requires shielding against light and electronic noise as well as stable contacts. Results are shown in Fig. 1.

A correlation between the physical appearance of the soft breakdown site and its electrical characteristics is still missing in the literature. Therefore, a new preparation approach for TEM lamella has been developed using the EMPA Dual Beam FIB (FEI 235). It enables a clear view on the complete dielectric layer of a test structure with a high success rate (Fig. 2). A Swiss patent filing has been made.

Current reliability prediction models are semi-empirical. They predict the failure statistics well. However, they use a “trap size” as a fit parameter, which is determined to about 3 nm diameter to fit the data. Such a model lacks the physical base for dielectrics of 3 nm thickness and less. Several software packages for quantum mechanical (ab initio) calculations of energies and states in material exist and have been evaluated. To include the electrical field and to calculate trap-induced leakage current, extensions of both models and software will be necessary.

A collaboration with industry partners has been arranged. A Ph.D. thesis is planned to address the kinetics of degradation of ultra-thin dielectric layers under electrical field, tunnel current and temperature, starting with the widely used Si-SiO_2-Si system.

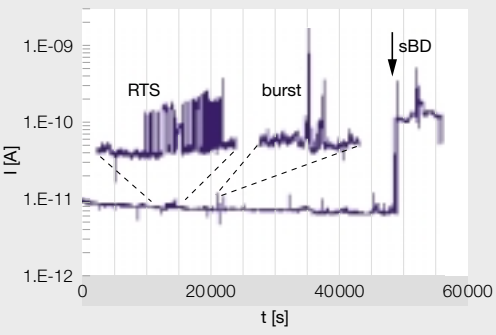

Fig. 1: *Gate leakage current during constant voltage stress of -6.7V, gate oxide thickness = 5 nm.*

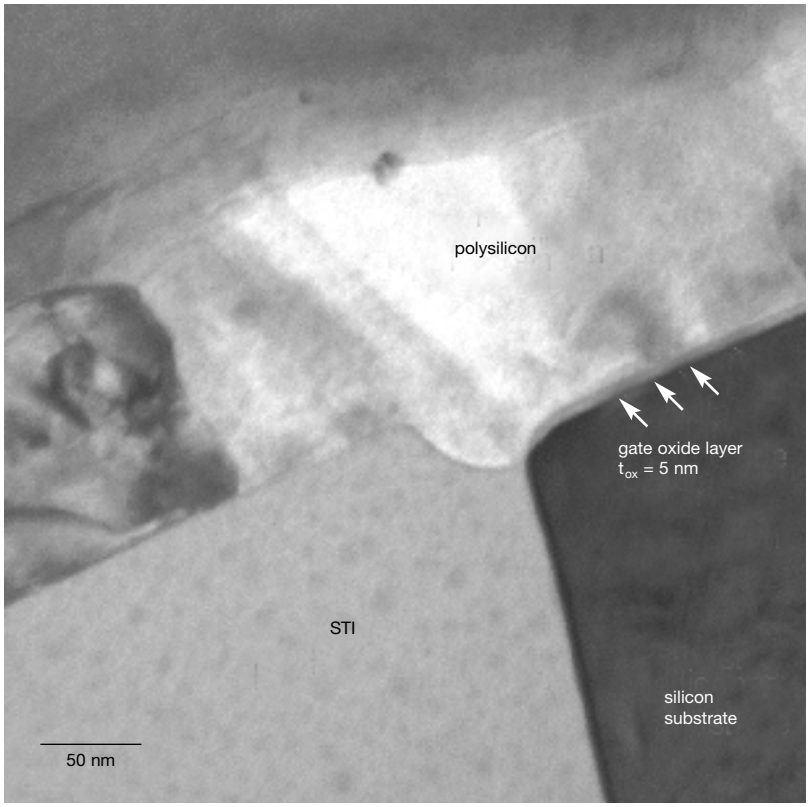

Fig. 2: *TEM image: cross section of a MOSFET.*

Links: www.empa.ch/abt173
> Reliability

Contact: *joachim.reiner@empa.ch*
References:
J.C. Reiner et al., Microelectronics Reliability 42, 1753 (2002)
Best poster award of the European FIB User Group Meeting EFUG (2002)
J.C. Reiner, Intern. Integrated Reliability Workshop, Final report, in press (2002)
Swiss patent, applic. no. 0661/02 (2002)

Applications of X-ray Tomographic Microscopy (XTM) in materials and life sciences

Due to the high beam brilliance at synchrotron light sources like SLS, ESRF and HASYLAB, the spatial resolution of computed tomography has been extended down to the 1 µm range. A dedicated X-ray tomographic microscopy (XTM) station with two detectors and a novel testing device for compressive loading has been developed and commissioned at SLS for samples from materials research and life science.

Peter Wyss,
Philipp Thurner,
Urs Sennhauser,
in collaboration with
IBT of ETH Zürich and
University of Zürich,
SLS of PSI (CH),
IKP at Jülich,
HASYLAB at DESY (D)

X-ray based computed tomography (CT) is well established in medicine, in materials science and in industry. Tomography with X-ray tubes specialized for industry and materials science applications reaches a spatial resolution of about 10 micrometers for an object size of a few millimeters. Investigations of material properties, biological specimen and microsystems often require a resolution of one micrometer or better. Tube based CT-systems do not reach this limit at feasible exposure time. The reason is the by far too small X-ray photon flux emitted from a tube target spot as small as one micrometer. Synchrotron sources, however, do not have this limitation and deliver a highly brilliant beam. High brilliance means high intensity and small divergence. The X-ray sources of the SLS have these characteristics and are very well suited for XTM.

The instrumentation for XTM was designed and built as a common project of EMPA as project leader, IBT of ETHZ/UNIZ, SLS/PSI, and financially supported by ETH-Council. Major design criteria were sample rotation with smallest runouts, stable rotation, low irradiation doses of the samples, minimum data acquisition and transfer time for the approximately 1000 full frame exposures required for tomogram reconstruction, a spatial resolution of 500 nanometer to 5 micrometer depending on field of view, and the best possible X-ray absorption and phase contrasts. The sample handler had not only to fulfil very tight mechanical tolerances but also to offer a sufficient load capacity to support an in-situ mechanical compression and staining device (IMCSD) (Fig. 1). A novel Bragg magnifier detector had been included to access sub-micrometer resolution range. The first six months of operation included commissioning, test runs and already several experiments. After some corrections on beam-line, apparatus and control software, the expected performance was achieved.

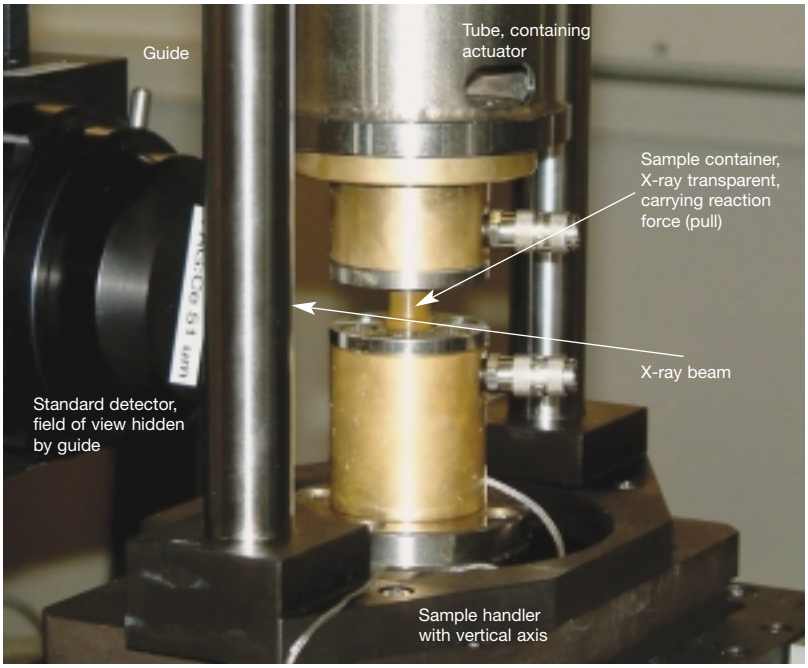

Fig. 1: *In-situ Mechanical Compression and Staining Device (IMCSD) of EMPA mounted on sample handler of XTM station.*

In Fig. 2, we show results from osteoporosis research with single bone trabeculae, mouse femurs and stained trabecular bone samples (Fig. 2). The applied lead-uranyl-acetate stain penetrates all voids and microcracks within the structure. Fig. 3 shows that microcrack formation and propagation induced by cyclic compressive loading at different load amplitudes can well be visualized by XTM using the IMCSD, which has been designed and built by EMPA. The direct mounting of the IMCSD onto the sample handler guaranteed that the position of the sample relative to the coordinate system of the tomography rotation axis remains unchanged between scans at different load steps. This simplifies very much the comparison of the structures before and after loading, which is required for failure modeling of bone structure. In the future, also cell distributions in bone will be visualized. Novel staining techniques have been developed for this task using a model system.

Three dimensional inspection of micromechanical high precision tools is shown in Fig. 4. Attempts of the manufacturer to characterize the inner geometry of these wire bonding capillaries by using scanning electron microscopy as well as a variety of other methods had not delivered sufficiently accurate data. First investigations with 3D tomography now accurately reveal the deviations of diameter and details of shape of the bores. This demonstrates that XTM will be a well suited method for investigating the inner structure of MEMS. In combination with IMCSD robustness, local deformation parameters and reliability of micro-devices can now be investigated non-destructively.

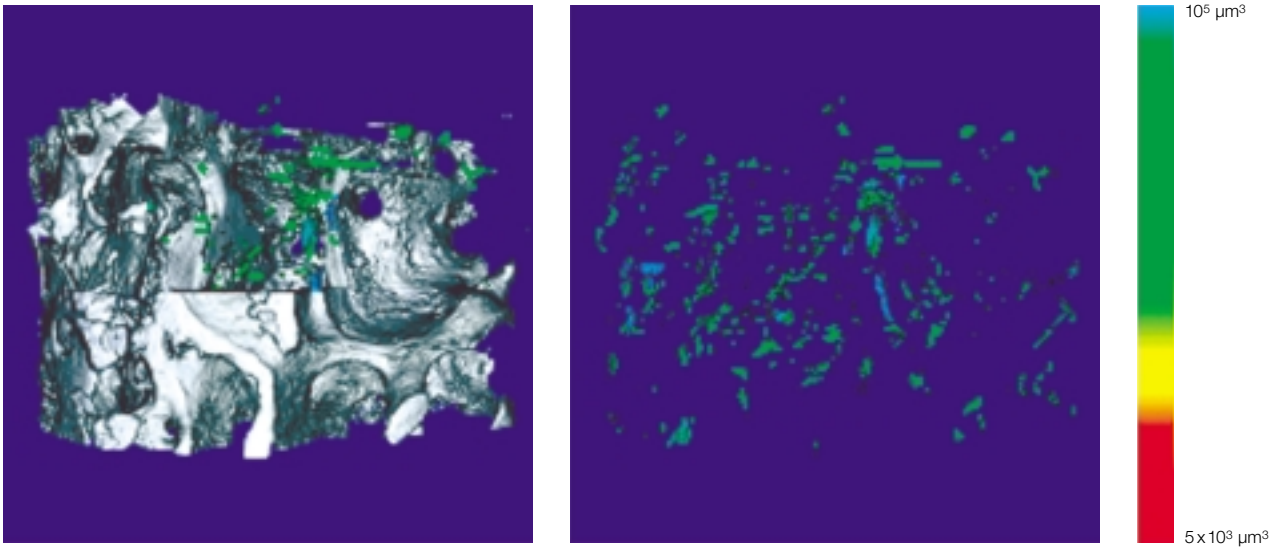

Fig. 2: *3D views of trabecular bone sample with lead-uranyl-acetate stained microcracks and cavities containing osteocytes. Microcracks and cavities are colored according to their size in µm³. Left: The bone is in partially cut block view. Right: The bone is fully transparent.*

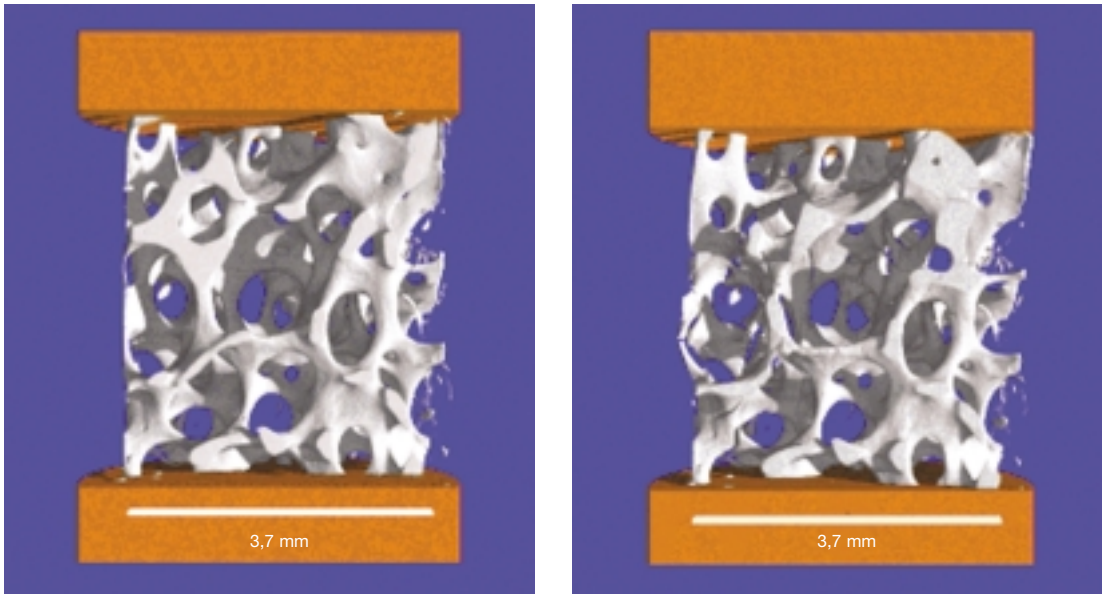

Fig. 3: *3D view of bone sample in the IMCSD before (left) and after (right) compressive loading.*

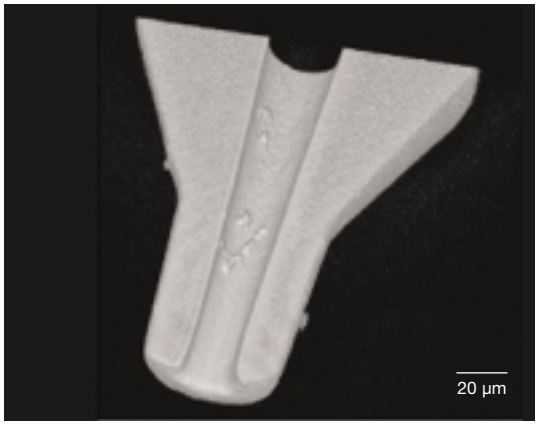

Fig. 4: *3D view of wire bonding capillaries for extracting dimensions and details of shape.*

Support: ETH-Council

Links: www.empa.ch/abt173
> Nondestructive test methods

Contact: *peter.wyss@empa.ch*
References:
M. Stampanoni et al., Nuclear Instruments and Methods A 491, 291 (2002)
Ph. Thurner et. al., Nuclear Instruments and Methods B, accepted (2002)

Information, Simulation Technologies, Reliability

Long-term performance of aerial optical fiber cables

We monitored three aerial optical fiber cable links across the Alps in Switzerland by measuring bit error rate, fiber and splice losses, degree of polarization of the back-scattered signals in fiber sections, and polarization mode dispersion.

Philipp M. Nellen,
Marcel Held,
in collaboration with the electricity companies ATEL Netz AG, BKW FMB Energie AG, and EGL Grid AG, with FKH, and Reichle & De-Massari AG (CH)

Long-term performance and reliability are required for both fiber optical telecommunication and sensor applications. In particular, this project investigates the physical limitations when data transfer rates of existing optical fiber links are increased up to 40 Gbit/s. Especially for cables exposed to environmental stress, polarization mode dispersion (PMD) is a critical parameter. PMD is the mean value over time and wavelength of the differential group delays (DGD) which are caused by polarization effects. The characterization of optical parameters with time serves as a basis for a decision on allowed maximum data rate for reliable communication using existing fiber links.

Fig. 1: *Pylon of power transmission line with optical fibers inside the ground wires.*

Since the installation of the monitored cables (Fig. 1), fiber attenuation and splice losses have not shown any significant degradation. At a bitrate of 2.488 Gbit/s we found a bit error rate below the detection threshold of 10^{-13}, as expected. Degree of polarization measurements revealed no PMD-critical fiber sections. The fibers are, therefore, well protected and the cables well fastened to the pylons.

Measured PMD-coefficients (PMD divided by square root of fiber length) are in the range of 0.02 to 0.25 ps/√km. DGD was found to be correlated to weather parameters. It was shown that usual singular PMD acceptance measurements of fiber links produce random results. Therefore, long term monitoring is required in order to completely characterize the underlying Maxwellian distribution of the DGD. This is necessary to calculate PMD-induced outage probabilities (Fig. 2). Depending on the restrictions made in terms of outage time per year, most tested fibers can be operated at 10 Gbit/s, however, some of them will not be able to transmit error free at 40 Gbit/s.

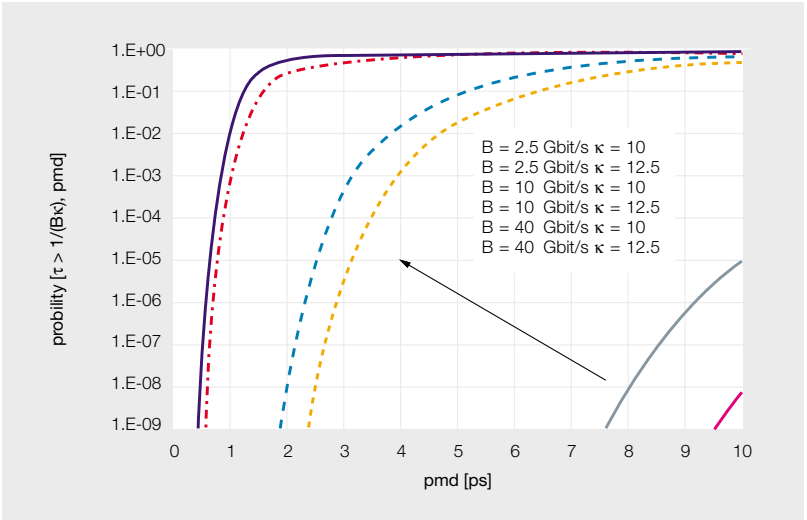

Fig. 2: *Outage probability of DGD τ exceeding 1/κ of the inverse bit rate 1/B versus PMD.*

Support: PSEL

Links: www.empa.ch/abt173
> Sensors

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References:
Ph. M. Nellen et al., Sensors and Actuators, A: Physical, Vol. 103/3, 364–376
M. Held et al., SPIE Vol. 4940, in print

A method to classify weather conditions for long-term averaging of sound levels

Jean Marc Wunderli, Kurt Heutschi

The laboratory of environmental acoustics of EMPA has taken great efforts in the last years to develop sound propagation models that can take weather effects into account (ray tracing, finite differences in the time domain). To allow a comparison of calculated results with measured sound exposure levels, it is necessary to characterize the meteorological conditions from an acoustical point of view. Therefore, a project has been started with the goal to derive the relevant parameters from meteorological data available and to predict sound propagation conditions based on those parameters.

Wind and temperature gradients are the most important influences of weather on sound propagation. As temperature gradients are difficult to measure, it is proposed to derive them indirectly by assessing the atmospheric stability. This can be done by a scheme according to Polster [1], which has as a major advantage the possibility to use either observations, measurements or calculations as input parameters. From the analysis of the radiation balance, it can be shown that positive temperature gradients with height only occur at nighttime in situations with low winds and limited cloud cover.

Sound propagation simulation with typical wind and temperature stratifications show a dominating influence of wind with wind speeds greater than 2 m/s (reference height 10 m). Based on this result, a classification system for sound propagation conditions has been developed that separates meteorological situations into two classes, namely a class for conducive sound propagation conditions and one for hindering conditions. A method is derived that permits determination of the propagation class in the field using wind speed and cloud cover as the only parameters. The ability to easily determine the necessary parameters in the field as well as from meteorological statistics is a major advantage of this approach. It is furthermore shown that long-term averages can be determined with higher accuracy and still reduced expenditure when using the proposed method to take weather effects into account.

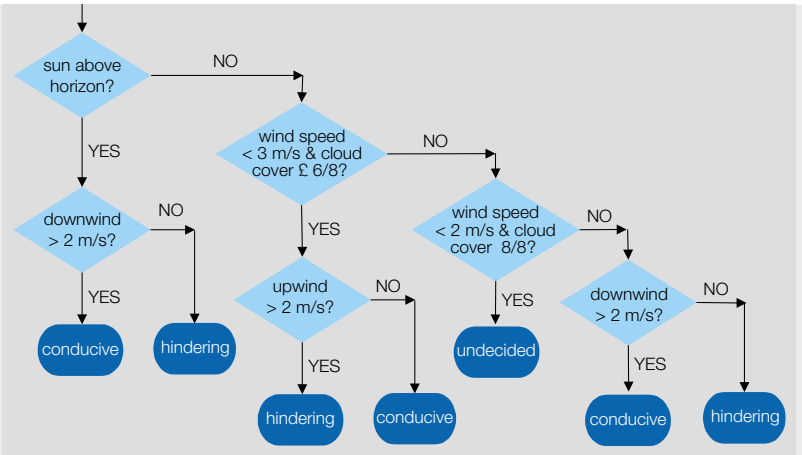

Fig. 1: *Classification of propagation conditions in* ***conducive*** *and* ***hindering*** *situations based on observations of the wind speed and direction, solar altitude and percentage of cloud-cover. Remark 1: The solar altitude can be derived from the geographical position, day and hour. For the scheme, a geographical position representative for central Europe had been chosen. Remark 2: Only the projection of the wind speed vector onto the direction of sound propagation must be taken into account.*

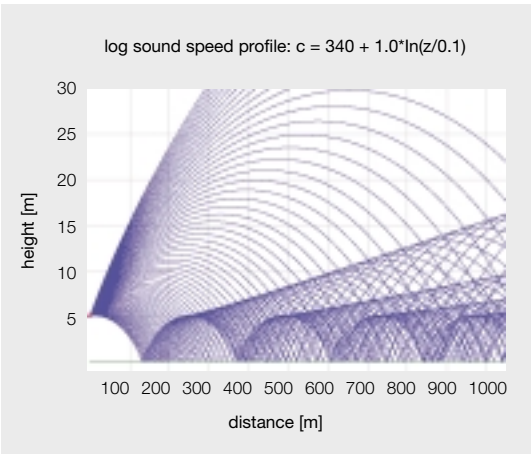

Fig. 2: *Visualization of weather influence on sound propagation using ray tracing. A situation with strong downwind conditions is shown.*

[1] G. Polster. Erfahrungen mit Strahlungs-, Temperaturgradient- und Windmessungen, Meteorologische Rundschau 22, 6 (1999).

Support: GR

Links: www.empa.ch/akustik

Contact: *jean-marc.wunderli@empa.ch*
References:
J. M. Wunderli et al., Acta Acoustica, submitted (2002)

Impacts of new information and communication technologies to the environment

The main part of the impact that the spreading of Information and Communication Technology (ICT) has on the environment is due to the life cycle of its hardware and its potential to influence traffic. Two projects in the framework of the "Sustainability in the Information Society" (SIS) program at Empa have assessed the environmental impacts of ICT for scenarios covering these two fields with a focus on "Pervasive Computing" and "Dynamic Vehicle Routing", respectively. As a third activity, the SIS program has initiated a Network of Excellence for "Environmental Informatics" within the 6th Framework Program of the EU.

Lorenz Hilty,
Frank Hartmann,
Thomas Ruddy,
in collaboration with
Sigfried Behrendt, IZT (D)

The technological and market trends are leading to a new type of ICT, pervasive computing, made possible by the ongoing miniaturization of digital electronics. Pervasive computing is understood as the provision of data processing, storage and wireless communication capacity in a variety of stationary or mobile objects, as well as on or in the human body. Manufacturers expect in their pervasive computing scenarios that around 1000 electronic components will be used per person. On contract from the Swiss Center for Technology Assessment (TA Swiss), Empa assessed the advantages and risks of pervasive computing for health and the environment. It was found that potential environmental problems of pervasive computing are connected to energy demand and electronics waste. The amount of e-waste is expected to be increased by the fact that the largest part of electronic components on the market is so light and small that they fall below the threshold at which separate treatment is efficient. On the other hand, there are developments in the ICT sector that affect material flows in ecologically favorable ways. As Fig. 1 shows, it is to be expected that the mass flow caused by purchases of monitors in Switzerland will decrease because LCD monitors are much lighter than CRT monitors. Besides that, they contain less toxic substances than CRT monitors, and thus cause fewer disposal problems.

Positive environmental impacts of ICT can be achieved in the transport sector. Telecommunications has increasing importance in fleet management. Mobile data communications in combination with a GPS (Global Positioning System) or cheaper location determination technologies based on a mobile telephone network such as TDOA (Time Difference of Arrival) or E-OTD (Enhanced Observed Time Difference) make it possible to exactly determine the location of a company vehicle at any time. Thus, all information is available that is necessary to react optimally to short notice perturbations, such as additional orders or traffic disturbances. In cooperation

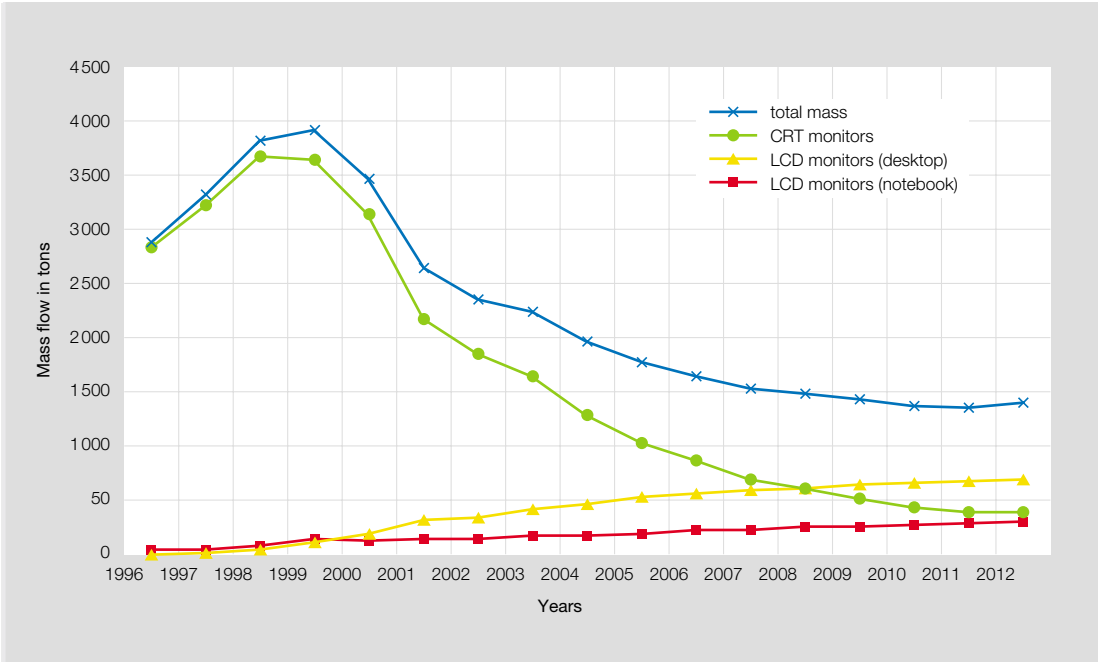

Fig. 1: *Forecast of mass flow caused by sale of computer monitors in Switzerland.*

with Circon AG and three universities of applied sciences (Solothurn, Basel, Luzern), Empa developed and validated a stochastic simulation model in the domain of dynamic vehicle routing. Given the fact that it is necessary to go from a static to a dynamic method of vehicle route planning in order to make use of the available information, a company must ask how to deal with orders coming in on short notice and what consequences different strategies to handle these orders have on the length of distances driven and the utilization of trucks. Two basic strategies are:

- Strategy 1: Short-notice orders are integrated into running routes optimally as regards time and costs, as they come in. Orders that have already been planned are not changed.

- Strategy 2: This strategy combines into a new route each short-notice order with those that have not yet been taken care of, although they have been already planned with the aid of the "Cheapest Insertion" algorithm. Thus, routes that were planned and optimized are destroyed.

Our simulation model is able to assess the performance of such strategies using a sample of the data from the trucking company under study. All constraints relevant in practice are represented as parameters such as the weight and volume capacity limits of vehicles, drivers' working times, distribution of order attributes etc. Another parameter makes it possible to vary hypothetically (0–100%) the percentage of orders considered "dynamic", i.e. the ones that have to be integrated into truck routes that are already proceeding. In this way, the relative performance of different strategies to solve a variation of the Dynamic Vehicle Routing Problem (DVRP) can be simulated under the assumption of different dynamic shares. Important output variables include the sum of distances driven, the associated costs for the company and the environmental impact. Our model was validated using a Swiss trucking company as an example. Fig. 2 shows how the performance of optimization strategies, indicated in this example by the total distance covered, can be compared on different levels of the dynamic share. The model uses the detailed geographic distribution of the customers and other specific data of the trucking company for which it is applied. The insights gained in simulation experiments can lead to considerable savings in traffic load and energy use.

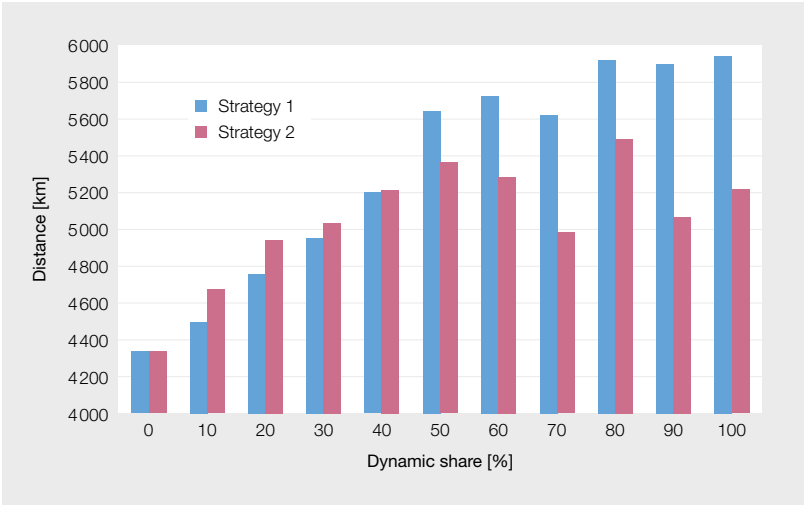

Fig. 2: *Comparison of total distance driven for two optimization strategies and different dynamic shares.*

Applications of ICT to monitor, analyse and reduce environmental load like the one described above are treated systematically in the discipline of Environmental Informatics. Empa has now initiated a Network of Excellence on Environmental Informatics within the 6th Framework Program of Research and Technological Development of the European Commission. Among the partners are the European Environment Agency (EEA) and the United Nations Environment Program (UNEP). The aim of the network is to stimulate convergence of activities towards: (i) standards for environmental data in space and time, (ii) user-friendly and multilingual tools and services, (iii) deriving knowledge from heterogeneous sources in a reproducible way, (iv) bridging the gap between environmental data and decisions to be taken in: natural resource management, risk prevention, crisis management, and resource-use efficiency.

Support: BBT-KTI 4980.1, Circon AG, TA Swiss

Links: www.empa.ch/sit

Contact: *lorenz.hilty@empa.ch*
References:
F. Hartmann, et al., Computers & Industrial Engineering, submitted (2002)

Information, Simulation Technologies, Reliability

ecoinvent – Switzerland's life cycle inventory database

In the global context of Sustainable Development (SD) and the Swiss governmental approach of an Integrated Product Policy (IPP), inventories of ecological data of materials and processes gain more and more importance. The project ecoinvent will provide Swiss and European Life Cycle Inventory (LCI) data allowing administration, industry and consultants to calculate complete value-added chains.

Roland Hischier, Hans-Jörg Althaus, Paul W. Gilgen, Klaus Richter, Mark Zimmermann, in collaboration with ETH Zürich, EPF Lausanne, PSI, FAL/FAT, esu-Services (CH), ifu (D)

Since the beginning of the 1990s, several institutes within the ETH domain started to establish their own inventory databases for life cycle studies. Due to their often limited scope and the fact that overlapping datasets sometimes based on different sources, inconsistent results did appear. Besides, support and regular actualization of the database are very time consuming activities – often too large for one single institute. In 1998 therefore, under the leadership of EMPA, the "Swiss Centre for Life Cycle Inventories" was created as a joint initiative of the ETH domain and Swiss Federal Offices to bring together the different efforts in the area of LCA.

In parallel, the project ecoinvent 2000 was initiated aiming at a unified, harmonized, transparent and actualized high quality life-cycle inventory database, valid for Swiss and Western European conditions. Each participating institute is responsible for the data of exactly defined areas based on LCI knowledge already built up within the last decade, with EMPA being responsible for numerous different types of material (Fig. 1).

On the technical side, several software components (Fig. 2) have been defined and developed in close collaboration with a major European LCA software producer. For the communication of the central database with the other components and with commercial LCA software, an open and future-oriented data exchange format based on XML-technology has been developed following international standardization efforts in the area of LCA data exchange (e.g. SPOLD, ISO 14'048).

On this online accessible database, consistent and coherent LCI unit process data are found allowing an easier performance of LCA studies and increasing the credibility and the acceptance of the life cycle results. This high quality of data together with their transparency and the public access are a prerequisite that LCA can support an Integrated Product Policy (IPP) efficiently.

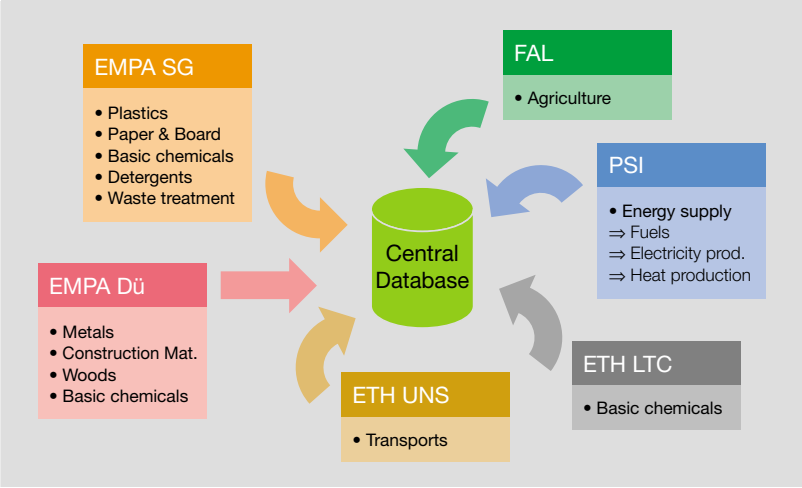

Fig. 1: *Content of the database and the respective responsible institute.*

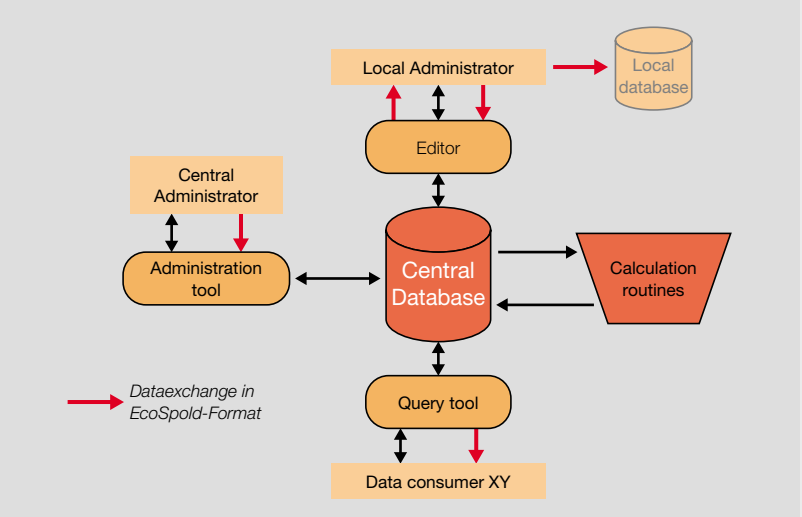

Fig. 2: *Components of the technical system of the database ecoinvent.*

Support: EAWAG, BUWAL, BFE, ASTRA, BBL, BLW, Holz-21

Links: www.empa.ch/abt293
> Environmental and geo-informatics

www.ecoinvent.ch

Contact: *roland.hischier@empa.ch*
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References:
P.W. Gilgen et al., R'02, Conf. Proceed., CD-Rom (2002)

Technology cooperation contributes to a sustainable development in Perú

Heinz W. Böni,
Paul W. Gilgen,
Xaver Edelmann

Limited access to technology and knowledge is an impeding factor for developing countries on the path to a sustainable development. Various initiatives on multilateral and bilateral level are supporting local efforts in developing countries. Since the beginning of 2002, EMPA has been involved in a cooperation with Perú, where a Cleaner Production Center was established in January.

The Cleaner Production Center in Lima is equally financed by the two donor countries Switzerland and the United States through their development agencies seco and USAID, and additionally by local counterparts totally amounting an overall program budget of US$ 2.4 Mio for a four-year duration.

Fig. 1: *Energy loss and air pollution in a foundry in Lima/Perú (Image: M. Flückiger).*

The overall strategy of the cooperation is to support the empowerment of local partners in the implementation of a sustainable industrial development mainly by increasing production efficiency and, thereby, improving the competitiveness. A multiple stakeholder approach tries to integrate private sector, government institutions and universities in these efforts.

We act as a resource and reference center by delivering in-house know-how and external expertise. One of the center's scope is the improvement of the efficiency in processes, products and services in various sectors. Additional topics include environmental management, corporate social responsibility and activities related to international environmental conventions like the Climate Change Convention and the Kyoto Protocol. The aims will be met by providing technical assistance, training and information to the related industries. These services are delivered by the staff of the Cleaner Production Center supported by technical experts within and outside EMPA, and from the American Reference Center (PA consulting group). The first year's activities concentrated on training, local networking and establishing the center's activities. Technology cooperation has been provided with foundries and the paint and resins industry.

Fig. 2: *The final product of the foundry goes to the mining sector (Image: M. Flückiger).*

In sinergy with current cooperations between our institute and Colombia (since 1998), Morocco (since 2000) and Sao Paulo (since 2001), this new program offers an additional potential for technology cooperation and highlights the leadership of EMPA.

Support: seco, UAS Basel, NeoSys AG (CH),
Cooperación Suiza Para el Desarollo Lima (Perú),
Universidad de Lima (Perú),
Universidad Agraria la Molina (Perú),
Sociedad Nacionál de Industria (Perú),
Consejo Nacionál del Medio Ambiente (Perú),
USAID, and PA-Consulting Group (USA)

Links: www.empa.ch/sustec
www.seco-admin.ch
www.cet.org.pe

Contact: *heinz.boeni@empa.ch*

Quality assessment of the JPEG 2000 compression standard

The well established JPEG format is about to be replaced by the upcoming JPEG 2000 offering low to highest lossy compression rates in conjunction with a variety of new exciting features. Since a new standard stands for major investments, JPEG 2000 has to offer convincing benefits for compensating the financial risks. The visual attributes of JPEG 2000 are of utmost importance, particularly in graphic arts industry. Due to its large experience in image quality rating, the EMPA media technology laboratory was asked by the international newspaper color association (ifra) to assess the image distortions caused by JPEG 2000, in contrast to JPEG.

Beat Münch,
Walter Steiger,
Klaus Simon

To achieve reliable quality estimations at varying compression rates, large amounts of different interactive visual ratings have been performed. Special importance was either attached to highest accuracy or to a large collection of test images, alternatively (Fig.1). Large evaluation series have been gathered by both common computer users and skilled graphic arts specialists. Some fundamental questions have been investigated, namely:

- At which compression rates is it possible to recognize differences of the compressed image compared to the original?
- What compression rates of JPEG and JPEG 2000 result in a visually comparable reproduction quality?
- At what compression rates does JPEG 2000 outperform JPEG and by what ratio?

The achieved evaluations yielded the following conclusions:

- JPEG 2000 is capable to compress at highest rates far beyond the scope of JPEG. The perceptive quality comparisons moreover acknowledge JPEG 2000 being clearly superior to JPEG at compression rates above 50.
- Most unexpectedly, the quality of JPEG 2000 underlies JPEG at compression rates below 50, on an average (Fig. 2).
- Those trends, however, are highly depending on the specific image motif. At medium compression rates, the inter-image scattering turned out to be considerably higher than the differences between the two compression standards.
- Evidently, the Wavelet transform used in JPEG 2000 is not superior to the DCT transform of JPEG, with regard to image compression. Better performance at high compression rates is rather due to the liquidation of tiling the image into 8 x 8 pixel blocks, as it is the case in JPEG.

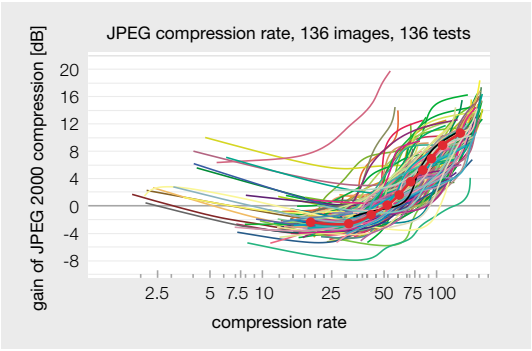

Fig. 2: *Utterly surprising JPEG 2000 gain in dB: Negative gains signifying JPEG being superior to JPEG 2000 are unexpectedly frequent. Each line represents a single image (~140 images in total). The median characteristic (bold red) does not achieve positive values till a compression rate of 50!*

To sum up, JPEG as well as lossy JPEG 2000 compression techniques are questionable for high quality imaging but well suitable for medium and low quality applications where especially JPEG 2000 contains a big potential. Beyond doubt, the statement of preferring JPEG rather than JPEG 2000 for compressions at medium rates below 50 is fairly exciting.

Support: ifra, D-Darmstadt

Links: www.ugra.ch

Fig.1: *The image basis at highest resolution for the JPEG 2000 quality assessments.*

Contact: *beat.muench@empa.ch*
References:
B. Münch et al., Ifra Special Report 2, 35 submitted (2002)

List of abbreviations

ASTRA	Swiss Federal Roads Authority
BAG	Swiss Federal Office of Public Health
BAM	German Federal Institute for Materials Research and Testing
BBL	Swiss Federal Office for Constructions and Logistics
BBT-KTI	Swiss Federal Office for Business Formation and Technology – Commission for Technology and Innovation
BBW	Swiss Federal Office for Education and Science
BFE	Swiss Federal Office for Energy
bfu	Swiss Federal Office for Accident Prevention
BLW	Swiss Federal Office for Agriculture
BUWAL	Swiss Agency for the Environment, Forest and Landscape
BVet	Swiss Federal Veterinary Office
CERN	European Organization for Nuclear Research
CWRU	Case Western Reserve University
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EPF(L)	Swiss Federal Institute of Technology Lausanne
ESA	European Space Agency
ETH(Z)	Swiss Federal Institute of Technology Zürich
EU Program IV	European Community, 4th Framework Program
EU Program V	European Community, 5th Framework Program
FAL/FAT	Swiss Agriculture Research Institutes
FKH	Expert Commission for High Voltage Issues
GR	Swiss Defence Procurement Agency
Holz-21	Swiss Federal Stimulation Program for the Wood
IBT	Institute of Biomedical Engineering
ifra	International Newspaper Color Association
ifu	German Institute for Environmental Informatics
IKB	Institute for Nuclear Physics
IPMS	Institute for Problems of Materials Strength
ISAC-CNR	Institute of Atmospheric Sciences and Climate – National Research Council of Italy
IZT	Institute for Future Studies and Technology Assessment
PSEL	Project and Study Fund of the Electricity Industry
PSI	Paul Scherrer Institute
seco	Swiss State Secretariat for Economic Affairs
SLS	Swiss Synchrotron Light Source
SNF-NFP	Swiss National Science Foundation – National Research Progam
SUVA	Swiss National Accident Insurance Organization
TA Swiss	Swiss Center for Technology Assessment
Top Nano 21	Research Program of ETH Council
TTM	Technik Thermische Maschinen
UAS	University of Applied Sciences
UGRA	Swiss Association for the Promotion of Research in the Graphic Arts Industry
UNIZ	University of Zürich
USAID	United States Agency for International Development

EMPA Activities 2002
Mobility and Environment

Sustainable development requires sustainable mobility. EMPA investigates mobility-based fluxes of pollutants in the exhaust as well as in the free atmosphere, and develops methods to reduce these fluxes. This is our contribution to the reduction of the pollution of the atmospheric boundary layer as well as of the emission of greenhouse gases. A central topic is the internal combustion engine, its exhaust emissions and the technical means for their reduction. Powerful analytical tools combined with models and engineering know-how open the way to new solutions.

EMPA

Tracing atmospheric pollution from space

Andrea Weiss,
Daniel Schaub,
Peter Hofer,
in collaboration with
Andrea Petritoli and
Paolo Bonasoni,
ISAC-CNR (I)

Satellite data have been employed to investigate air pollution transport. In a case study, high NO_2 pollution was observed from the satellite GOME to reside over Switzerland and adjacent France. We identified the source of pollution to be in the region of Belgium, the Netherlands and adjacent Germany by pollution tracing employing trajectories.

Nitrogendioxid (NO_2), a substance emitted by traffic and industry, is a health hazard and causes ozone pollution. Tropospheric NO_2 column from the satellite GOME has been provided by the University of Bremen for analysis and application. A convenient tool for data visualization has been prepared (Schaub, 2002). Air pollution transport, e.g. from Europe to Switzerland, can be observed from spaceborne and ground-based observations. The source attribution requires modeling of the air mass transport. This is done with the wind fields of numerical weather prediction models.

For example, in our case study of February 17, 2001, very high NO_2 was recorded by GOME over central Europe (Fig.1). The weather chart showed an occlusion at the location where the highest NO_2-values were situated, connected with transport of considerable amounts of pollution above the stratus into the middle troposphere (Weiss et al., 2002a).

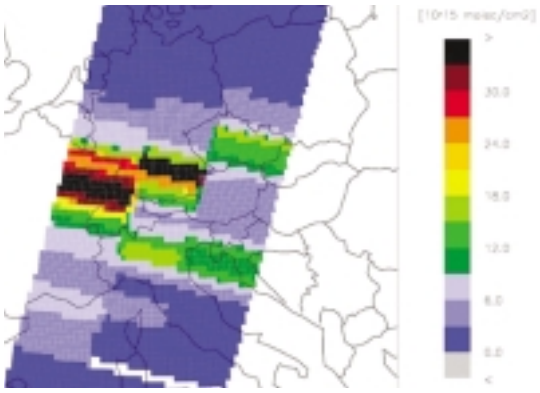

Fig. 1: *High tropospheric NO_2 estimates are observed over central Europe from GOME.*

For tracing the pollution recorded by GOME, we calculated an ensemble of backward trajectories with LAGRANTO (provided by IACETH, Zurich), covering the satellite pixel and the tropospheric column. Trajectories residing near the ground in highly industrialized areas are identified as potential source regions of the pollution observed by GOME. For the case study, the origin of observed pollution is indicated (Fig. 2) over Germany, Belgium and the Netherlands.

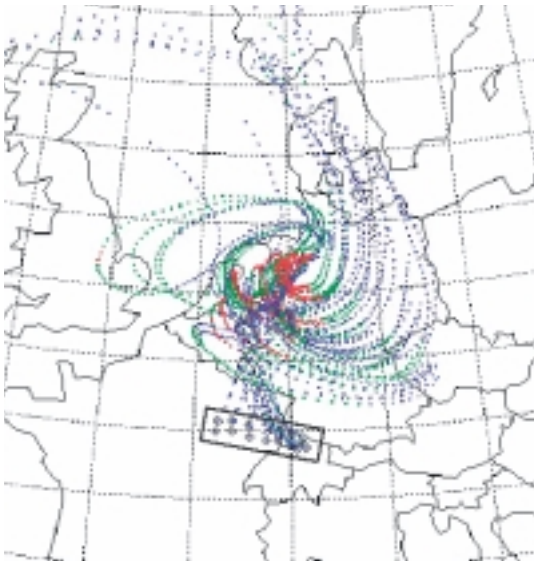

Fig. 2: *Selected backward trajectories travelling near the ground. The 15 starting points (marked o) are distributed over a GOME pixel with a high NO_2 column. Colors code the trajectory height as red: $\Delta p < 50$hPa, green: 50hPa$< \Delta p <$100hPa, blue: h100hPa$< \Delta p <$150hPa.*

Satellite observations from GOME have been demonstrated capable to trace atmospheric pollution (Weiss et al., 2002b). NO_2 transport on a European scale can be observed from GOME (1) above low-level stratus, (2) during frontal activity and active conveyer belts, (3) when occlusions lift near-to-the ground pollution to the middle troposphere, and (4) on cloud-free days.

Support: Data User Project of ESA

Links: www.empa.ch/abt134
> Satellite data

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References:
D. Schaub, DUP-POLPO I ESA report (2002)
A. K. Weiss et al., DUP-POLPO II ESA report (2002a)
A. K. Weiss et al., TROPOSAT report 2001, EUROTRAC-2 (2002b)

Compensating the dynamics of gas transport in instantaneous emission measurement

For the modeling of the emission behavior of cars on a short time scale (1–10 Hz), it is mandatory to run a time correction on the measured emission signals to compensate for the transport dynamics between the car's engine and the analyzers. This transport has to be modeled by linear time varying differential equations. The original signals that are delayed and convoluted over up to ten seconds may be reconstructed to a quality of 0.5 s accuracy.

Martin Weilenmann,
Patrik Soltic,
Delia Ajtay

Exhaust emissions of passenger cars depend on a multiplicity of different input parameters such as: Vehicle speed, street slope, load, ambient temperature and humidity, etc. in a highly nonlinear way. Due to cost reasons, not all combinations of parameters can be measured on the chassis dynamometer during emission inventories. Thus, models are developed to calculate the emissions for unmeasured driving situations. Since technology is progressing, the models used in the 1990s do not work anymore. EMPA, who unifies technical and environmental skills, is among the leaders in developing more accurate models. Such emission models are used by various bodies for emission inventories, air quality monitoring and the verification of the impact of new regulations on regional, national and European scales. EMPA cooperates with BUWAL, ARTEMIS, a 5th EU-FP project, as well as in a "D.A.CH" (German, Swiss, Austrian) project.

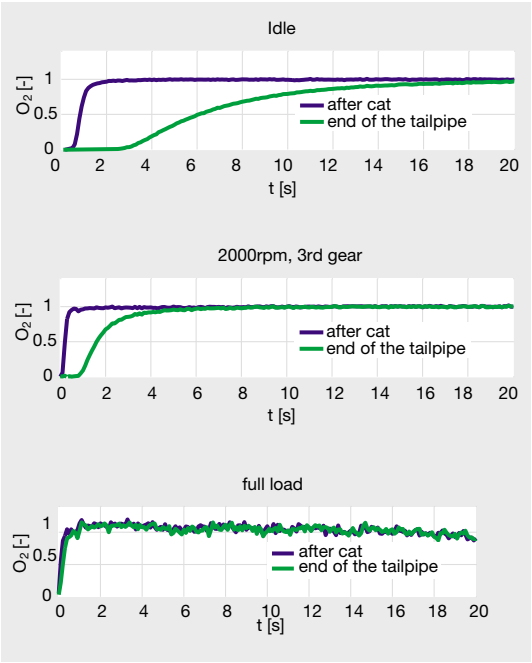

Fig. 1: *Results of gas injection tests. Different time delays and different dynamic flattening takes place during the gas transport in the exhaust system of a car, depending on the actual volume flow.*

Since these emissions vary within several orders of magnitude with a frequency content of up to 5 Hz in practical operations, the emission measurements used for the modeling have to be done with a sampling of 10 Hz or more, and the signals are not allowed to be convoluted by the measurement process more than about one second. As visible in Fig. 1, the transport of the exhaust gases through the car's exhaust system violates this condition (Please note that the signals of Figs. 1, 3 and 4 are generated by fast oxygen sensors. Such sensors are not available for other emission gases). Moreover, the dynamics of that gas transport depend on the volume flow, thus, they are time varying. Therefore, before building vehicle models, the convolution of the measurement signals must be compensated. To do so, we developed an invertible transport model. This model has to be easy to parameterize, since it has to be applicable to many different cars.

In general, the transient, turbulent gas transport in pipes is very difficult to model and leads to partial differential equations with a high number of geometry dependent parameters. The authors decided to follow a bottom up approach to look for the easiest possible model structure with a minimal number of parameters: For a fixed exhaust volume flow, the most simple approach that fits to the step responses of Fig. 1 consists of two parts: A pure time delay stands for a piston flow in one part of the transport volume. The rest of the volume is assumed to be a mixing chamber with perfect mixing (no local gradient of concentrations), which results in a linear first order differential equation (Fig. 2). By reason of the law of mass conservation, the sum of the time delay

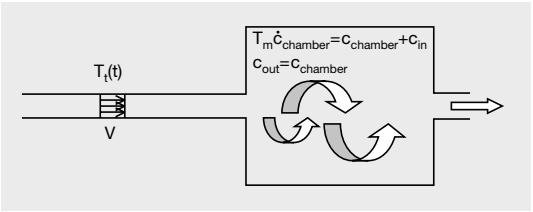

Fig. 2: *Simple gas transport model: a piston flow in the first submodel and a mixing chamber with homogenous concentration in the second submodel.*

and the time constant of the mixing dynamics are equal to the quotient of the pipes' volume and the actual volume flow. Tests showed that the ratio between these two parameters is equal for all different volume flows as well as for different cars. Thus, the model parameters become easy functions of the exhaust volume flow and a general model is found to describe the transport dynamics in the car's exhaust system. The coincidence of the measured signal at tailpipe and the signal obtained by simulation for the same point highlight the quality of this model (Fig. 3).

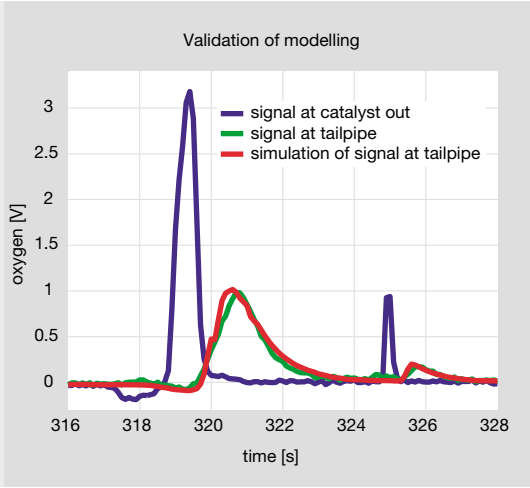

Fig. 3: *Validation of the transport model for the exhaust system in a dynamic FTP-75 test. The oxygen peak at t = 319 is caused by a deceleration phase, where the engine goes into overrun fuel cut-off.*

For the compensation of these gas transport dynamics, we need the inversion of this transport model to reconstruct the original signal out of the convoluted measurements. Since the model describes a low pass system, the inverse is a high pass system. However, high pass systems amplify measurement noise massively. Thus, we included a noise filter to the inversion process. The bandwidth of that filter was chosen so that the measurement noise is damped without flattening the wanted signal. The optimal solution for this trade-off depends on the signal to noise ratio, thus, it relies on the analyzer quality.

Fig. 4 shows the quality of the inversion in a highly transient situation. This reconstruction of the original signal allows us to allocate the exhaust emissions to the driving condition with a high quality by introducing only one single additional parameter, namely the volume of the exhaust system. The results are the basis for the ongoing development of a new vehicle emission model.

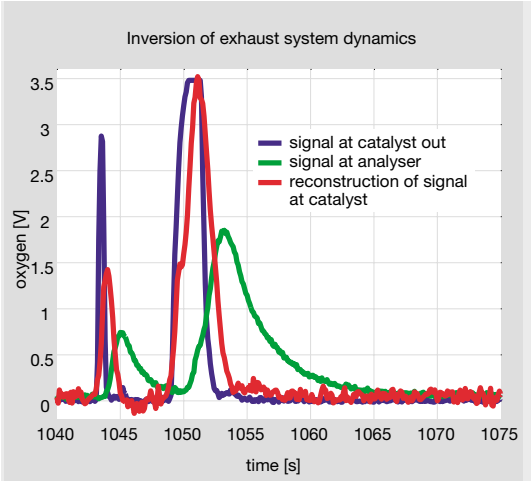

Fig. 4: *Inversion of transport dynamics of the exhaust system. The oxygen peak at 1043 s occurs during a gearshift from third to second, the peak at 1050 s occurs in an overrun fuel cut-off situation while decelerating. Please note that the plateau of the oxygen signal at tailpipe is not a sensor overflow but that pure air is in the tailpipe during this period.*

Support: BUWAL, BBW, EU Program V

Links: www.empa.ch/abt137
> Modelling

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References:
M. Weilenmann et al., Atmospheric Environment, accepted (2002)
M. Weilenmann et al., Transport and Air Pollution Symp., Graz, Conf. Proceed. (2002)

Catalyst-induced benzene formation

The benzene emission characteristic of gasoline-driven vehicles representing the current technology (EURO-2) was determined by time-resolved chemical ionization mass spectrometry. The conversion efficiencies of the involved catalytic systems were deduced from pre- and post-catalyst data. Optimal benzene conversion (> 95%) was obtained when driving 30–90 km h^{-1} but reduced efficiency was found below 20 or above 100 km h^{-1}. No net benzene conversion was observed when driving above 130 km h^{-1}. In contrast, the post-catalyst benzene levels exceeded those of the untreated exhaust gas by up to 50%. Thus, benzene is formed across the catalyst under these conditions. These findings were verified on a EURO-1 vehicle, which was extendedly operated under fuel-rich combustion conditions. At most, the benzene emissions after the catalyst increased by 350% when driving 125 km h^{-1} at a lambda value of 0.87.

Norbert Heeb,
Anna-Maria Forss,
Stefan Brühlmann,
Martin Weilenmann

Benzene (C_6H_6) is an aromatic hydrocarbon which is a constituent of gasoline but is also found in exhaust gases from different combustion processes. The benzene emissions of gasoline-driven vehicles are an important source of pollution affecting the ambient air quality in urban and suburban surroundings. Benzene is a known human carcinogen, and the atmospheric benzene level is now regulated to an annual mean of 5 µg m^{-3} under the current European legislation. In Switzerland, atmospheric benzene concentrations in urban surroundings which are effected by motor traffic are close to this threshold level. Typically, the highest atmospheric benzene levels are observed during wintertime.

The implementation of the three-way catalyst technology (TWC) has reduced the emissions of most toxic exhaust gas components. Nevertheless, we have proven that benzene is not always converted in the catalyst, but can also be formed at certain driving conditions. Thus, benzene has to be regarded as a secondary emission like ammonia or hydrogen sulfide. These findings were observed on a car of the preceding vehicle technology (EURO-1). The question was raised to what extent a catalyst-induced benzene formation had to be expected for the current EURO-2 vehicle technology. Therefore, we investigated in detail the emission characteristics of six gasoline-driven EURO-2 vehicles. The performance of the current three-way catalyst technology was addressed by simultaneously monitoring the pre- and post-catalyst emissions.

Within a 2-year test program funded by the BUWAL, a total of 30 EURO-2 passenger cars and 10 EURO-2 light duty vehicles were studied for their emissions under transient driving conditions using time-resolved exhaust gas analysis techniques such as chemical ionization mass spectrometry (CI-MS). Each vehicle was selected based on the current Swiss car sales statistics. From this representative vehicle fleet, a smaller set of six vehicles was chosen for an additional test program with a focus on the benzene emissions. The sub-set was comparable to the entire fleet with respect to its carbon monoxide (CO), nitrogen oxide (NO_x) and hydrocarbon (HC) emissions.

As shown in Fig.1, the benzene emissions of today's gasoline-driven vehicles significantly increase at highway driving. On those conditions we found that, on average, benzene is formed over the catalyst and the amount of benzene released is independent of the benzene level in the fuel (Heeb et al., 2002). As a result of this, the average benzene conversion of

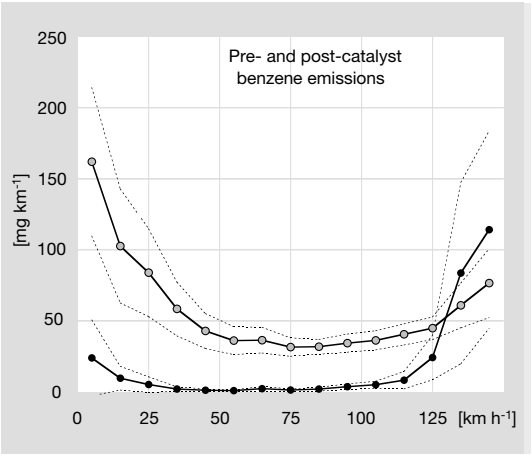

Fig. 1: *Mean velocity-dependent benzene emissions (mg km^{-1}). The pre- (grey) and the post-catalyst (black) emissions are given.*

the tested vehicle fleets becomes negative when driving faster than 130 km h^{-1} (Fig. 2). Therefore, we have to assume that both the EURO-1 as well as the EURO-2 vehicles, which together represent about 70% of the actual passenger car fleet, release significant amounts of benzene when operated at fuel-rich combustion conditions. Such conditions can occur for a short period of time at any vehicle speed, for example when accelerating, or when driving at higher engine loads on ascending roads or with loaded vehicles. However, as deduced from the acceleration- and velocity-dependent conversion data (Fig. 2), such sub-optimal combustion conditions most frequently occur when driving above the current Swiss speed limit.

It is still unclear which exhaust gas components can be converted into benzene. Therefore, we are now investigating the formation potential of possible benzene precursors and are studying their chemical transformation reactions at fuel-rich combustion conditions. Fig. 3 displays the influence of the air-to fuel ratio on the benzene conversion rate of a passenger car equipped with a three-way catalyst. When operated at 125 km h^{-1}, the investigated catalyst can indeed produce an impressive amount of benzene. At a lambda of 0.87, a negative benzene conversion rate of -3.4 was found corresponding to pre- and post-catalyst emission factors of 167 and 740 mg km^{-1}, respectively. On the same conditions, most hydrocarbons were successfully converted at efficiencies increasing from 0.2 to 0.8 when rising lambda from 0.83 to 0.98. Therefore, we conclude that at fuel-rich combustion, the majority of the emitted benzene is formed in the catalyst via efficient chemical transformation processes. The chemistry of this secondary emission pathway is currently under investigation.

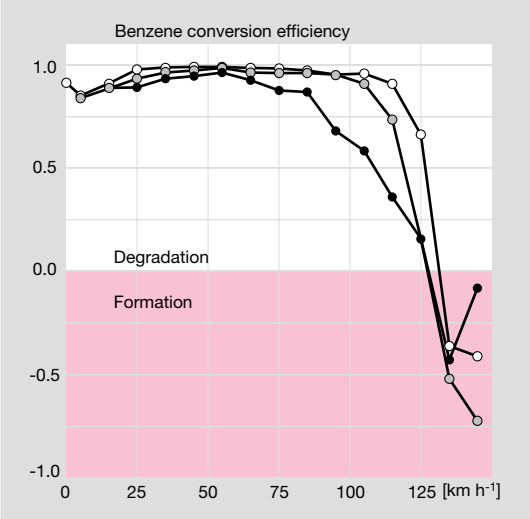

Fig. 2: *Mean acceleration- and velocity-dependent conversion efficiencies of six EURO-2 gasoline vehicles. The data at no acceleration (white), at intermediate (grey) and at maximum acceleration (black) is given.*

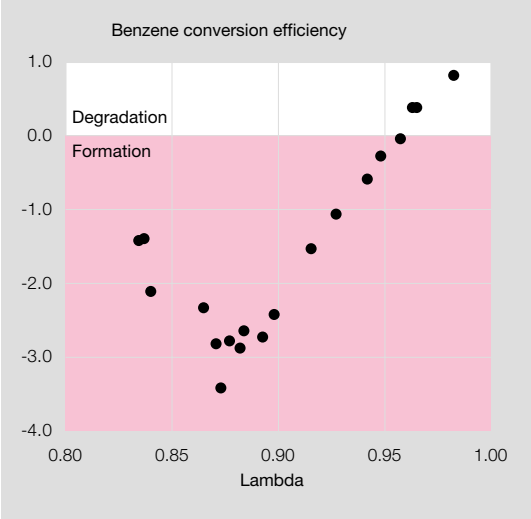

Fig. 3: *Lambda-dependent benzene formation under fuel-rich combustion conditions.*

Support: BUWAL

Links: www.empa.ch/abt132
> Exhaust gas analysis

Contact: *norbert.heeb@empa.ch*
References:
N.V. Heeb et al., Atmospheric Environment 36, 4745–4756 (2002)

European source allocation of halogenated greenhouse gases using high-quality measurements at Jungfraujoch

In this project, we investigate the Central European emissions of a wide range of halogenated greenhouse gases by high-quality measurements at the High Alpine Research Station Jungfraujoch. The dominant European source regions of the individual trace gases are identified and quantified by meteorological models. Within an EU-project, designed in the course of this project, a European network consisting of four monitoring stations has been developed in order to observe the emissions of these greenhouse gases from Western Europe. This approach has the potential to control compliance of European countries with important international protocols (Montreal, Kyoto).

Stefan Reimann,
Daniel Schaub,
Konrad Stemmler,
Andrea Weiss

Halogenated gases are important industrial products which are used in a wide variety of applications, such as refrigeration, foam blowing, cleaning and fire extinction. Many of these halocarbons are very persistent in the environment and, therefore, accumulate in the atmosphere. They act as greenhouse gases and contribute to the radiative forcing of the atmosphere depending on their emissions, their atmospheric lifetimes and their infrared-absorption coefficients.

Fig. 1: *The High Alpine site of Jungfraujoch (3580 m a.s.l.).*

With regard to their environmental impact, the halogenated substances can be divided into two groups: First, substances containing chlorine and bromine (i.e. chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halones and long-lived chlorinated solvents), which are responsible for the depletion of the stratospheric ozone layer. They are regulated by the Montreal Protocol. Second, fluorocarbons (i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs)), and SF_6, which do not affect the earth's ozone layer. These compounds often have long atmospheric lifetimes and are listed, among carbon dioxide, methane and nitrous oxide in the Kyoto Protocol as anthropogenic greenhouse gases. Halocarbons in total are estimated to be responsible for about 14% of the radiative forcing of all anthropogenic greenhouse gas emissions.

In January 2000, we began to measure halogenated greenhouse gases continuously by gaschromatography-mass spectrometry (GCMS) at the High Alpine Research Station Jungfraujoch (Fig. 1). Our instrument is designed to monitor the increasingly important fluorocarbons in ambient air, which was not possible with previous analytical methods. The instrument is one of only five units of this type worldwide. Four instruments (Monte Cimone, Italy; Spitsbergen, Norway; Jungfraujoch, Switzerland; and Mace Head, Ireland) were combined in the network of the EU-project SOGE (System for Observation of Halogenated Greenhouse Gases in Europe) with the aim to model the emissions of halogenated greenhouse gases of large parts of Western Europe. Additionally, the measurement at the Jungfraujoch is used for the Swiss National project HALCLIM, with the aim of estimating the Swiss emissions of these gases.

The 3 years of measurement data of the different halocarbons show a stabilization of the concentrations of Montreal Protocol regulated substances, whereas the newer HFCs exhibit a rapid growth in their atmospheric concentrations. As an example for an important hydrofluorocarbon, Fig. 2 shows the increase of the atmospheric background mixing ratio of refrigerant HFC 134a, the major replacement product for the forbidden CFC 12. Remarkably, deviations from the background concentration are higher in the data series from the Jungfraujoch than in those from Ireland and Spitsbergen. This is due to the vicinity of the Jungfraujoch to the most important European source regions.

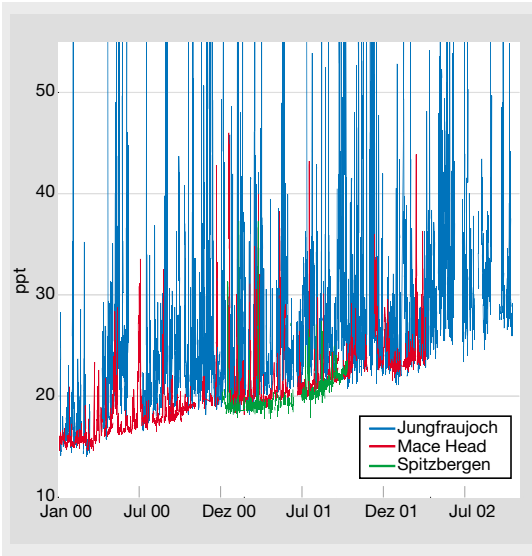

Fig. 2: *Data series of the refrigerant HFC 134a at the European background sites of Jungfraujoch, Mace Head (Ireland) and Ny-Alesund (Spitsbergen).*

By combining measurements at Jungfraujoch with backward trajectories in a statistical model, potential source regions can be detected. Thus, in Fig. 3 potential source regions and their temporary evolution are shown. Thereby, a decline in the source strength of the cooling agent HFC 134a has been observed in Southern Europe within the last 2 years. On the other hand, source strengths of the foam propellant HFC 152 have been increased considerably over Europe in the same time period.

In future, the modeling activities at the four SOGE stations will be combined in order to reach an integral and quantitative emission source allocation over Europe.

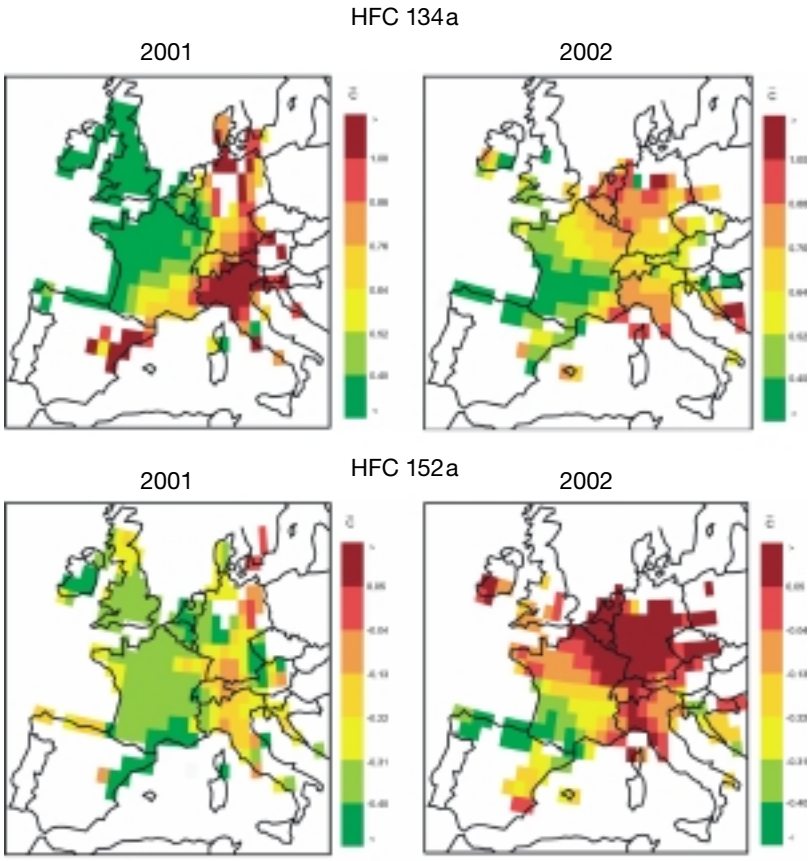

Fig. 3: *Source allocation of the refrigerant HFC 134a and the foam blowing agent HFC 152a achieved with a statistical trajectory model of the data series at Jungfraujoch.*

Support: BUWAL, EU Program V

Links: www.empa.ch/abt134
> Pollutant source identification
www.nilu.no/niluweb/services/soge/

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References:
S. Reimann, et. al., 3rd Conf. on Non-CO_2 Greenhouse Gases, Conf. Proceed., 571 (2002)
S. Reimann, et. al., 7th IGAC meeting, Crete, Conf. Proceed. (2002)

Analysis of fuel additives in emissions of diesel vehicles with particle traps

Fuel additives used with particle traps have to comply with environmental directives and must not support formation of additional toxic substances. The emission of metal additives from diesel engines with downstream particle traps has been studied. A mass balance calculation shows the retention rate of filters and a possible deposit of additives in the engine.

Andrea Ulrich,
Adrian Wichser

Even the latest diesel engines emit fine soot particles which can cause serious health problems. Several countries regulate particulate matter emissions. Particle traps (Fig. 1) are suitable tools to minimize soot emissions. Different filter types are available. Pore size must compromise optimal particle retention and less clogging. A technical challenge is the regeneration of clogged filters. Offline regeneration with external heaters is prevalent at construction sites but not practical for on-road vehicles. Online regeneration demands a minimum temperature of 550 °C but additives can decrease ignition temperature by catalyses of transition metals.

The assessment of secondary emissions is an important criterion for suitability of particle filters. EMPA studies the trap-induced formation of hazardous organic compounds and the emission of additive metals. Trap systems with additive regeneration must not emit heavy metals. Therefore, retention for ultrafine particles and possible trap penetration of additive metals have been studied for several filter types in different driving situations. Emission rates have been compared for standard and additive fuels.

The determination of the additive metals in such low concentrations requires a suitable sampling procedure, preparation and determination. Contamination risk and memory effects in engine and test facility are not negligible. An optimization of the complete chain is evident to achieve reliable results and is described in Ulrich et al., 2002.

Fig. 1: *Particle trap system on a heavy duty vehicle.*

Exemplary size classified sampled emissions of a particle trap equipped heavy duty engine driven with a cerium Ce additive are presented here. Ce quantities sampled without trap were significantly higher than with trap. This indicates a high retention rate of the trap. The efficiency assessment and a potential penetration risk of additive metals have been investigated by a mass balance. Therefore, the measured metal mass on the ELPI foils (electrical low pressure impactor) was extrapolated for the total emissions based on the dilution ratio during sampling. Results are given in Table 1. In comparison to the dosed additive amount, the calculated total Ce mass in the exhaust gas without trap was relatively low. It seems that an unexpectedly large additive proportion was retained or deposited in the engine. Further studies should answer where additive deposition occurs. Furthermore, emissions under different trap conditions (loading, regeneration) should be investigated as well as longterm stability tests of additives in fuels.

Tab. 1: *Mass balance for a cerium additive.*

Data based on total mass per cycle	Cerium	%
Dosed additive quantity	473 mg	100
Total mass exhaust gas without particle trap (calculation based on measured total mass ELPI)	15.4 mg	3.3
Total mass exhaust gas with trap (calculation based on measured total mass ELPI)	0.3 mg	0.1
Calculated deposition in engine	457 mg	96.7
Calculated deposition in the particle trap	15.1 mg	3.2
Calculated emission into ambient	0.3 mg	0.1
Total	473 mg	100
Calculated filtration rate engine	96.7 %	
Calculated filtration rate particle trap	98.2 %	
Calculated total filtration rate system	99.9 %	

Support: BUWAL, TTM, UAS Biel, industry partners

Links: www.empa.ch/abt131
> Particle traps

Contact: *andrea.ulrich@empa.ch*
References:
A. Ulrich et al., Proceed. of 6th Conf. on Nanoparticle-Measurement, ETH Zürich (2002)

Railway traffic – a source of fine particles? Contributions of railway traffic to local PM10 concentrations – a preliminary field study

Robert Gehrig,
Matz Hill,
Ralf Kägi,
Judith Kobler,
in collaboration with
Urs Baltensperger, PSI (CH), and Jürg Heldstab, INFRAS (CH)

Are elevated concentrations of PM10 to be expected in the vicinity of railway lines? To answer this question, PM10 and its iron content were measured at two sites which are dominated by freight or passenger trains respectively. Pronounced differences in the iron content of PM10 compared to nearby background sites indicate a clear effect of the railway traffic.

Based on mass losses of wheels, brakes and tracks due to abrasion, the emissions of PM10 from railway traffic were recently estimated to account for 2800 t/year in Switzerland. Compared to 6000 t/year from road traffic, this would represent a considerable source of PM10 and should lead to an observable increase of ambient PM10 concentrations near railway lines.

Measurements of PM10 and iron were carried out during one month at two sites, one dominated by freight train traffic (Brugg), the other by passenger train traffic (Basel). The contribution of the railway traffic was determined by comparison with parallel measurements at nearby sites with similar background pollution but no direct exposure to railway traffic. The sampling points were placed at a distance of only 2 m from the tracks, in order to represent a "worst case". This ensured that a possible increase of PM10 due to railway emissions could reliably be detected.

The measurements at Brugg and Basel show that railway traffic, indeed, emits PM10, which can be detected as elevated concentrations of ambient PM10. A considerable part of the PM10 consists of iron, which is presumably at least partly oxidized (Fig.1). However, significant amounts of coarse iron particles, which were found in deposited dust near the tracks (Fig. 2), suggest that at least a part of the abraded iron particles are not in the PM10 fraction. Sensitivity tests with a PM10 model based on these data as well as on preliminary emission measurements of iron cast block brakes on a test facility suggest railway induced PM10 emissions of 800–1200 t/year rather than 2800 t/year. Further and more detailed measurement campaigns at distances of 10–200 m from tracks which are more representative for public exposure will be conducted in a new research project starting in 2003.

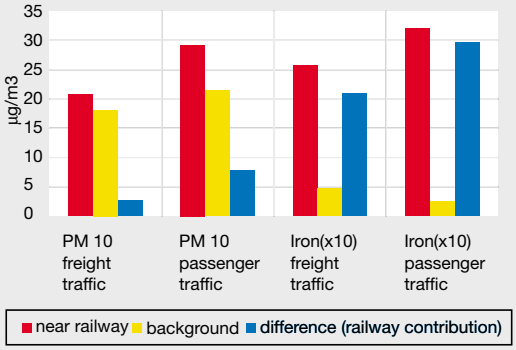


Fig. 1: *Comparison of mean PM10 concentrations [µg/m³] and the iron concentration [µg/m³ calculated as Fe_2O_3] at the railway site and the background site. The differences indicate the contribution of the railway traffic.*

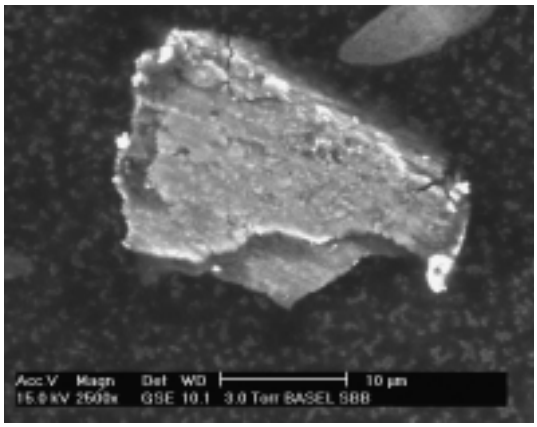


Fig. 2: *Example of a coarse iron particle deposited near the railway line at Brugg.*

Support: BUWAL

Links: www.empa.ch/abt134
> Pollutant source identification

Contact: *robert.gehrig@empa.ch*
References:
R. Gehrig et al., Proc. 11th Int. Symp. Transport and Environment; VKM-THD-Mitteil., 81, 267 (2002)
J. Heldstab et al., BUWAL, Bern, Umwelt-Materialien, Luft Nr. 144 (2002)

The source of high dioxin levels in Swiss food of animal origin

The presence of dioxins (polychlorinated dibenzo-*p*-dioxins and dibenzofurans) in food of animal origin is caused by bioaccumulation along the food chain. Therefore, these foodstuffs (e.g. dairy products, eggs, fish, and meat) generally contain higher dioxin levels than vegetable foodstuffs. If the diet of farm animals is contaminated with dioxins, elevated levels in the respective products are detected. After cases of dioxin contamination detected in Swiss feedstuffs and food, EMPA was a partner in a research project initiated by the Swiss Department of Home Affairs in order to assess the extent and circumstances of the contamination of the food supply.

Peter Schmid,
Erika Gujer,
Markus Zennegg,
in collaboration with
Arnold Kuchen and
Claude Wüthrich,
BAG (CH)

Between 1997 and 1999, several cases of dioxin contamination in food of animal origin occurred in Europe due to feedstuffs contaminated by several independent sources: citrus pulp pellets, fat containing polychlorinated biphenyls (PCB), and kaolin used as an anti-caking agent in pelleted feed. As a consequence, a survey on dioxins in food of animal origin was initiated by the Swiss authorities in order to assess the extent of dioxin contamination of the food supply in cooperation with EMPA. Since 1980, EMPA has played an active role in the exploration of the fate of dioxins in the environment, and trace analysis of these contaminants has been one of our core competencies.

Investigation of a total of 128 foodstuff samples of animal origin (cow's milk, poultry, eggs, and meat) revealed several cases of residue levels distinctly above the background exposure limit of approximately 2 ng I-TEQ/kg (Fig. 1). The concentration of dioxins is expressed as total toxicity equivalents (I-TEQ), reflecting the levels of the relevant dioxins weighted by their respective toxicities.

At background contamination levels, polychlorinated dibenzo-*p*-dioxins (PCDD) and dibenzofurans (PCDF) contribute to about 50% each to the total I-TEQ. In contrast, the total I-TEQ of kaolin is strongly dominated by PCDD, while PCDF are almost completely absent. The formation pathways of the dioxins in kaolin originating from deposits in Rhineland-Palatinate (Germany) are still unknown, but anthropogenic influence can be excluded. In the case of dioxin transfer from contaminated kaolin to food, the share of the total I-TEQ resulting from PCDD rises distinctly (>80%). Fig. 2 shows typical samples with background levels (cow's milk) and with additional dioxins originating from kaolin (indicated by increased PCDD percentages).

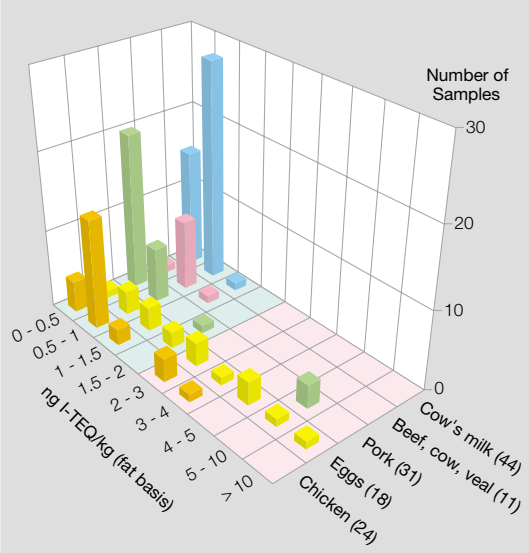


Fig. 1: *Dioxin levels (ng I-TEQ/kg fat) detected in food of animal origin (in parentheses: number of samples).*

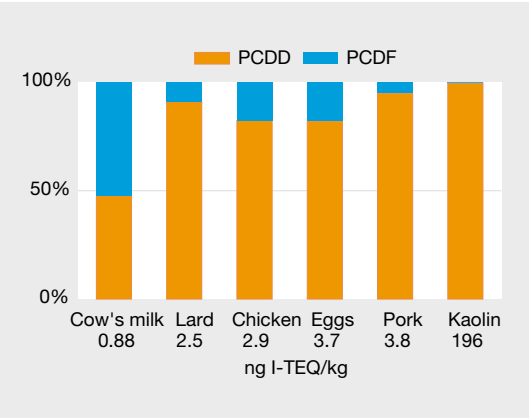


Fig. 2: *Total I-TEQ levels and PCDD/PCDF composition of selected foodstuff samples and kaolin (ng I-TEQ/kg fat for food samples, ng I-TEQ/kg dry weight for kaolin).*

Support: BAG, BVet

Links: www.empa.ch/abt132
> Analytical chemistry of pollutants
http://dx.doi.org/10.1021/jf025669z

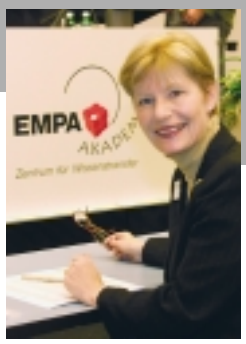
Contact: *peter.schmid@empa.ch*
References:
P. Schmid et al., J. Agric. Food Chem. 50, 7482 (2002)

List of abbreviations

ASTRA	Swiss Federal Roads Authority
BAG	Swiss Federal Office of Public Health
BAM	German Federal Institute for Materials Research and Testing
BBL	Swiss Federal Office for Constructions and Logistics
BBT-KTI	Swiss Federal Office for Business Formation and Technology – Commission for Technology and Innovation
BBW	Swiss Federal Office for Education and Science
BFE	Swiss Federal Office for Energy
bfu	Swiss Federal Office for Accident Prevention
BLW	Swiss Federal Office for Agriculture
BUWAL	Swiss Agency for the Environment, Forest and Landscape
BVet	Swiss Federal Veterinary Office
CERN	European Organization for Nuclear Research
CWRU	Case Western Reserve University
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EPF(L)	Swiss Federal Institute of Technology Lausanne
ESA	European Space Agency
ETH(Z)	Swiss Federal Institute of Technology Zürich
EU Program IV	European Community, 4th Framework Program
EU Program V	European Community, 5th Framework Program
FAL/FAT	Swiss Agriculture Research Institutes
FKH	Expert Commission for High Voltage Issues
GR	Swiss Defence Procurement Agency
Holz-21	Swiss Federal Stimulation Program for the Wood
IBT	Institute of Biomedical Engineering
ifra	International Newspaper Color Association
ifu	German Institute for Environmental Informatics
IKB	Institute for Nuclear Physics
IPMS	Institute for Problems of Materials Strength
ISAC-CNR	Institute of Atmospheric Sciences and Climate – National Research Council of Italy
IZT	Institute for Future Studies and Technology Assessment
PSEL	Project and Study Fund of the Electricity Industry
PSI	Paul Scherrer Institute
seco	Swiss State Secretariat for Economic Affairs
SLS	Swiss Synchrotron Light Source
SNF-NFP	Swiss National Science Foundation – National Research Progam
SUVA	Swiss National Accident Insurance Organization
TA Swiss	Swiss Center for Technology Assessment
Top Nano 21	Research Program of ETH Council
TTM	Technik Thermische Maschinen
UAS	University of Applied Sciences
UGRA	Swiss Association for the Promotion of Research in the Graphic Arts Industry
UNIZ	University of Zürich
USAID	United States Agency for International Development

EMPA Activities 2002

EMPA Academy



The EMPA Academy is the platform for knowledge transfer of the results of our comprehensive research and development activities as well as services. The events in the form of conferences, courses and lectures are open to attendees interested in our work and in broadening the know-how of their special field of activity. Furthermore, opportunities for panel discussions, exchange of experience, and networking are given. The perfomances are presented by EMPA collaborators, our scientific and industrial partners, and further national and international experts, who readily share their great experience with the audience.

Empa Academy
The center for knowledge-transfer

In its third year, the Empa Academy was once again able to increase the number of participants for courses and conferences up to 6000 people. The interest in the results of Empa's research and testing is still rising. We offer courses and organize lectures and conferences covering all the Empa priority programs and activities.

Renewable Energy – Reality and Visions

Under this title, a conference took place in the Academy in Dübendorf in November 2002. It was organized by Empa Academy in cooperation with the Swiss Society of Solar Energy (SSES). The presentations of the eight speakers covered scientific, social and financial aspects of renewable energy skills. The goal of this conference was to show a great number of aspects, and to give the audience the opportunity to discuss the problems with specialists.

Mark Zimmermann, Head of the Center for Energy and Sustainability in Civil Engineering at Empa, presented his vision of a 2000-Watt-Society, which implies reducing the power consumption per person to the level of the year 1960. Empa, with its development of energy saving isolation material, could help to achieve this goal.

As a representative of the government, Regine Aeppli advocated a new attitude and propagated the internalization of external costs. In her opinion, fossil and nuclear energies are still too cheap. According to her, the strong economic-conservative lobby is to blame for this.

"The sun doesn't send a bill" – was the topic of the conference held by the famous TV moderator Franz Alt, who talked about the benefits of solar energy. The horror-vision as seen in a scenario by the "Münchener Rückversicherung" (Reinsurance Company of Munich) predicts that by 2050, the costs for removing the damages in nature will exceed the gross national product of the whole world. Franz Alt sees the last resort in the sustainable energy politics.

Anne Satir

Regine Aeppli, Parliamentarian

TV moderator Franz Alt

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Links: *www.empa-akademie.ch*

List of Courses and Conferences in 2002

EMPA Academy

Courses

January	**11**	Präsentationstechnik Kurzworkshop
	25 + 28	Wirkungsvoll präsentieren
March	**08**	The Power of Networks
	12	Systematische Qualitätskontrolle im Workflow der grafischen Industrie
	13	Planung und Einführung von CtP – Technisch orientiert
	14	Planung und Einführung von CtP – Management orientiert
	18	Farbe im digitalen Workflow – Color Management
	19	Farbe im digitalen Workflow – Digitales Proofing
April	**17**	Bestimmung der Messunsicherheit
	26./29	Thermoaktive Bauteilsysteme tabs – Teil I + II
May	**07**	Passivhaus konkret – Das Passivhauskonzept
	14	Passivhaus konkret – Die Gebäudehülle - Haustechniksysteme
	23	Einführung in das Programm OGIP
	28	Passivhaus konkret – Nachhaltigkeitsbetrachtungen – Passivhaus-Nachweis
June	**05**	Passivhaus konkret – Das Passivhauskonzept
	10	XML – Schlüssel zum Crossmedia-Publishing (Management orientiert)
	11	XML – Schlüssel zum Crossmedia-Publishing (Technisch orientiert)
	12	Planung von Mediendatenbanken im digitalen Workflow
	16	Evaluation of Measurement Uncertainty in Analytical Chemistry
	19	Passivhaus konkret – Die Gebäudehülle – Haustechniksysteme
	25	Meteorologie und Schallausbreitung
August	**21**	Passivhaus konkret – Das Passivhauskonzept
	28	Passivhaus konkret – Die Gebäudehülle – Haustechniksysteme
September	**02–04**	Forschung erfolgreich vermarkten – Block I
	03	Bauakustik-Kurs EMPA/SGA
	05	Passivhaus konkret – Nachhaltigkeitsbetrachtungen – Passivhaus-Nachweis
	23–25	Forschung erfolgreich vermarkten – Block II
	26–27	Kunststoffrohre richtig planen, berechnen und verlegen
October	**23**	Systematische Qualitätsplanung im Workflow der grafischen Industrie
November	**05/06**	Wie lange hält ein Kunststoffbauteil?
	11	Neue Wege bei der Durchführung von Audits
	12	Einführung in das Programm OGIP
	14	Farbe im digitalen Workflow – Color Management
	15/18/29	Workshop “Wirkungsvoll Präsentieren”
	15	Farbe im digitalen Workflow – Digitales Proofing

Conferences

January	**10**	SZFF Plenarversammlung
February	**08**	Integrales Mangement der baulichen Gemeindeinfrastruktur
March	**01**	Bauen mit Geotextilien (SG)
	21	Textiltagung (Hotel Marriott Zürich)
April	**11**	Stoffliches Recycling in der CH
	19	Verbrennungsmotoren
May	**16**	Partikelfilter – Schwerpunkt Öffentl. Verkehr
	17	Partikelfilter – Schwerpunkt Bau- und Transportgewerbe
	27–30	RIGA 2002 – Global Atmosphere Watch
	31	Integrales Mangement der baulichen Gemeindeinfrastruktur
June	**04**	Schallschutz durch massives Bauen
	07	MR 2002 Symposium
	13	10 Jahre Hochleistungskeramik
	17/18	Workshop on Measurement Traceability and Uncertainty in Analytical Chemistry
	20	VSKF Infotagung: Umweltschonendes Sandstrahlen
	20	Silent Joint-Fahrbahnübergänge
	24	Einweihungsfeier FIB-Anlage
July	**05**	Braucht die Schweiz ein Zentrum für Archäometallurgie
September	**12**	Fortschrittliche ZfP-Methoden
	12/13	Status-Seminar “Energie und Umweltforschung im Hochbau”
	24/25	Grundlagen der Betriebsfestigkeit
October	**22**	Internet- und Crossmedia-Publishing
	24	2. Wirtschaftsforum glow
November	**05**	Textiles Schadenfall Meeting
	06	Qualitätssicherung bei Lackierarbeiten
	06/07	Dächer, leistungsfähig und ausdrucksstark mit Holz
	15	Erneuerbare Energien – Realität und Visionen
	28	Eurokobra
December	**02**	Weltraumtechnik – Die Rolle der Empa
	11	Nachhaltige Verwertung gebrauchter Elektronik

EMPA Activities 2002
Appendix

EMPA Activities 2002
Teaching Activities

Swiss Federal Institute of Technology, Zürich (ETH)

Architecture	K. Eggenschwiler	Raumakustik
	P. Flüeler	Kunststoffe im Bauwesen
	P. Flüeler	Baustoffkunde II: Kunststoffe
	Dr T. Geiger	Kunststoffe im Bauwesen, Betonbeschichtungen
	Prof Dr J. Sell	Baustoffkunde II: Holz
	S. Zetterholm	Baustoffkunde II: Metalle
Civil Engineering	Th. Frank	Spezialfragen Bauphysik
	Prof Dr J. Sell	Holz und Holzwerkstoffe
Electrical Engineering	Dr U. Sennhauser	Physik der Ausfälle und Ausfallanalyse elektronischer Schaltungen
Forest Sciences	Dr K. Richter	Qualität und Dauerhaftigkeit im Holzbau
	Prof Dr J. Sell	Holz/Holzverwendung/Umwelt II
	Dr R. Steiger	Maschinelle Holzsortierung und Holzbaunormen
Geomatics Engineering	K. Eggenschwiler	Lärmbekämpfung
	Dr P. Hofer	Luftreinhaltung I + II
Informations Technology	Dr Heutschi K.	Akustik I + II
	Dr Heutschi K.	Akustisches Kolloquium
	Dr K. Simon	Bild-Farbe-Reproduktion
	Dr K. Simon	Informatik 1
Management and Manufacturing	B. Zigerlig	Schweissen und Löten
Materials Engineering	Dr T. Graule	Herstellungsverfahren keramischer Rohstoffe
	Dr B.A. Keller	Oberflächentechnik

Teaching Activities

	Materials Science	O. Beffort	Metallmatrix-Verbundwerkstoffe
		Prof U. Meier	Verbundwerkstoffe
		Prof U. Meier	Kolloquium für Materialwissenschaften
		Prof U. Meier	Grundlagen zum Bemessen von Kunststoffbauteilen
		A. Necola	Moderne Fügetechnik: Kunststoffschweissen
	Mechanical Engineering	V. Dorer	Technik erneuerbarer Energien
		Dr R. Kieselbach	Festigkeit und Zuverlässigkeit im Maschinenbau
		R. Koller	Einführung in die Betriebsfestigkeit
		Dr G. Kovacs	Ausgewählte Kapitel der Seilbahntechnik
		Dr G. Kovacs	Seilbahntechnik
	Mineralogy	Dr H. Vonmont	Physikalische Methoden der Mineral- und Gesteinsanalyse
	Process Engineering	Prof Dr M. Farshad	Dimensionierungskriterien bei Strukturinstabilitäten
		Prof Dr M. Farshad	Anwendung der Methode der Finiten-Elemente in der Biomechanik
School of Engineering, Lausanne	Informations Technology	Dr K. Münger	Umweltmanagement
		H. Schefer	Digitaldruck
School of Graphic Art and Communication, Lausanne	Ecology	R. Hischier	Sustainable Information Technology
Swiss Technical School for Fashionwear and Textiles St. Gallen, Wattwil		Franziska Ammann	Titration
		Franziska Ammann	Mikroskopie / Faseranalyse
		R. Hufenus/M. Halbeisen	Textilprüfung
		Dr R. Rossi/M. Weder	Hightech Textilien
		U. Schrade	Lehrlingsausbildung, Technologie- und Warenkunde, Wirkerei/Stickerei
Swiss Technical School of Graphics, Zürich	Informations Technology	R. Hischier/M. Harzenmoser	Nachhaltige Informationstechnologie
		Dr K. Münger	Qualitätsmanagement
		H. Schefer	Informatik
Technical College TS, Pfäffikon		Dr M.N. Partl	Baumaterialien
University of Applied Sciences Aargau, Windisch	Mechanical Engineering	R. Koller	Bauteilfestigkeit: Schweissen
University of Applied Sciences, Bern	Materials Engineering	Dr T. Graule/J. Kuebler/ Dr U. Vogt	Werkstofftechnik
		Dr O. Beffort	Leichtmetalle
		Dr B.A. Keller	Werkstofftechnik
		Dr J. Michler/Dr St. Siegmann/ St. Rollier/Dr L. Rohr/	Oberflächentechnik

Teaching Activities

		P. Schwaller	
University of Applied Sciences, Burgdorf	Materials Engineering	O. Beffort	Leichtmetalle
University of Applied Sciences, Chur	Materials	Dr Maria M. Schirle	Kleben und Klebstoffe
	Chemistry	Dr T. Geiger/ M. Schicker	Polymerchemie: Lacke und Anstriche
University of Applied Sciences, Luzern	Building Technology	V. Dorer	Natürliche und hybride Lüftung
		P. Eggimann/Th. Frank/ Dr K. Ghazi/Dr H. Manz/ Dr H. Simmler	Bauphysik / Energie III
		M. Koschenz	Thermoaktive Bauteilsysteme
University of Applied Sciences, Rapperswil	Civil Engineering	Dr H. Manz	Bauphysik
	Informatics	Dr M. Weilenmann	Computergesteuerte Anlagen
	Mechanical Engineering	Dr M. Weilenmann	Mess-/ Regelungstechnik
University of Applied Sciences, Solothurn	Ecology	Th. Ruddy	Internationale und Europäische Studien
University of Applied Sciences, Wädenswil	Biotechnology	Dr Brigitte Buchmann	Luftschadstoffe
University of Applied Sciences, Winterthur	Chemistry	Dr P. Lienemann	Elementanalytik
		Dr P. Lienemann	Methoden in der organischen Strukturanalyse
		Dr. S. Wunderli	Analytische Chemie I
University of Applied Sciences, Zürich	Civil Engineering	Dr K. Moser	Beton/Bauchemie
		Christiane Raab	Erdölprodukte (Materialtechnologie)
		Tanja Zimmermann	Materialtechnologie - Holz
University of Bern	Chemistry	Dr Veronika Meyer	Chromatographische Analytik
		S. Mikhailov/P. Hug	Elementanalytik
University of Fribourg	Physics	Prof Dr L. Schlapbach	Physik I für Mediziner
University of Leoben (D)	Institut for general and analytical chemistry	Dr M. Rösslein	Qualitätssicherung im chemischen Labor
University of St. Gallen	Economy and Ecology	K. Eggenschwiler	Lärmschutz
		Dr P. Hofer	Luftreinhaltung
Webster University, Geneva	Ecology	Th. Ruddy	Integration, Globalization and the Information Society

EMPA Activities 2002
PHD Theses

General Direction	Christophe Emmenegger	Nanostructures de carbonne comme composants pour le stockage d'énergie dans les condensateurs électrochimiques à double couche (ECDL) ▼	University of Fribourg, Physics Dept.
	Carine Galli Marxer	Protein and cell adsorption: topographical dependency and adlayer viscoelastic properties determined with the oscillation amplitude of a quartz resonator ▼	University of Fribourg, Physics Dept.
Acoustics/Noise Abatement	Georg Thomann	Zuverlässigkeit von Fluglärmprognosen und die raum-planerischen sowie wirtschaftlichen Folgen von Berechnungsunsicherheiten ♦	ETH Zürich, Geomatics Engineering Dept.
Air Pollution/Environmental Technology	Sandy Ubl	Lufthygienische Fenster der NABEL-Stationen und räumliche Ausbreitung von Schadstoffen aus Transportmodellierungen ♦	ETH Zurich, Environmental Science Dept.
Biocompatible Materials	Erwin Achermann	A Tool for Evaluating Measurement Uncertainty, Thesis No. 14573 ▼	ETH Zürich, Scientific Computing Dept.
	Franziska Baumgartner	Effects of changes in surface topology on human bone marrow cell performance ♦	ETH Zürich, Materials Science Dept.
CFRP in Structural Engineering	Alberto Belloli	Active Control via Shunted Embedded Piezoelectric Fibers: Composite Design for Structural Damping ♦	ETH Zürich, Information Technology and Electrical Engineering Dept.
	Dominik Niederberger	Active Control via Shunted Embedded Piezoelectric Fibers: Control Design for Structural Damping ♦	ETH Zürich, Mechanical Engineering Dept.
	Thomas Ulaga	Thermoplastische CFK-Lamellen ♦	ETH Zürich, Geomatics Engineering Dept.
Functional Fibers and Textiles	Rudolf Hufenus	Material parameters for the design of soil structures reinforced with geosynthetics ♦	ETH Zürich, Industrial Management and Manufacturing Dept.
High Performance Ceramics	Juliane Heiber	Entwicklung und Charakterisierung von flexiblen, piezoelektrischen Fasern ♦	Technical University Illmenau (DE), Mechanical Engineering Dept.
	Markus Wegmann	Microextrusion of Barium Titanate for PTCR Applications ▼	University of Strathclyde (Glasgow, GB), Mechanical Engineering Dept.
	Alexandre Thomas	Solid free-form fabrication of porous ceramic parts from ceramic powders and preceramic polymers ♦	EPF Lausanne, Mechanical Engineering Dept.

♦ in progress
▼ submitted in 2002

EMPA Activities 2002

PHD Theses

I.C. Engines/Furnaces	Elisabeta Ajtay Delia	Dynamische Emissionsmodellierung von Motorfahrzeugen ▼	ETH Zürich, Materials Dept.
	Christian Lämmle	Flammenausbreitung und Klopfverhalten eines aufgeladenen Erdgasmotors ▼	ETH Zürich, Materials Dept.
	Urs Mathis	Untersuchung der Nanopartikel von Verbrennungsprozessen unter besonderer Berücksichtigung der Nukleide ▼	ETH Zürich, Materials Dept.
Inorganic Analytical Chemistry/ Characterization of Solids	Marianne Senn	The craft of smithing in the north of the Swiss Alps from celtic to early medieval times ♦	ETH Zürich, Prehistory Dept.
Materials Technology	Rémy Gassilloud	Metallic nanopatterning by electrochemical deposition on prescratched semiconductors ♦	University of Erlangen (DE), Materials Sciene Dept.
	Thomas Keller	Void structures in thermally sprayed metallic Ni-based deposits and their influence on material properties ♦	ETH Zürich, Physics Dept.
	Simon Kleiner	Thixocasting, Textur und mechanische Anisotropie von stranggepressten Magnesiumlegierungen ♦	ETH Zürich, Materials Sciene Dept.
	Benedikt Moser	Deformation and fracture of continuous alumina fibre reinforced aluminium composites, Thesis No. 2532 ▼	EPF Lausanne, Materials Sciene Dept.
	Rodolfo Rabe	Entwicklung einer Positioniereinheit für Nanoindentations- und Nanostrukturierungsexperimente im Rasterelektronenmikroskop ♦	EPF Lausanne, Microengineering Dept.
	Cornelis Schreuders	Fundamental research on ceramic nanoparticles ♦	ETH Zürich, Mechanical Engineering Dept.
	Sven Stauss	Micromaterials: Assessment of Mechanical Properties by Indentation Technologies ♦	EPF Lausanne, Materials Sciene Dept.
	Jong-Won Shin	In-situ monitoring of the synthesis on nano-powders by an RF thermal plasma ♦	EPF Lausanne, Center of Plasma Physics Research
	Jürg Zenke	Entwicklung einer Indentationseinheit für Nanoindentations- und Nanostrukturierungsexperimente im Rasterelektronenmikroskop ♦	University of Oldenburg (DE), Informatics Dept.
Structural Engineering	Daniel Gsell	Nicht axialsymmetrische Wellenausbreitung in anisotropen zylindrischen Strukturen, Thesis No. 14733 ▼	ETH Zürich, Mechanical Engineering Dept.
Wood	Patrick Fonti	Investigations into ring shake of chestnut (Castanea sativa), Thesis No. 14732 ▼	ETH Zürich, Forest Science Dept.
	Werner Frank	Interdependencies Between LC-modelling And The Use Of LCA In Product Design-related Decision Situations Thesis No. 14750 ▼	ETH Zürich, Environmental Science Dept.
	Raoul Klingner	Thermodynamics in Hornet Nets ♦	ETH Zürich, Architecture Dept.

♦ in progress
▼ submitted in 2002

PHD Patente

Patents granted

CFRP In Structural Engineering	Urs Meier, Iwan Stöcklin, Andreas Winistörfer	Method and Device for Applying Presented Tension-Proof Reinforcing Strips to a Construction	US 6,464,811 B1
Functional Fibers and Textiles	Eva M. Moser.	Flexbar	PCT/CH99/00575
	Eva M. Moser et al.	Plasmakammer	PCT/CH96/
High Performance Ceramics	Christian Englisch, Karl Berroth	Keramik-Metall- oder Metall-Keramik-Komposite	CH 692296/A5
Test Materials	Daniel Fäh	Modul für mikrobiologische Beurteilungen	CH 692918/A5

Patents applied for

CFRP In Structural Engineering	Urs Meier, Iwan Stöcklin, Andreas Winistörfer	Multilayer Traction Element in the Form of a Loop	JP 8-527 940
	Urs Meier, Iwan Stöcklin, Andreas Winistörfer	Method and Device for Applying Presented Tension-Proof Reinforcing Strips to a Construction	JP 2002-505 392
Electronics/Metrology	Joachim Reiner, Philippe Gasser	Verfahren zur Präparation einer TEM-Lamelle	0661/02
Energy Systems/ Building Equipment	Markus Koschenz, Beat Lehmann	Thermoaktives Wand- und Deckenelement	2002 0175/02
Functional Polymers	Christiane Löwe, Christoph Weder	Color Tunable Photoluminescent Blends	applied for in the USA
High Performance Ceramics	Frank Clemens	Method for the Production and Use of a Microcrystalline Al2O3 Shaped Body,	PCT/EP01/01336
	Katja Lemster, Jakob Kübler	Keramik-Metall- oder Metall-Keramik-Komposite	1890/02
Polymers/Composites	Mehdi Farshad	Lightweight Composite Element, Method for the Production and use thereof	PCT WO 02/099218/A1
	Hans Kramer	Verfahren und Vorrichtung zur Zustandsprüfung von Fahrbahnübergängen vom Typ Finger	EP/1270818/A2
Funtional Fibers and Textiles	Felix Reifler, Axel Ritter et al.	Verfahren zur Bestimmung der geruchshemmenden Eigenschaften von Textilhilfsmitteln	Ref.-Nr. P2/PFE 309
Surface and Joining Technology	Benno Zigerlig et al.	Verfahren zum Aufbringen von Partikeln auf einen Träger	EP1208945

EMPA Activities 2002
Conferences

Special Topics

Kläntschi, N. Wissensmanagement als strategisches Element der Empa, Pfäffikon ZH 09-20 ⓘ

Kläntschi, N. Wissensmanagement heute, Zürich 10-10 ⓘ

Kläntschi, N. Wissensmanagement an der Empa, Bern 11-20 ⓘ

Schlapbach, L. Zur Geschichte des Wasserstoffs, vom Phlogiston zum synthetischen Treibstoff, Festkolloquium Geburtstag Dr. Otto Haas, PSI, Villigen 01-23 ⓘ

Schlapbach, L. Neue Ausrichtung der Empa, Plenarversammlung der Hochschulversammlung, ETH Zürich, Zürich 04-25 ⓘ

Schlapbach, L. Empa Swiss Federal Laboratories for Materials Testing and Research, Evaluation ETH-Bereich, ETH-Rat, Zürich 05-29

Schlapbach, L. New Energy Concepts for Transportation, European Guest, US-DOE Workshop, Maryland, USA 06-16 thru 18 ⓘ

Schlapbach, L. Empa als Materialforschungsinstitution im ETH-Bereich, Generalversammlung 2002, Physikalische Gesellschaft Zürich, Zürich 07-04 ⓘ

Schlapbach L. Impulse aus F+E für nachhaltige Energieeffizienz (Gebäude, Verkehr und Solarstrom), Impulse für eine regenerative Energiewissenschaft, Wissenschaftsforum Berlin, Germany 10-22 ⓘ

Advanced Materials and Surfaces

Schlapbach, L. Hydrogen-solid interaction to store energy for mobility, 2002 TMS Annual Meeting, Seattle, USA 02-18 thru 21 ⓘ

Schlapbach, L. Hydrogen, IEA Semiannual-Workshop, Task 17, Solid and Liquid State Hydrogen Storage Materials, Seattle, USA 02-22 ⓘ

Schlapbach, L. Carbon nanostructures, properties and applications, 19th General Conference of the EPS Condensed Matter Division, Brighton, United Kingdom 04-10 ⓘ

Schlapbach, L. Lösen Nanostrukturen (Carbon Nanotubes) das Wasserstoffspeicherproblem?, ENET-Seminar, Bern 04-18 ⓘ

Schlapbach, L. Storage of hydrogen, IMRA, Sophia-Antipolis, France 05-23 thru 24 ⓘ

Schlapbach, L. Characterization methods of the electronic properties of sp2 carbon materials, Forum on New Materials, CIMTEC 2002, Florence, Italy 07-14 thru 15 ⓘ

Schlapbach, L. Carbon nanostructures, growth and electron emission, NIMS, Tsukuba, Japan 07-19 ⓘ

ⓘ invited

Conferences

	Schlapbach, L.	Hydrogen storage technology, a challenge for materials science, MH2002 International Symposium on Metal Hydrogen Systems, Annecy, France 09-01 thru 5 ⓘ
	Schlapbach, L.	Energy policy – efficiency of energy technology, IEA Semiannual-Workshop, Task 17, Solid and Liquid State Hydrogen Storage Materials, University of Geneva, Geneva 09-10 ⓘ
	Schlapbach, L.	Wasserstoff und seine Speicherung: gibt es Fortschritte? Globale Energieversorgung im 21. Jahrhundert, Energietag 2002, Oesterreichische Physikalische Gesellschaft, Arbeitskreis Energie, Wien, Austria 10-16 ⓘ
	Schlapbach, L.	Wasserstoff: Eigenschaften, Wechselwirkung mit Festkörpern, Speicherung, Wasserstoffspeicherung mit neuen Materialien, DECHEMA-Kolloquium, Frankfurt am Main, Germany 11-07 ⓘ
	Schlapbach, L/Zuettel, A.	Ways to hydrogen technologies: the materials science approach, 2nd Hiroshima Workshop – Transport and Thermal Properties of Advanced Materials, Hiroshima University, Japan08-16 thru 19 ⓘ
	Schlapbach, L/Zuettel, A.	Hydrogen interactions with solids: thermodynamics, electronics and kinetics, Thermodynamics of Alloys,TOFA 2002, Rome, Italy 09-13 ⓘ
	Schlapbach, L/Zuettel, A.	Hydrogen storage for mobile applications, First Materials Science Forum on Future Sustainable Technologies, University of Augsburg, Germany 09-17 thru 18 ⓘ
Corrosion/Surface Protection	Brunner, S.	Environmental parameters for aircraft coatings, FATIPEC2002, Dresden, Germany,09-09 thru 11. IACC2002, 6th Internat. Aerospace Corrosion Control Symposium, Amsterdam, Netherland, 10-09 thru 11
	Faller, M.	Das Korrosionsverhalten des Kupferdaches des KKL Luzern, Umweltforum Kupfer, Basel 01-24 ⓘ
	Faller, M.	Niederschlagswasser von Metalldächern – aktuelle Untersuchsergebnisse, 11. Deutscher Klempnertag, Würzburg, Germany 01-31 thru 02-02 ⓘ
	Faller, M.	Korrosionserscheinungen an nicht rostenden Stählen, Elektromechanische Anlagen, Chur 02-12 ⓘ
	Faller, M.	Corrosion Attack on Zinc after 1 and 2 years of exposure, 18th Meeting of the Programme Task Force UN ECE ICP Materials, Kjeller, Norway 05-13 thru 14 ⓘ
	Faller, M.	Aus Erfahrungen lernen – 15 Jahre nach Uster, Einsatz nichtrostender Stähle in Schwimmbädern, Made, Netherlands 11-14 ⓘ
	Faller, M.	Atmospheric Corrosion and Runoff, Presentation of Dissertation Mrs W. He, Stockholm, Sweden 11-29 ⓘ
	Geiger, T./Hany, R./Zinn, M.	Funktionalisierte Biopolyester, Vortragstagung «Funktionspolymere für Systemlösungen» der Gesellschaft Deutscher Chemiker (GDCh), Fachgruppe Makromolekulare Chemie, Darmstadt, Germany 03-18 thru 19
	Geiger, T./Hartmann, R./ Zinn, M./Hany, R.	Functional Polymers from Poly[(R)-3-hydroxyalkenoates]: Protection of Surfaces from Biofouling, International Symposium on Biological Polyesters (ISBP), Münster, Germany 09-22 thru 26
	Hartmann, R./Hany, R./ Geiger, T./Schmid, M./ Pletscher, E./Egli, T./Zinn, M.	Synthesis of poly([R]-3-hydroxyalkanoate) with a defined portion of unsaturated side-chains in Pseudomonas putida GPo1, Biopolymers: limits of natural performances & prospects for overcoming (Workshop), Leipzig, Germany 03-30 thru 31
	Kürsteiner, J.	Vorbehandlung von Aluminium, Qualität ergibt Sicherheit. Qualitätsprüfungen von Beschichtungen auf Aluminium im Betrieb, Empa-Akademie, Dübendorf 03-21 ⓘ
	Kürsteiner, J.	1) Umgang mit Chemikalien. 2) Chemische Vorbehandlung der Substrate. 3) Mechanische Vorbehandlung der Substrate. 4) Physikalische Messmethoden Teil 2. Seminar: Qualitätssicherung bei Lackierarbeiten, Empa-Akademie, Dübendorf 11-06 ⓘ
	Kürsteiner, J.	1) Korrosion. 2) Metallische Untergründe. Seminar: Korrosion, Untergründe und deren Vorbehandlung, Empa, Dübendorf 11-27
	Michel F./Geiger T./Reichlin A./ Teoh-Sapkota G./Mörsch G.	Funori, ein japanisches Festigungsmittel für matte Malerei. (6 Vortragsblöcke), Kolloquium an der ETH Zürich vom Institut für Denkmalpflege der ETH Zürich, der Eidgenössische Materialprüfungs- und Forschungsanstalt (Empa) und dem Zentrum für Konservierung des Schweizerischen Landesmuseums, ETH Zürich 08-28

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Conferences

	Nagel, M./Fráter, G./ Hansen, H.-J.	Synthesis of Macrocyclic Ketones by Repeatable Two-Carbon Ring Expansion Reactions [cf. Abstract 96 in Chimia 2002, 56, 352], Fall Meeting 2002, Basel 10-17
	Schicker, M.	Polymere als Beschichtungsstoff und ihr Verhalten auf verschiedenen Substraten, Weiterbildung zum Malermeister, Modul: Materialkunde und Anstrichschäden, Bern 03-09 ⓘ
	Schicker, M.	1) Probleme und Schadenfälle. 2) Machu- und ESS-Sprühtest. 3) Ist eine Qualitätsüberwachung notwendig? Qualität ergibt Sicherheit. Qualitätsprüfungen von Beschichtungen auf Aluminium im Betrieb, Empa-Akademie, Dübendorf 03-21 ⓘ
	Schicker, M.	Korrosionsschutz in Kläranlagen, Aus- und Weiterbildung von Klärwerkpersonal, Rüdlingen 03-22 ⓘ
	Schicker, M.	Beschichtungen auf Feuerverzinkungen, 34. Arbeitstagung, Kastanienbaum 09-19 thru 20 ⓘ
	Schicker, M.	1) Beschichtungstoffe und Schäden aus der Praxis. 2) Substrate und ihre Erkennung. Seminar: Qualitätssicherung bei Lackierarbeiten, Empa-Akademie, Dübendorf. 11-06 ⓘ
	Schleuniger, J.	Frei-/Schnellbewitterung, Alterung, Seminar: Qualitätssicherung bei Lackierarbeiten, Empa-Akademie, Dübendorf 11-06 ⓘ
	Schleuniger, J.	1) Mineralische Untergründe. 2) Kunststoff als Substrat. Seminar: Korrosion, Untergründe und deren Vorbehandlung, Empa, Dübendorf 11-27
	Sidler, T.	Prüfen von Beschichtungen, Qualität ergibt Sicherheit. Qualitätsprüfungen von Beschichtungen auf Aluminium im Betrieb, Empa-Akademie, Dübendorf 03-21 ⓘ
	Sidler, T.	Im Korrosionsschutz eingesetzte Beschichtungen, VSKF Informationstagung, Empa-Akademie, Dübendorf 06-20 ⓘ
	Sidler, T.	Physikalische Messmethoden 1, Seminar: Qualitätssicherung bei Lackierarbeiten, Empa-Akademie, Dübendorf 11-06 ⓘ
	Sidler, T.	Holz und Holzwerkstoffe als Substrat, Seminar: Korrosion, Untergründe und deren Vorbehandlung, Empa, Dübendorf 11-27
	Tuchschmid, M.	Organische Altanstriche an Stahlobjekten: Zerstörungsfreier Nachweis von Schwermetallen, VSKF Informationstagung, Empa-Akademie, Dübendorf 06-22 ⓘ
	Von Trzebiatowski, O.	1) Möglichkeitendes Rasterelektronenmikroskopes bei der Beurteilung von Schäden an Polymer- und Faserverbundwerkstoffen. 2) Ausgewählte Schadensbeispiele. Rasterelektronenmikroskopie und Analyse von Mikrobereichen und Oberflächenschichten, TAE Sarnen 06-10 thru 14 ⓘ
	Zinn, M./Hartmann, R./ Hany, R./Geiger, T./Egli, T.	1) Tailor-made synthesis of bioplastic (poly(3-hydroxyalkanoate)) in Pseudomonas putida (oleovorans). 2) Intracellular degradation of poly(3-hydroxyalkanoate) in Pseudomonas putida (oleovorans). Annual Assembly of the Swiss Society for Microbiology, Luzern 02-20 thru 21
	Zinn, M./Hartmann, R./ Pletscher, E./Geiger, T./Hany,R./ Witholt, B./Egli, T.	Tailored biosynthesis of polyhydroxyalkanoate under multiple nutrient limited growth conditions, International Symposium on Biological Polyesters, Münster, Germany 09-22 thru 26 ⓘ
	Zinn, M./Hartmann, R./ Pletscher, E./Geiger, T./Hany, R./ Witholt, B./Egli, T.	Multiple nutrient limited growth of bacteria as a means to tailor-make polyhydroxyalkanoate, VAAM Mini-Symposium and Workshop on biocatalysis, Zürich 10-10 thru 11
High Performance Ceramics	Clemens, F.	Fasern für die Halbleiterindustrie, Empa-Akademie, Dübendorf 06-13
	Clemens, F.	Computing Fibers for Smart Textiles, ICEWES Conference 2002, Brandenburgische Technische Universität (BTU), D-Cottbus, Germany 12-10 thru 11 ⓘ
	Clemens, F./Buchser, W./ Graule, T.	Silicon Carbide Fibre Extrusion – Manufacturing and Tensile Strength of Fine Sintered SiC-Fibres, Tenth International Ceramics Congress and the Third Forum on New Materials, Florenz, Italy 07-14 thru 18
	Clemens, F./Buchser, W./ Graule, T.	Shaping Silicon Carbide Powder in Fibres by Extrusion Process, Second International Conference on Shaping of Advanced Ceramics (Shaping 2), Gent, Belgium 10-24 thru 26

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Conferences

Clemens, F./Mathweson, A./ Ullsberger A./Healy, T./ Papadas, C.	FiCom, UbiCom 2002, Göteburg, Sweden 09-30 thru 10-02
Clemens, F./Vital, A./Graule, T.	Synthesis of spherical, non-aggregated silica nanoparticles by a flame aerosol process, Tenth International Ceramics Congress and the Third Forum on New Materials, Florence, Italy 07-14 thru 18
Graule, T.	Hochleistungskeramik – ein Werkstoff mit glänzender Zukunft, Ostschweizer Technologiesymposium 2002: Neue Werkstoffe, Technologien und Methoden, Mechatronikzentrum Waldau, St.Gallen 11-08 ⓘ
Herzog, A.	1) CIMTEC A new approach to short fibre reinforced reaction bonded silicon nitride, 26th Annual Internat. Conf. on Advanced Ceramics & Composites, Florida, USA, 01-14 thru 17, Florence, Italy , 08-15 thru 18
Herzog, A.	Short fibre reinforced reaction bonded silicon nitride (RBSN) by precursor route, Polymerkeramik, Deutsche Keramische Gesellschaft, Empa Dübendorf 05-22
Herzog, A.	Von polymeren Precursoren zur Verbundkeramik, Hochleistungskeramiken im industirellen Einsatz,¨ Empa-Akademie, Dübendorf 06-13
Holtappels, P./Braun, B./ Liebermann, S./Rzepka, M./ Stimming, U.	Simulation of gasoline and diesel fuelled, various sized SOFC power generation systems for mobile applications, 5th European Solid Oxide Fuel Cell Forum, Lucerne 07-01 thru 05
Holtappels, P./Gauckler, L./ Graule, T./Gut, B./Honegger, K./ Joerger, M./McEvoy, A.-J./ Perednis, D./Rambert, S./ Robert, G./Vogt, U.	Fabrication and performance of anode supported solid oxide fuel cells, ETFS-3 Energy technolgies for a sustainable future: Fuel Cell and combustion engines in competition for the future, Paul Scherrer Institut, Villigen 11-29
Holtappels, P./Vogt, U./ Schindler, H.-J./Gut, B.	Metall oxide and perovskite synthesis by spray pyrolysis, ESF-Workshop on SOFC and proton conductivity, Roskilde, Denmark 04-11 thru 12
Holtappels, P./Vogt, U./ Schindler, H.-J./Gut, B.	Perovskite synthesis by spray pyrolysis, 5th European Solid Oxide Fuel Cell Forum, Lucerne 07-01 thru 05
Holtappels, P./Vogt, U./ Vaucher, S./Van herle, J./ Buffat, P./Bucheli, O.	Ceramic nanopowder fabrication and application as an active and stable cathode material in Solid Oxide Fuel Cells, TOP Nano 21, 3rd Annual Meeting, Bern 10-01
Klingner, R.	DKG Jahrestagung 2002, DKG Jahrestagung 2002, Eindhoven, The Netherlands 10-21 thru 23 ⓘ
Kübler, J.	Hochzähe Keramik-Laminatwerkstoffe, Empa Akademie, Dübendorf 06-13
Kuebler, J../Clemens, F./ Aquino, E./Graule, T.	Correlation between properties of extruded ZrO_2-rods in the green and as sintered state, CIMTEC 2002, 10th International Conference on Modern Materials & Technologies, Florence, Italy 07-14 thru 18¨
Kuebler, J../Clemens, F./ Aquino, E./Graule, T.	Optimierung von ZrO_2-Extrusionsmassen mit Festigkeitsmessungen und Fraktographie, Robert Bosch GmbH, D-Gerlingen 09-27
Kuebler, J../Lemster, K.	Eisen, Fe-Basis oder Ni-Basislegierungen/Oxidkeramik- MMCs durch Reaktivinfiltration, VDMA-Haus, D-Frankfurt/Main 11-15
Mueller, R./Vital, A./ Kammler, H.K./Pratsinis, S.E./ Beaucage, G./Burtscher, P.	Dry synthesis of non-agglomerated silica nanoparticles for nanocomposites, AIChE Annual Meeting, Indianapolis, IN, USA 11-03 thru 08
Rambert, S./McEvoy, A.J./ Holtappels, P./Vogt, U.	Sprayed thin-film electrolyte in anode supported cells, 5th European Solid Oxide Fuel Cell Forum, Lucerne 07-01 thru 05
Thünemann, M.	Herstellung poröser SiC-Keramiken, Fachhochschule Münster, Steinfurt, Germany 09-23 ⓘ
Thünemann, M.	Herstellung poröser SiC-Keramiken durch Bindung mit präkeramischen Polymeren, Eindhoven, The Netherlands 10-21 thru 23 ⓘ

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EMPA Activities 2002

Conferences

Materials Technology	Vital, A.	Oxidische Nanopulver – Herstellung und Einsatz, Empa-Akademie, Dübendorf 06-13
	Vital, A./Müller, R.	Herstellung metall-oxidischer; Nanopartikel via Flammgassynthese, Empa Dübendorf 05-23
	Vital, A./Müller, R.	Non-agglomerated fumed silica nanoparticles, Annual meeting of GVC/DECHEMA, Wiesbaden, Germany 06-11 thru 13
	Vital, A./Müller, R.	Oxidische Nanopartikel – Herstellung und Anwendung, Empa Dübendorf 06-13
	Vogt, U.	Porous SiC ceramics with oriented structure from natural materials, 26th Annual Conference on Composites, Advanced Ceramics, Materials and Structures, Cocoa Beach, Fl / USA 01-12 thru 19
	Vogt, U.	Poröse SiC Keramik mit orientierter Porenstruktur von natürlichen Materialien, Universität Augsburg, Augsburg, Germany 03-25 thru 28 ⓘ
	Vogt, U.	Über die Biomimetik zur Keramik, Empa-Akademie, Dübendorf 06-13
	Vogt, U.	Porous SiC Ceramics via Carbothermal Reduction from Pyrolysed Wood, Tenth International Ceramics Congress and the Third Forum on New Materials, Florence, Italy 07-14 thru 18
	Vogt, U.	Poröse keramische Strukturen, Fachhochschule Münster, Steinfurt, Germany 09-23 ⓘ
	Vogt, U.	Perovskite Powder Synthesis by Spray Pyrolysis, Annual Meeting, Deutsche Keramische Gesellschaft, Eindhoven, Netherlands 10-21 thru 23
	Vogt, U.	Porous Ceramic Materials produced by different methods, 6. Steinfurter Keramik-Seminar, Material Research and Application, D-Steinfurt 12-15 thru 19
	Wegmann, M./Clemens, F./ Graule, T.	Extrusion of Ultra-Small BaTiO3 PTCR Elements, Tenth International Ceramics Congress and the Third Forum on New Materials , Florenz, Italy 07-14 thru 18
	Wegmann, M./Clemens, F./ Graule, T./Hendry, A,	Miniature BaTiO3 PTCR Elements Fabricated by Extrusion, Second International Conference on Shaping of Advanced Ceramics (Shaping 2), Gent, Belgium 10-24 thru 26
	Zürche, S./Graule, T./Kaiser, A.	Nanodispersions for low sintering of thin films SOFC electrolytes, Board of the Swiss Ferderal Institutes of Technology ETH Board, KTI-CTI Commission for Technology and Innovation, Berne 10-01
	Beffort, O.	Metallmatrix-Verbundwerkstoffe: Eigenschaften, Anwendungen und Bearbeitung, 6. Internationales IWF-Kolloquium 2002 – Feinstbearbeitung technischer Oberflächen, Egerkingen 04-18 ⓘ
	Biedermann, P.	Veranstaltungsreihe Nanotechnologie, Thun 10-28
	Kleiner, S.	Magnesium und seine Legierungen, 6. Internationales IWF-Kolloquium 2002 – Feinstbearbeitung technischer Oberflächen, Egerkingen 04-18 ⓘ
	Leparoux, S.	Evaluation of Microwave-Assisted Processing of Compacted Metal/Ceramic Powder Mixtures, Materialica, Materials Week 2002, München, Germany 09-30 thru 10-02
	Margadant, N.	Towards Fracture Mechanics of Thermally Sprayed Metallic Coatings Using Indentation Technique for Edge Chipping on a Micron Scale, ITSC 2002 International Thermal Spray Conference, Essen, Germany 06-03 thru 04
	Michler, J.	Depth profiling of hard coatings by radiofrequency glow discharge optical emission, 18th annual meeting of SAOG/GSSI, Fribourg 01-24
	Michler, J.	Determination of plastic properties of metals by instrumented indentation using different sharp indenters, First European Nanoindenter User Meeting, Berlin, Germany 11-06 thru 07 ⓘ
	Michler, J./Schwaller, P./ Rollier, St.	Einführung in die Topographie, FSRM-Kurs, Thun 11-29
	Rohr, L.	Energie aus Brennstoffzellen – Vision oder Realität?, Naturwissenschaftliche Gesellschaft Thun, Thun 01-22
	Rohr, L.	Mechanical properties of small devices: From nanoindentation to reverse analysis, 3rd Korea-Switzerland Joint Symposium on «New Materials and Process Issues in MEMS and Nano-Technology, Jeju Island, Corea 06-19 thru 20 ⓘ

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Conferences

	Rohr, L.	Computerunterstütztes Arbeiten im Werkstoffbereich, 12. Meeting der Forschungsgruppe Werkstofftechnik (Gruppe Rüstung), Thun 10-25
	Rohr, L.	Vom Mikrometer zum Nanometer, Veranstaltungsreihe Nanotechnologie, Thun 10-28
	Rohr, L./Schwaller, P.	Workshop: Neue Perspektiven in der Materialmikroskopie, Thun 12-17 thru 18
	Schneider, Ph.	Hochtemperatur-Verschleissverhalten von thermisch gespritzten Hartmetallschichten für Ventilspindeln in Dampfturbinen, ITSC 2002 International Thermal Spray Conference, Essen, Germany 03-04 thru 06
	Schwaller, P.	Topographiemessung: Bildgebende Verfahren bis hin zur atomaren Ausflösung, Workshop Neue Perspektiven in der Materialmikroskopie, Thun 12-17 thru 18
	Siegmann, S.	Vacuum plasma sprayed coatings and freestanding parts of Ni-Ti shape memory alloys, ITSC 2002 International Thermal Spray Conference, Essen, Germany 03-04 thru 06
	Siegmann, S.	Einfluss der Haftgrundvorbereitung auf die enststehende Topographie und Schichthaftung; Ein dreidimensionales Fraktalanalyse-Verfahren, 2. GTV Kolloquium – Thermisches Spritzen, Luckenbach, Germany 06-23 ⓘ
	Siegmann, S.	Cambridge Materials Selector (M.F. Ashby), 12. Meeting der Forschungsgruppe Werkstofftechnik (Gruppe Rüstung), Thun 10-25
	Vaucher, S.	Selective Laser Sintering of Aluminium-Silicon Carbide Metal Matrix Composite, Materialica, Materials Week 2002, München, Germany 09-30 thru 10-02
Polymers/ Composites	Barbezat, M.	Zeitabhängiges mechanisches Verhalten, Wie lange hält ein Kunststoffteil? Empa, Dübendorf 11-05 thru 06
	Brunner, A.J.	ESIS TC4 Polymers & Composites: Organisation, Ziele und Tätigkeiten, SVMT, Fachgruppe Strukturintegrität, Aarau 03-06
	Brunner, A.J.	Schallemissionsanalyse – Grundlagen und Anwendungen, Fortschrittliche ZfP-Methoden, Empa, Dübendorf 09-12
	Brunner, A.J.	Liste von Normen, Richtlinien und publizierten Verfahren der Schallemissionsanalyse, 35. Sitzung¨ Fachausschuss Schallemissionsprüfverfahren der Deutschen Gesellschaft für Zerstörungsfreie Prüfung, Augsburg, Germany 11-06
	Brunner, A.J./Blackman, B.R.K.	Delamination fracture in cross-ply laminates: What can be learned from experiment? 3rd ESIS TC4 Conference on Fracture of Polymers, Composites and Adhesives, Les Diablerets 09-15 thru 18
	Brunner, A.J./Cartié, D.D.R.	Bruchmechanische Untersuchungen und simultane Schallemissionsanalyse von dreidimensional verstärkten CFK-Laminaten, Institut für Polymerforschung e.V., Dresden, Germany 10-07 ⓘ
	Brunner, A.J./Cartié, D.D.R.	Schallemissionsanalyse bruchmechanischer Versuche an dreidimensional verstärkten CFK-Laminaten, 2. DACH-Seminar zu Stand und Zukunft der Schallemissionsprüfung (AT3-Treffen), Empa, Dübendorf 11-01
	Brunner, A.J./Williams, J.G./ Blackman, B.R.K.	Deducing bridging stresses from GIC test on fibre composites, 3rd ESIS TC4 Conference on Fracture of Polymers, Composites and Adhesives, Les Diablerets 09-15 thru 18
	Cartié, D.D.R./Brunner, A.J./Partridge, I.	Effects of mesostructure of Z-pinned laminates on their crack control characteristics, 3rd ESIS TC4 Conference on Fracture of Polymers, Composites and Adhesives, Les Diablerets 09-15 thru 18
	Farshad, M.	Beulen von Rohrleitungen: Erfahrung, Berechnung und Verhinderung, Empa-Akademie, Dübendorf 06-05
	Farshad, M.	Nichtlinearitäten, Kurs Qualitätssicherung bei FE-Analysen., ETH Zürich 09-20
	Farshad, M.	1) Statische Berechnung von thermoplastischen Rohrleitungen. 2) Beulwiderstand der Rohrleitungen, Kunststoffrohre richtig planen, berechnen und verlegen. 2. Seminar für IngenieurInnen und PlanerInnen von Versorgungsleitungen, Kandersteg 09-26 thru 27
	Farshad, M.	Stabilität 1+2, Kurs Qualitätssicherung bei FE-Analysen, ETH Zürich 10-04

ⓘ invited

Conferences

Farshad, M.	Dimensionierung mit Berücksichtigung des Langzeitverhaltens, Wie lange hält ein Kunststoffteil? Empa, Dübendorf 11-05 thru 06
Farshad, M.	Modellierung von Kunststoffen und Composites, Symposium Die Mechanik der Zukunft, Pfäffikon/SZ 11-30
Flüeler, P.	Evaluationsverfahren Abdichtungssysteme für Basistunnel der NEAT, Erkenntnisse und Umsetzung, Informationsveranstaltung für Ingenieure der Bauleitung des Lötschberg-Basistunnels, Kandersteg 01-29
Flüeler, P.	The Sealing of Deep-Seated Swiss Alpine Railway Tunnels New Evaluation Procedure for Wateproofing Systems, 9th International Conference on Durability of Materials and Components, Brisbane, Australia 03-17 thru 20
Flüeler, P.	Kunststoff – ein vielfältiger Werkstoff für hohe Ansprüche, VKR, Verband Kunststoffrohre und-Rohrleitungsteile, Fachhochschule Aargau, Windisch 04-24
Flüeler, P.	Evaluation von Abdichtungssystemen für die tiefliegenden Eisenbahntunnel der Alpentransversalen NEAT, AlpTransit-Tagung, Thun 06-13 thru 14
Flüeler, P.	Evaluation von Abdichtungssystemen für die tiefliegenden Eisenbahntunnel der Alpentransversalen NEAT, Erkenntnisse und Umsetzung, Informationsveranstaltung für Ingenieure der Bauleitung Gotthard Basistunnel, Altdorf 06-17
Flüeler, P.	1) Werkstoffkunde der Kunststoffe im Rohrleitungsbau. 2) Zeitabhängigkeit der Kunststoffrohr-Eigenschaften. 3) Abdichtung von tief liegenden Eisenbahntunnels durch die Alpen. Neues Evaluationsverfahren für Abdichtungssysteme. Kunststoffrohre richtig planen, berechnen und verlegen. 2. Seminar für IngenieurInnen und PlanerInnen von Versorgungsleitungen, Kandersteg 09-26 thru 27
Flüeler, P.	Evaluationsverfahren Abdichtungssysteme für Basistunnel NEAT, Fachtagung Eidg. Finanzkommission/BAV, VSH Versuchsstollen Hagenbach, Sargans 11-01
Flüeler, P.	100 Jahre unter erschwerten Bedingungen? Teil 1, Wie lange hält ein Kunststoffteil? Empa, Dübendorf 11-05 thru 06
Flüeler, P./Farshad, M.	Bruchzähigkeit von Kunststoffrohren, Widerstand gegen Schnelle Rissausbreitung. Kunststoffrohre richtig planen, berechnen und verlegen. 2. Seminar für IngenieurInnen und PlanerInnen von Versorgungsleitungen, Kandersteg 09-26 thru 27
Kramer, H.	1) Wie lange hält es, wenn es der Natur ausgesetzt ist? 2) 100 Jahre unter erschwerten Bedingungen. Wie lange hält ein Kunststoffbauteil? Technische Akademie Wuppertal e.V., Wiesbaden, Germany 06-03 thru 04
Kramer, H.	Fahrbahnübergänge Typ «Finger», Arbeitstagung der Brückeningenieure der kantonalen Strassenverwaltungen, Basel 10-24 thru 25
Kramer, H.	Wie lange hält es, wenn es der Natur ausgesetzt ist? Teil 1 + 2, Wie lange hält ein Kunststoffteil?, Empa, Dübendorf 11-05 thru 06
Löwe, Ch.	100 Jahre unter erschwerten Bedingungen? Teil 2, Wie lange hält ein Kunststoffteil?, Empa Dübendorf 11-05 thru 06
Löwe, Ch.	OIT-Messungen an PE-EVA Blends, STK, Schweizerische Gesellschaft für Thermoanalyse und Kalorimetrie, Greifensee 11-06
Necola, A.	Design of GRP Flanges and Tests to verify the Design and to Determine Long-Term Properties of GRP Pipes, ComTec, Forschungs- und Entwicklungs-Gesellschaft für Verbundwerkstoffe mbH, Aachen, Germany 05-15 thru 17
Nordstrom, R./ Brunner, A.J./Bohse, J.	A First Atlas of AE Activity, 45th Regular Meeting Acoustic Emission Working Group, Evanston, IL USA 08-21
Snedeker, J.G./Rogelj, J./ Farshad, M./Schmidlin, F./ Niederer, P	Finite Element Models of Abdominal Organs for Use in Trauma Research, 4th World Congress of Biomechanics, Calgary Canada 08-04 thru 09

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Conferences

Surface and Joining Technology

Elsener, H.R./Piazza, D.	Entwicklung von ionenoptischen Komponenten für das RTOF-Massenspektrometer: Highlights – Die Schweiz im Weltraum – Die Empa ist auch dabei, Empa Akademie, Dübendorf 12-02
Ernst, K.-H.	True and False Chirality: Asymmetric Synthesis via Magnetic Fields?, Surface Science Seminar, Dübendorf 01-13
Ernst, K.-H.	Chiralität in Chemie und Physik, Physikalisches Kolloquium, Ulm, Germany 01-28 ⓘ
Ernst, K.-H.	Supramolecular Chiral Films, SPS-Meeting, Lausanne 03-01 thru 02 ⓘ
Ernst, K.-H.	Molecular Chiroptical Dipole Switches, Surface Science Seminar, Dübendorf 03-06
Ernst, K.-H.	Spin-polarised electrons in chiral media, Surface Science Seminar, Dübendorf 04-04
Ernst, K.-H.	Adsorption of chiral aromatic hydrocarbons on metal surfaces, Bunsentagung 2002, Potsdam, Germany 05-09 thru 11
Ernst, K.-H.	Chiral Hydrocarbons on Metal Surfaces, Physics and Chemistry of Chiral Systems – 24h of Leuven, Leuven, Belgium 05-23 thru 24 ⓘ
Ernst, K.-H.	Chiral Modification of Metal Surfaces, Zürich 06-03 ⓘ
Ernst, K.-H.	Supramolecular Chiral Films, Internat. Symp. on Optical Science and Technology SPIE 47, Seattle USA 07-07 thru 12
Ernst, K.-H.	Chirality at Surfaces: Chiral Hydrocarbons on Metals, Nanoscience Seminar, Seattle, USA 07-12 ⓘ
Ernst, K.-H.	World in a mirror: the concept of chirality, Doktorandenseminar Seminar, Stuttgart, Germany 12-03 ⓘ
Ernst, K.-H./Fasel, R./Kuster, Y.	Supramolecular Chiral Films, Molecular Nanosystems: From Single Molecules to Supramolecular Assemblies, Ascona 14-04 thru 19
Fasel, R.	Fabrication of a chiral surface with single-phase helical orientational order, Symposium on Surface Science, St. Christoph am Arlberg, Austria 03-08
Fasel, R.	Determination of molecular orientation in adsorbate systems by means of angle-scanned x-ray photoelectron diffraction, SLS-Seminar, Paul Scherrer Institut, Villigen 12-13 ⓘ
Harzenmoser, M.	1) Schadenfälle. 2) Schweissfehler in: QM im Schweissen, Kurs Sichtprüfung, Winterthur, 01-23, 06-04, 11-12 01-23
Harzenmoser, M.	Die neue Norm SIA 263/1, SQS Erfa 729, Chatel St. Denis 09-25
Harzenmoser, M.	Joining Group and our first Work Package, Kick-off Meeting «NanoRotor», Baden 11-25
Hauert, R.	Tailored tribological behaviour of diamond-like Carbon by alloying with F, Ti or Si, SAOG, 18th annual Meeting, Fribourg 01-24
Hauert, R.	Moderne Hartstoffschichten – verbesserte Eigenschaften durch Nanostrukturierung, 6. Intern IWF Kolloquium, Feinstbearbeitung technischer Oberflächen, Egerkingen 04-19 ⓘ
Hauert, R.	Nanostrukturierte Schutzschichten für leistungsfähige Komponenten, Wissenschaftsapéro, Dübendorf 04-29
Hauert, R.	Tailored tribological and biological behavior of diamond-like carbon, SMAC 2002, 4th Specialist Meeting on Amorphous Carbon, Barcelona, Spain 09-05 thru 06 ⓘ
Hauert, R.	A review of modified DLC coatings for biological applications, DIAMOND 2002, Granada, Spain 09-09 thru 13 ⓘ
Hauert, R./Hug. P	Adhäsion als Grenzflächenproblem, Swiss Bonding, Rapperswil 05-27 ⓘ
Janczak-Rusch, J.	Joining of Si_3N_4/TiN Ceramics with Steel Components Using Particle Reinforced Active Brazing Alloys, 6. International Conference on Joining Ceramics, Glass and Metal, München, Germany 09-30

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Conferences

Janczak-Rusch, J./Zigerlig B./ Klotz, U.E./Elsener, H.R./ Brem, F./Kübler, G./Blugan G.	Joining of Si_3N_4/TiN Ceramics with Steel ComponentsUsing Particle Reinforced Active Brazing Alloys, 6th International Conference on Joining Ceramics, Glass and Metals, München, Germany 09-30 thru 10-01
Klotz, U.E.	Transmissionelektronenmikroskopie (TEM) an der Empa Dübendorf, Dübendorf 03-18
Klotz, U.E.	Wir blicken für Sie durch – TEM-Untersuchungen in der Materialwissenschaft, Einweihung FIB-Anlagen, Empa, Dübendorf 06-18
Klotz, U.E.	Interdiffusion in geHIPten Gasturbinen-Rotorscheiben, Arbeitskreis Hochtemperaturwerkstoffe, Baden 07-05
Klotz, U.E.	Microstructure investigations and thermodynamic modelling of a particle reinforced active brazing alloy, 6th International Conference on Joining Ceramics, Glass and Metal, München, Germany 10-01
Klotz, U.E./Elsener, H.R./ Zigerlig, B./Janczak-Rusch, J.	Microstructural Investigations and Thermodynamic Modelling of Particle Reinforced Active Brazing Alloys, 6th International Conference on Joining Ceramics, Glass and Metals, München, Germany 09-30 thru 10-01
Müller, U.	Investigations of the static friction coefficient of diamond-like carbon films, 8th International Conference on Plasma Surface Engineering (PSE2002), Garmisch-Partenkirchen, Germany 09-09 thru 13
Müller, U./Hauert, R./Gobrecht, J./Gröning, P./Kleinlogel, C.	Low impurity deposition surfaces for liquid flow applications, 3rd Annual Meeting TOP NANO 21, Bern 10-01
Müller, Y.	Die Anodisation von Titan – Einflüsse der Anodisation auf die Eigenschaften der Titanoxidschicht, SVMT-Sitzung «Praktische Werkstoffuntersuchungen», Sulzer Innotec AG, Winterthur 10-30
Parschau, M.	Chiral Nanostructures via Self-Assembly of Helical Molecules, Workshop on Nanoscience, Twannberg 09-30 thru 10-04
Parschau, M.	Adsorption of Heptahelicene on Cu(111): Chiral Nanostructures in self-assembled monolayers, Surface Science Seminar, Dübendorf 11-13
Patscheider, J.	Wear-protective coatings consisting of TiC-aSiC-aCH deposited by reactive magnetron sputtering, International Conference on Metallurgical Coatings and Thin Films, ICMCTF `02, San Diego, USA 01-22 thru 26
Patscheider, J.	Structure and Properties of Nanodispersive Hard Coatings, Tagung der Schweizerischen Arbeitsgemeinschaft Oberflächen und Grenzflächen (SAOG), Fribourg 01-24 ⓘ
Patscheider, J.	Modern Concepts in Novel Hard Coatings, Seminar Prof. J.E. Greene, University of Illinois at Urbana-Champaign, Urbana, USA 05-03 ⓘ
Patscheider, J.	Building Principles for Nanocomposite Hard Coatings, Seminar Prof. Y.-W. Chung, Northwestern University, Evanston, USA 05-17 ⓘ
Patscheider, J.	Structures and Properties of Nanodispersive Hard Coatings, 12th International Conference on Thin Films, Bratislava, Slovakia 09-15 thru 20 ⓘ
Patscheider, J.	Structure-properties-performance relations in nanocomposite hard coatings, 36th IUVSTA Workshop on the mechanisms of formation and applications of hard nanostructured coatings, Plzen, Czechoslovakia 10-20 thru 24 ⓘ
Patscheider, J.	Nanostrukturierte Schichtmaterialien, 3. Fachforum Nanotechnologie, Regensburg, Germany 10-23 thru 24 ⓘ
Patscheider, J.	Nanostructured and nanolayered materials, AVS 49th International Symposium, Denver, USA 11-03 thru-08 ⓘ
Piazza, D./Elsner, H.R./ Kiser, M./Zigerlig B.	Brazing, Welding and Design Aspects of a Multifunctional Titanium – Alumina Ceramic Components for a Space Application, 6th International Conference on Joining Ceramics, Glass and Metals, München, Germany 09-30 thru 10-01
Roth, M.	Praktische Beispiele III: Schadensuntersuchungen mit Oberflächenanalytik, Fortbildungsseminar Systematische Beurrteilung technischer Schadensfälle, Ermatingen 03-21

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Conferences

Roth, M.	1) Zuordnung von Schäden an keramischen Bauteilen mit dem REM. 2) Schadensuntersuchungen mit Oberflächenanalytik. Seminar: Rasterelektronenmikroskopie und Analyse von Mikrobereichen und Oberflächenschichten, TAE Sarnen 06-12
Roth, M.	Nanotechnologie, 2. Wirtschaftsforum von glow. das Glattal, Empa, Dübendorf 10-24
Roth, M.	Neuartige Verschleissschutzschichten durch Nanostrukturierung, Widmannstättentagung, Linz, Austria 11-06
Trüllinger, S.	Neues zu asiatischen Krisen, Tagung «Braucht die Schweiz ein Zentrum für Archeometallurgie?», Empa, Dübendorf 07-05
Winkler, R.	Methodik bzw. Hilfsmittel in der Schadensanalytik, Arbeitskreis Mikroanalytik, Düsseldorf, Germany 10-30
Woodtli, J.	Der Ingenieur als Frau und Mutter, Forum HSW, Hochschule Wädenswil, 05-16. Generalversammlung SVIN, Bern, 09-20 ⓘ
Woodtli, J.	Beurteilung von Brüchen an metallischen Bauteilen mit der Rasterelektronenmikroskopie, Seminar Rastermikroskopie und Analyse von Mikrobereichen und Oberflächenschichten, TAE, Sarnen 06-10 thru 14 ⓘ
Woodtli, J.	Beurteilung von Schäden an metallischen und nichtmetallischen Werkstoffen mit der rasterelektronenmikroskopie, Seminar Rasterelektronenmikroskopie und Mikrobereichanalyse, Esslingen, Germany 09-23 thru 25 ⓘ
Woodtli, J./Kieselbach, R.	Failures in prestressed tendons, European Conference on Fracture ECF 14, Cracow, Poland 09-09 thru 12
Zgraggen, M.	Metallographie – ein alter Zopf? Das Potenzial der klassischen Metallographie in der modernen Materialographie, 02-11, Empa, Dübendorf, SVMT-Tagung, Baden, 04-23
Zgraggen, M.	Schäden im Zusammenhang mit dem Feuerverzinken, Tagung Gefüge und Bruch, Leoben, Germany 03-11
Zgraggen, M.	Schäden aufgrund falscher Wärmebehandlung, SVW-Gruppe Zürich/Schaffhausen, Oerlikon 06-06 ⓘ
Zgraggen, M.	Möglichkeiten und Grenzen der ambulanten Metallographie, ATM-Workshop Metallographische Probenpräparation, Hallau 06-06 ⓘ
Zgraggen, M.	Beurteilung von Brüchen an metallischen Bauteilen mit der Rasterelektronenmikroskopie, Rasterelektronenmikroskopie und Analyse von Mikrobereichen und Oberflächenschichten, TAE, Sarnen 06-12 ⓘ
Zgraggen, M.	Metallographie in der Schadensanalytik, Workshop, Dättwil 06-19 ⓘ
Zgraggen, M.	Wärmebehandlungsfehler, SVW-Gruppe Bern, Solothurn 07-04 ⓘ
Zigerlig, B. (Chairman)	Die Schweiz im Weltraum – Die Empa ist auch dabei, Empa Akademie, Dübendorf 12-02

Materials and Systems for Civil Engineering

Applied Physics in Building

Affolter, Ch.	Thermisch-mechanische finite-Elemente-Simulation an Leichtbauwänden, Vorlesungsreihe Spezialfragen Bauphysik, ETH Zürich 01-18 ⓘ
Binder, B.	Component testing for industrial clients: Multiple glazing with PCM, Energy efficient & Healthy Buildings in Sustainable Cities, Lyon, France 10-25 ⓘ
Büchli, R.	Unterhalt von Flachdächern in öffentlich rechtlichen Körperschaften, Empa-Akademie, Dübendorf 02-08 and 05-31
Büchli, R.	Massnahmen im Bereich der Bauphysik, Hochschule Rapperswil 05-23
Büchli, R.	Bauschäden, Sedrun 09-11

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Conferences

	Büchli, R.	Wärmebrückenbedingte Bauschäden, Erfahrungen aus der Praxis, Empa-Akademie, Dübendorf 11-28
	Büchli, R./Raschle, P.	Schäden an verputzten Aussenwärmedämmungen, Hochschule für Technik, Wirtschaft und Soziale Arbeit, St.Gallen 05-15
	Frank, Th.	Gebäude mit hohem Glasanteil, Plenarversammlung SZFF, Empa-Akademie, Dübendorf 01-10
	Frank, Th.	Bauphysik des Wintergartens, Weiterbildungskurs: Wintergarten, Empa-Akademie, Dübendorf 04-11
	Frank, Th.	1) Fenster: Wärme- und Sonnenschutz. 2) Glasdatenbank GLAD. 3) Luftdichtigkeits-Messung, 4) Neue Materialien . 5) Thermischer Komfort . 6) Wärmebrückenatlas EUROKOBRA. Passivhaus konkret: Gebäudehülle, Empa-Akademie, HTA Horw 05-14/06-19/08-28
	Frank, Th.	Outdoor component performance testing and evaluation, Energy efficient & Healthy Buildings in Sustainable Cities, Lyon, France 10-25 ⓘ
	Frank, Th.	Bauphysikalische Nachweise bei Dachkonstruktionen, SAH Tagung Dächer, Weinfelden 11-06 thru 07 ⓘ
	Frank, Th.	Wärmebrückennachweise in der Schweiz, EU-Projekt EUROKOBRA, Empa-Akademie, Dübendorf 11-28
	Ghazi, K.	Feuchteadaptive Dampfbremsen – Wo ist deren Einsatz sinnvoll?, Vorlesungsreihe Spezialfragen Bauphysik, ETH Zürich 01-11 ⓘ
	Ghazi K.	Punktuelle Wärmebrücken, EU-Projekt EUROKOBRA, Empa-Akademie, Dübendorf 11-28
	Manz, H.	CFD-Modellierung der Rauchausbreitung im Brandfall, Vorlesungsreihe Spezialfragen Bauphysik, ETH Zürich 01-18 ⓘ
	Manz, H.	Nummerische Strömungsberechnung (CFD): Anwendungsbeispiele in der Bauphysik, 12. Schweizerisches Stastus-Seminar, ETH Zürich 09-12
	Nussbaumer, Th.	sia 180 – Behagliches Raumklima, VKFS Tagung, SISH Biel 06-11
	Simmler, H.	Sonnenschutz von Glasfassaden, Plenarversammlung SZFF, Empa-Akademie, Dübendorf 01-10
	Simmler, H.	Ein Jahr Erfahrungen mit dem Empa-Solarfassadenprüfstand, Vorlesungsreihe Spezialfragen Bauphysik, ETH Zürich 02-08 ⓘ
	Simmler, H./Ghazi, K.	Vakuumdämmung im Baubereich, VIP-Workshop (IEA Annex 39), Basel 09-10
	Tanner, Ch.	Bauphysikalische Untersuchungen, Abteilung Bauingenieure, Hochschule Rapperswil 01-24 ⓘ
	Tanner, Ch.	Bauphysikalische Grundlagen und Versuche, Kurs Aussenwärmedämmung, Empa, Dübendorf 01-24
	Tanner, Ch.	Luftdichtigkeit und IR Thermografie, Praktikum für Metallbauingenieure, Empa, Dübendorf 04-09
Center for Energy and Sustainability in Buildings (ZEN)		Tagungsorganisation und -leitung 12. Schweiz. Status-Seminar der Energie- und Umweltforschung im Hochbau, ETH Zürich 09-12 thru 13
	Zimmermann, M.	Leitung Kurs: Passivhaus konkret, Empa-Akademie, Dübendorf, 05-07 thru 28, 08-21 thru 09-05. HTA Luzern, 06-05 thru 07-03
	Zimmermann, M.	Energieapéro Bern – MINERGIE-P – ein Projekt für Pioniere, Hochschule für Technik und Architektur HTA Bern 03-04 ⓘ
CFRP In Structural Engineering	Meier, U.	Making Better Use of the Outstanding Properties ... Beyond the Basics, 6th World Pultrusion Conference, Prague, Czechien 04-03 thru 04 ⓘ
	Meier, U.	The development of composites and its utilisatin in Switzerland, Conference Advanced Polymer Composites for Structural Applications in Construction, ACIC 2002, University of Southampton, England 04-17 thru 17 ⓘ
	Meier, U.	Multifunctional Use in Advanced Composite Materials in Structural Engineering, 7th Annual

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Conferences

		Conference of Intelligent Sensing for Innovative Structures, A Canadian Network of Centres of Excellence, Winnipeg, Canada 05-01 thru 03 ⓘ
	Meier, U.	Verklebung von CFK-Bändern auf Beton mit Spannungsgradient und Prozessregelung, Swiss Bonding 2002, 16th International Symposium, Fachhochschule Rapperswil 05-27 thru 29 ⓘ
	Meier, U.	Faserverbundwerkstoffe für Tragwerke, Schweizer Kunststoff-Symposium 2002, KATZ, Kunststoff-Ausbildungs- und Technologie-Zentrum, Aarau 06-06 ⓘ
	Meier, U.	Kompetenzzentrum «Adaptive Werkstoffsysteme» an der Empa im Aufbau, Wissenschaftsapéro (R)evolutionieren adaptive Werkstoffsysteme die Technik?, Empa-Akademie, Dübendorf 06-10 ⓘ
	Meier, U.	Maximale Leistung mit minimalem CFK-Einsatz, Fachveranstaltung Kunststoffe im Leichtbau des Schweizerischen Technischen Verbands STV/Swiss Engineering, RUAG Aerospace, Emmen 06-20 ⓘ
	Meier, U.	Civil Engineers can make better use of the strength of CFRP, International Symposium on Lightweight Structures in Civil Engineering, Warsaw University of Technology, Warsaw, Poland 06-24 thru 28 ⓘ
	Meier, U.	Brigth Future for Carbon Fibres in Construction, International SIKA-Seminar «Pre- and Posttensioning with CarboDur Composites», Zürich 06-27 ⓘ
	Meier, U.	Adaptive Materials in Structural Systems, International Workshop Structural Health Monitoring of ISIS Canada, Intelligent Sensing for Innovative Structures, A Canadian Network of Centres of Excellence, Winnipeg, Canada 09-19 thru 20 ⓘ
	Meier, U.	Denkende Materialien: Eigenschaften intelligenter und funktioneller High-Tech-Werkstoffe, Hochschulforum HTW, Chur 10-17 ⓘ
	Meier, U.	The development of advanced composites Worldwide, Seminar Innovation in Construction, Oxford, England 10-28 thru 29 ⓘ
	Meier, U.	The Use of Composites in Public Works, Arquimacom 2002, Congresso Int. de Compositos na Arquitetura e Construcao, ITM Expo, São Paulo, Brasil 11-19 thru 21 ⓘ
	Meier, U.	Fibrous Composites in Structural Engineering, Escola Politécnica da Universidade de São Paulo, Brasil 11-22 ⓘ
	Meier, U.	Novel development of CFRP systems in structural engineering, Universidade de Brasília, Brasilia, Brasil 11-25 ⓘ
	Stoecklin, I.	Strengthening of Concrete Structures with Prestressed and Gradually Anchored CFRP Strips, International Conference on Bridge Maintenace, Safety and Management, IABMAS 02, Barcelona, Spain 07-14 thru 17 ⓘ
	Ulaga, T.	The Premature Failure of CFRP Laminate-Strengthened Concrete Structures: International Conference on Bridge Maintenace, Safety and Management, IABMAS 02, Hotel Fira Palace, Barcelona, Spain 07-14 thru 17 ⓘ
	Winistörfer, A.	CFK-Zugglieder im Brückenbau, Verbindungstechnik im Bauwesen, 20. Internationales Klebtechnik-Symposium, Fachhochschule Rosenheim, Germany 01-31thru 02-02 ⓘ
	Winistörfer, A.	Externe Vorspannung mit CFK Elementen, Nachträgliche Statische Verstärkung mit Kohlefaserprodukten, Universität für Bodenkultur, Wien, Austria 02-18 ⓘ
	Winistörfer, A.	CFRP Tendons for Active Shear Enhancement Purposes, International Conference on Bridge Maintenace, Safety and Management, IABMAS 02, Barcelona, Spain 07-14 thru 17 ⓘ
	Winistörfer, A.	Advanced Composite Tendon System, Proceedings Materials Week 2002, European Congress on Advanced Materials, their Processes and Applications, München, Germany 09-30 thru 10-02 ⓘ
Concrete/ Construction Chemistry	Holzer, L./Lothenbach, B./ Winnefeld, F.	Der Einfluss der mikrostrukturellen Entwicklung und der Porenlösungschemie auf das Erstarrungsverhalten von Zementpasten, 4. Tagung Bauchemie, Weimar, Germany 09-30 thru 10-01
	Kaufmann, J./Winnefeld, F.	Influence of addition of ultrafine cement on the rheological properties and strength of Portland cement pastes, Challenges of Concrete Construction, Dundee, United Kingdom 09-05 thru 11

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Conferences

	Leemann, A./Hoffmann, C./ Olbrecht, H.	Selbstverdichtender Beton: Zusammensetzung und Eigenschaften, 8. Holcim Betontagung, Zürich 09-04 ⓘ
	Moser K./Edvardsen C.	Engineering Design Methods for Service Life Prediction, 9th International Conference on the Durability of Building Materials & Components, Brisbane, Australia 03-18 thru 20
	Moser, K.	Vom Zementmörtel zum belegreifen Unterlagsboden, 14. KBS Unterlagsboden-Fachtagung, Lenzburg 01-16
	Olbrecht, H.	Dauerhafter Bauwerksbeton, Kraftwerk Rheinau, Benken 01-10
	Olbrecht, H.	Prüfen von Bauwerksbeton, Beton und Stahlbeton im 3. Jahrtausend, 2. Internationale wissenschaftlich-praktische Konferenz, Rostow, Russia 09-04 thru 08
	Olbrecht, H.	Betonarten verschiedener Zeitepochen, Schweizerischer Baukaderverband, Schaffhausen 10-21
	Romer M./Holzer L./Pfiffner M.	Swiss tunnel buildings: concrete damage by formation of thaumasite, First International Conference on Thaumasite in Cementitious Materials, Garston, United Kingdom 06-19 thru 21
	Romer, M.	Steam locomotive soot and thaumasite – a case study, First International Conference on Thaumasite in Cementitious Materials, Garston, United Kingdom 06-19 thru 21
	Winnefeld, F.	Historische Kalkmörtel, Parifondkurs Sumpfkalk, Effretikon 02-06
	Winnefeld, F.	Rheological behavior of portland cement pastes during early hydration, 24th International Conference on Cement Microscopy, San Diego, USA 04-07 thru 11
Energy Systems/ Building Equipment	Dorer, V.	Ventilation concepts for sustainable buildings, World Renewable Energy Congress VII, Köln, Germany 06-29 thru 07-05 ⓘ
	Dorer, V.	Energieeffiziente und bedarfsgerechte Abluftsysteme mit Abwärmenutzung, 12. Status Seminar Energie- und Umweltforschung im Bauwesen, ETH Zürich 09-12 thru 13 ⓘ
	Dorer, V.	Abluftanlagen: Einfache Systeme, aber schwierig zu planen, Energie-Apéro Winterthur, Winterthur 11-27 ⓘ
	Haas, A.	Welches Passivhaus für die Schweiz?, Jahresversammlung der Energiefachleute beider Basel, Liestal 06-13 ⓘ
	Haas, A.	Warmluftheizung – Chancen und Grenzen aus heutiger Sicht, Energie-Apéro Zürcher Hochschule Winterthur, Winterthur 11-27 ⓘ
	Koschenz, M.	Thermoaktive Bauteilsysteme in modernen Gewerbebauten, REHAU-Fachtagung, München, Germany, 03-15, Erfurt, Germany, 04-17 ⓘ
	Koschenz, M.	Planungsunterstützung durch Gebäude- und Systemsimulation, Clima-Suisse Energietagung, Technopark, Zürich 04-24 ⓘ
	Pfeiffer, A.	Energieeffiziente und bedarfsgerechte Abluftsysteme mit Abwärmenutzung, Forschungsprojekt ENABL, CLIMA-SUISSE – Energietagung 2002, Technopark, Zürich 04-24 ⓘ
	Pfeiffer, A.	Thermoaktive Bauteilsysteme tabs: Umsetzung mittels tabscal, Empa, Dübendorf 04-29
	Pfeiffer, A.	tabscal – Das Programm zur Dimensionierung thermoaktiver Bauteilsysteme, 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich 09-12 thru 13
	Rueegg, T./Sprecher, P.	Industrielle Absaugung grosser Reichweite mit Labordemonstration, ZHW: Zürcher Hochschule Winterthur 02-18 ⓘ
	Rueegg, T.	Local Ventilation with REinforced EXhaust Systems (REEXS): Optimizing the capture range in a test cabin, RoomVent 2002, 8th International Conference on Air Distribution in Rooms, Copenhagen, Denmark 09-08 thru 11
	Weber, A.	TRNFlow: Integration von COMIS im TRNSYS TYPE56, TRNSYS Usertag, Stuttgart, Germany 02-22 ⓘ

ⓘ invited

EMPA Activities 2002

Conferences

Road Engineering/ Sealing Components

Gubler, R.	Stellen Filler einen Risikofaktor für die Alterung von Asphaltbelägen dar? Empa Akademie, Dübendorf 01-17
Gubler, R.	Betonstrassen/Brückenbeläge aus Beton. D-A-CH Informationstagung, Neufahrn, Germany 11-21 ⓘ
Gubler, R./Hean, S.	D-A-CH Informationstagung 2002, Neufahrn, Germany 10-20 thru 21 ⓘ
Hean, S.	Verhalten von Silent-Joint; Laboruntersuchungen und Objektzustände. Fachtagung Fahrbahnübergänge, in Dübendorf und an der Hochschule Bern 06-20 and 21 ⓘ
Hean, S./Partl, M.N.	Fahrbahnübergänge aus Polymerbitumen, Praktische Empfehlungen und Neuheiten, ASTRA Arbeitstagung der Brückeningenieure 2002, Basel 10-24 ⓘ
Hugener, M.	Aspects de Recyclage en Suisse, Colloque F-CH, Lyon, France 04-12 ⓘ
Hugenschmidt, J.	A One-to-One Comparison Between Radar Results and Reality on a Concrete Bridge, 9th International Conference in Ground Penetrating Radar, Santa Barbara, Cal., USA 04-29 thru 05-02 ⓘ
Hugenschmidt, J.	GPR-Inspection of the Rock Surface beneath a Pass Road, Deutsche Geophysikalische Gesellschaft and English Geophysical Society, European Section, Neustadt/Weinstrasse, Germany 10-25
Neubauer, O.	Marshall- und Gyratorverdichtung von Splittmastixasphalt, Empa Akademie, Dübendorf 11-05
Partl, M.N.	Experience with MMLS3 at Empa, Workshop during AAPT annual meeting, Colorado Springs, USA 03-17
Partl, M.N.	1) Overview on Activities of Empa and Center of Road Engineering/Sealing Components. 2) Evaluation of Improved Porous Asphalt by Various Test Methods (Recent Empa Results), JHRI Seminar, Machida, Japan 10-22 ⓘ
Partl, M.N.	1) Bridge Pavement Research and Swiss LTPP, JH Workshop on Bridges, 2) Swiss Road and Pavement Research, JH-Seminar, EXTEC Center, Tokio, Japan 10-23 ⓘ
Partl, M.N.	Global and Swiss Road Research Developments, Special Lecture at Hokkaido University, Japan 10-24 ⓘ
Partl, M.N.	RILEM Research Activities on Performance Testing and Evaluation of Bituminous Materials. SIIV 2002 Symposium on Functional Rehabilitation and Safety of Road Network, Società Italiana Infrastrutture Viarie, Parma, Italy 10-30 ⓘ
Partl, M.N./Hean, S.	Practical Aspects of Interaction Between Mastic Asphalt and Waterproofing Components in Bridge & Tunnel Construction, 4th European Symposium on Performance of Bituminous and Hydraulic Materials in Pavements, Nottingham, England 04-12 ⓘ
Partl, M.N./Hean, S./ Poulikakos, L. D.	Asphalt Plug Joint Characterization and Performance Evaluation, 9th International Conference on Asphalt Pavements, ISAP, Copenhagen, Denmark 08-17 ⓘ
Partl, M.N./Piber, H.	Interlaboratory Tests on Performance Prediction of Pavements. 9th International Conference on Asphalt Pavements, ISAP, Copenhagen, Denmark 08-17 ⓘ
Poulikakos, L.D./ Sayir, M. B./Partl, M.N	Long Term Field Characterisation of Polymer Modified Bitumen Using a New Torsional Dynamic Resonance Rheometer 4th European Symposium on Performance of Bituminous and Hydraulic Materials in Pavements, Nottingham, England 04-12 ⓘ
Stimolo, M.	Spezialkurs Spritzgiessen und Extrudieren, Testmethoden der Werkstoff/Bauteiluntersuchungen, Thermographie-Methoden, Empa, Dübendorf 03-05 ⓘ
Stimolo, M.	SPIE Society of Photo-Optical Instrumentation Engineers; THERMOSENSE XXIV , Thermal Sensing and Imaging Diagnostic Application; 1–4 April 2002; Pratical utilization of thermography in road construction and in waterproofing systems, Orlando, Florida, USA 04-03 ⓘ
Stimolo, M.	Möglichkeiten der Erkennung von Belagsschäden und Inhomogenitäten auf Brücken, Tagung Fortschrittliche ZfP Methoden, Empa, Dübendorf 09-02 ⓘ
Stimolo, M.	Détection de dommages et contrôle de qualité par thermographie infrarouge, Journée technique,

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Conferences

		LAVOC, EPF, Lausanne 09-25 ⓘ
	Stimolo, M.	Utilizzo della termografia ad infrarossi nel rilevamento di defetti nel rivestimento stradale deo ponti. SIIV 2002 Symposium on Functional Rehabilitation and Safety of Road Network, Società Italiana Infrastrutture Viarie, Parma, Italy 10-31
Strength and Technology	Kieselbach, R.	Rescue helicopter hoist failure, ISTLI SPT-7 Conference, Vienna, Austria 06-12 thru 14 ⓘ
	Kieselbach, R.	Failure in prestressed tendons, Europeen conference on fracture, Cracow, Poland 09-08 thru 13
	Kieselbach, R./Koller, R.	Schwingfestigkeit und Lebensdauervorhersage. Seminar: Grundlagen der Betriebsfestigkeit, Empa Akademie, Dübendorf 09-24 thru 25
	Koller, R.	Technische Schadenfälle, DGM-Seminar, Ermatingen 06-03
	Kovacs, G.	Reducing stationary vibrations on continously circulating monocable, OITAF-NACS, Girdwood, Alaska 09-15 thru 20 ⓘ
	Michel, S.	Bruchmechanik. Seminar: Grundlagen der Betriebsfestigkeit, Empa-Akademie, Dübendorf 09-24 thru 25
	Piskoty, G.	Mehrkörperdynamik. Seminar: Grundlagen der Betriebsfestigkeit, Empa-Akademie, Dübendorf 09-24 thru 25
	Piskoty, G.	Komplexe Ursache eines Seilrisses in einem Gasleitungsstollen, SVTM, Bern 04-23 ⓘ
	Piskoty, G.	Schadenanalyse, Informationsbesuch vom Wissenschaftlichen Dienst der Stadtpolizei Zürich 04-25 ⓘ
	Piskoty, G.	Schadenanalyse mit Hilfe von ADAMS, 7. Schweizer CAD-FEM User Meeting, Zürich 06-13 ⓘ
	Soyka, G.	Ermittlung von Betriebslasten. Seminar: Grundlagen der Betriebsfestigkeit, Empa-Akademie, Dübendorf 09-24 thru 25
	Weisse, B.	Konstruktion und Formgebung. Grundlagen der Betriebsfestigkeit, Empa-Akademie, Dübendorf 09-24 thru 25
Structural Engineering	Bergamini, A.	Non-destructive Testing of Stay Cables – Field Experience in South Asia, 3rd Conference on Structural Control, Como, Italy 04-07 thru 12
	Bergamini, A.	Zerstörungsfreie Prüfung von Brückenseilen, Fortschrittliche ZFP-Methoden, Empa-Akademie, Dübendorf 09-12
	Czaderski, Ch.	Shear strengthening with prefabricated CFRP L-shaped plates, IABSE Symposium, Melbourne, Australia 09-11 thru 13
	Czaderski, Ch.	Shear strengthening with prefabricated CFRP L-shaped plates, First fib Congress, Osaka, Japan 10-13 thru 19
	Feltrin, G.	Einfluss von Schädigungen und Umwelteinwirkungen auf die dynamischen Eigenschaften einer Brücke, 5. MR2002 Symposium, Empa Akademie, Dübendorf 06-07 ⓘ
	Feltrin, G.	Vibration based damage detection on a Highway Bridge, IABMAS'02 First International Conference on Bridge Maintenance, Safety and Management, Barcelona, Spain 07-14 thru 17 ⓘ
	Feltrin, G.	Temperature and damage effects on modal parameters of a reinforced concrete Bridge, Eurodyn 2002, Munich, Germany 09-02 thru 05 ⓘ
	Maeck, J./Feltrin, G./ De Roeck, G.	Vibration based Damage Identification on a Concrete Highway Bridge, 1st European Workshop on Structural Health Monitoring (SHM2002) 12-10 ⓘ
	Motavalli, M.	Experimental Facilities and Activities of the Department of Structural Engineering at Empa, 3rd Conference on Structural Control, Como, Italy 04-07
	Motavalli, M.	1) Acitivities and experimental facilities of the Department of Structural Engineering, Sharif University of Technology, Tehran, Iran, 04-30, 2) University of Tehran, Tehran, Iran, 05-08, 3) University Lulea, Sweden, 07-06 ⓘ
	Motavalli, M.	Adaptives Brückenmodell, Wissenschaftsapéro, Empa-Akademie, Dübendorf 12-16 ⓘ

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Conferences

Wood

Weber, F.	Dämpfung von Seilschwingungen mit geregeltem magnetorheologischem Dämpfer, 5. MR2002-Symposium über Bauwerksdynamik und Erschütterungsmessungen, Empa-Akademie, Dübendorf 06-07 ⓘ
Weber, F.	Cable Vibration Mitigation Using Controlled Magnetorheological Fluid Dampers: A Theoretical and Experimental Investigation, Footbridge 2002, Paris, France 11-20 thru 22
Althaus, H.J.	Nachhaltigkeit. Kurs: Passivhaus Konkret, Empa Akademie, Dübendorf/HTA Luzern 05-28/07-03/09-05 ⓘ
Arnold, M.	Holzqualität, Lagerung und Verwendung von Sturmholz. Statusseminar der Schweiz. Arbeitsgemeinschaft für Holzforschung SAH. ETH Zürich 06-12 ⓘ
Graf, E.	Das Langzeitverhalten von druckimprägnierten Leitungsmasten im Freilandversuch. Fachkommission Holzschutz, Verband Schweiz. Elektrizitätsuntrnehmen (VSE) / Verband Schweiz. Holzimprägnierwerke (VSHI), Zürich 02-26 ⓘ
Graf, E.	Artificial Weathering prior to the Biotest. CEN/TC 38 WG 25, Paris, France 04-15 ⓘ
Graf, E.	Empa's Laboratory experiences with the European experimental standard EN 807 and the consequences on the test procedure. Centre Technique du Bois, Paris, France 04-16 ⓘ
Graf, E.	Ökologische, hygienische und ökonomische Aspekte der Bekämpfung holzzerstörender Insekten. Tagung «Holzschädlinge in historischen Gebäuden – Neue Ansätze in der Bekämpfung». Westfälisches Freilichtmuseum – Landesmuseum für Völkerkunde, Detmold, Germany 06-02 ⓘ
Graf, E.	Durability Requirements Regarding Different Wood and Wood Based Products – Current State of the Art in the Various Signatory Countries. COST Action E 22, 4th Workshop and 5th Management Committee Meeting, SF-Tuusula, Finland 06-02 ⓘ
Klingner, R.	Keramisierung von Holz mittels der Infiltration von SiO_2-Sol. Anlässlich: Hans-Walter-Hennicke-Award. Annual Meeting DKG & NKV, Universität Eindhoven, The Netherlands 10-22 ⓘ
Künniger, T.	Ökobilanz von Konstruktionen im Garten- und Landschaftsbau. 12. Schweiz. Statusseminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich 09-12 ⓘ
Nay, M.	Visible Aerial/Subaerial Biofilms on Buildings: Causes, Microorganisms, and Effects. Biofouling and Materials, COST-520 Abschlusstagung, Stockholm, Sweden 03-10 ⓘ
Nay, M.	Algen und Pilze an Fassaden – Biologie auf Oberflächen: Können moderne Fassaden (WDVS) vor mikrobiellem Befall geschützt werden. 12. Schweiz. Statusseminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich 09-12 ⓘ
Pöhler, E./Zimmermann T.	Biotechnologie im Nanobereich – Cellulosefibrillen zur Polymerverstärkung. 10. Internationale Tagung «Stoffliche Verwertung nachwachsender Rohstoffe», Chemnitz, Germany 10-09 thru 10 ⓘ
Richter, K.	Procesos para el tratamiento industrial de la madera e implicaciones para el medio ambiente y la sanidad. Produccion Mas Limpia en los procesos de aserrado y acabado y manejo sustenible del recourso maderable. Servicio Nacional de Aprendizaje, Centro Nacional de la Madera, Itagüi – Antioquia, Colombia 03-12 ⓘ
Richter, K.	LCA von Konstruktionen im Landschafts- und Gartenbau. Statusseminar der Schweiz. Arbeitsgemeinschaft für Holzforschung SAH. ETH Zürich 06-12 ⓘ
Richter, K.	Holzeinsatz im Garten- und Landschaftsbau: Sind Beständigkeit und Ökologie vereinbar? Erfahrungsaustausch Interessengruppe VSSG, Winterthur 09-26 ⓘ
Richter, K.	Ökologische Beurteilung der Holzverwendung. Von Ökobilanzen zur Modellierung von Kohlenstoff-Flüssen. Forstwissenschaftliche Tagung 2002, Waldbau im globalen Wandel, Göttingen, Germany 10-11 ⓘ
Richter, K	Europäische Normen für Holzwerkstoffe und holzbasierte Produkte. Holzwerkstoffe Schweiz, Partnertreff 2002, Baden 11-20 ⓘ
Richter, K./Schirle, M.A	1) Behaviour of 1 K PUR Adhesives under increased moisture and temperature conditions.

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Conferences

		2) Interactions of 1 K PUR Adhesives and different Wood Surface Parameters. Wood K Plus/Cost E 13 Final Conference «Wood Based Materials- Wood Composites and Chemistry», Wien, Austria 09-20 ⓘ
	Sell, J.	Massnahmen im Bereich des Holzschutzes. 15. Fortbildungskurs Holzbau «Erneuern, Umnutzen, Verstärken von Holzkonstruktionen». Hochschule für Technik HSR, Rapperswil 05-23
	Steiger, R.	1) Erneuern, Umnutzen, Verstärken von Bauwerken. 15. Fortbildungskurs Holzbau. 2) Zustandserfassung und Zustandsbeurteilung «Erneuern, Umnutzen, Verstärken von Holzkonstruktionen». Hochschule für Technik HSR, Rapperswil,. 05-23 ⓘ
	Steiger, R.	1) SIA 265: Die neue Schweizer Holzbaunorm. Statusseminar der Schweiz. Arbeitsgemeinschaft für Holzforschung SAH. ETH Zürich, 06-12, 2) SFS-Zimmermannshöck 2002, Rebstein, 11-21 ⓘ
	Steiger, R.	Fibre reinforced plastics (FRP) in timber structures – Investigations and developments. EUROWOOD Workshop 2002 on «Engineered Wood Products – Innovation and Exploitation», VTT, FIN-Espoo (Helsinki) 06-28 ⓘ
	Werner, F.	Poster LCA and Decision Making – Conclusions from a Review and a Case Study about Paper Recycling. SETAC Europe 12th Annual Meeting, Wien, Austria 05-12 ⓘ
	Werner, F.	Interdependencies between LC-modelling and the use of LCA in product design-related decisions; ETH Zürich 07-22 ⓘ
	Werner, F.	Zukunftsorientierte Entwicklungen im Fensterbau. Fachverband Fenster- und Fassade, Forum 2002 Lenzburg 09-19 ⓘ

Materials and Systems for Protection and Wellbeing of the Human Body

Biocompatible Materials	Bruinink, A.	What connects a blind cow with a cell?, TU Dresden, Dresden, Germany 02-28 ⓘ
	Bruinink, A./Jaschko, A./ Scharnweber, D./Müller, B./ Worch, H.	Effects of surface coating ot titanium on human bone cell performance, Symp. On Tissue Engineering Science, Tissue Engineering Society, Mykonos, Greece 05-19 thru 23
	Felber, H.	Das chemische Labor im Spannungsfeld verschiedener Kräfte – Anforderungen der Akkreditierung versus ökonomischer Druck, Vortragstagung von Eurachem D/CH, Gesellschaft Deutscher Chemiker, Stuttgart, Germany 11-13 thru 14 ⓘ
	Fortunato, G./Reichmuth, A./ Richard, P./Wunderli, S.	Detailed uncertainty budget for mass values determined by electronic balances in analytical chemistry, Eurachem/Citac-Workshop, Eurachem/Empa, Luzern, (Poster) 06-16 thru 18
	Hedinger, R.	Bestimmung der Messunsicherheit, Empa-Akademie, Dübendorf 04-17
	Hedinger, R.	Software for the Evaluation of Measurement Uncertainty in Analytical Chemistry: UncertaintyManager, Eurachem/Citac-Workshop, Eurachem/Empa, Luzern, (Poster) 06-16 thru 18
	Kaiser, J.P.	Mobility and behaviour of 3T3 fibroblast cells on titanium discs, 1st Swiss Zeiss-LSM User Meeting, Workshop, Carl Zeiss AG, EPFL, Lausanne 10-09 thru 10 ⓘ
	Meyer, V.K.	Messunsicherheit in der chemischen Analytik, Division Analytische Chemie der Schweizerischen Chemischen Gesellschaft, Winterthur 02-26 thru 27
	Meyer, V.K.	Messunsicherheit in der chemischen Analytik, Forschungszentrum Jülich, Jülich, German 11-19 thru 20
	Meyer, V.K.	1) Messunsicherheit in der chemischen Analytik, 2) Das HPLC-Chromatogramm unter der Lupe, NOVIA GmbH Frankfurt a.M., Bad Soden, Germany 11-27 thru 28
	Meyer, V.K./Van Look, G.	The purity of laboratory chemicals with regard to measurement uncertainty, Poster Eurachem/ Citac-Workshop, Eurachem/Empa, Luzern, 06-16 thru 18, Herbstversammlung der Schweizerischen Chemischen Gesellschaft, Basel, 10-17
	Noger, D.	Ausbildungskurs zur Durchführung des Empa-Ascheschnelltests, Schweizerischer

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Conferences

	Kaminfegermeisterverband, Olten, 04-23, SKMV, Verein Rauchfangkehrer Graz, Murau, Austria, 05-16 thru 17
Noger, D.	Der Empa-Schnelltest, Fachhochschule Biel, Biel 06-05
Ritter, A.	1) Restlösungsmittel in Kunststoffbeschichtungen, 2) Quantitative Bestimmungen von Schwermetallen in Kunststoffen, 3) Antioxydantiengehalt in Polyolefinen, Ringversuchstagung, Empa, St. Gallen 10-14
Rösslein, M.	Automatic uncertainty evaluation, PITTCON-2002, The Pittsburgh Conference, New Orleans, USA 03-17 thru 22 ⓘ
Rösslein, M.	Introducing measurement uncertainty in commercial laboratories, Analytical Chemistry Division NIST, Gaithersburg, USA 03-25 ⓘ
Rösslein, M.	1) Chairman: Evaluation techniques/practical examples, 2) Introduction to Eurachem/Citac uncertainty guide 2nd edition, 3) Chairman: Traceability for existing methods, 4) Why do we have measurement uncertainty?, Eurachem/Citac-Workshop, Eurachem/Empa, Luzern 06-16 thru 18 ⓘ
Rösslein, M.	1) Ermitteln der Unsicherheit mit Software, 2) Fallbeispiele – Unsicherheit analytischer Verfahren, Haus der Technik München, Germany 11-11 thru 12
Schmid, M.	1) Glasübergang mit DSC, 2) Kristallinität mit DSC, Ringversuche an polymeren Werkstoffen, Ringversuchstagung, Empa, St. Gallen 10-14
Schmid, M.	DSC-Ringversuche an Kunststoffen: Wiederhol- und Vergleichsgrenzen bei Glaspunkt- und OIT-Messungen, STK Jahrestagung, Schweizerische Gesellschaft für Thermoanalyse und Kalorimetrie (STK), Greifensee 11-06 ⓘ
Wampfler, B.	Messunsicherheit – Umsetzung in der analytischen Chemie, Empa, Dübendorf 04-17 ⓘ
Wampfler, B.	Validierung von chemisch-analytischen Verfahren, Schweizerische Chemische Gesellschaft, Winterthur 04-25
Wampfler, B.	1) Der Paradigmawechsel in der Messtechnik, 2) Robustheit – Wiederholbarkeit – Vergleichbarkeit, EAWAG, Dübendorf 06-06 ⓘ
Wampfler, B.	Workshop Validierung, EAWAG, Dübendorf 06-20
Wampfler, B.	Contribution of Sampling to Measurement Uncertainty, International ILAC/IAF Conference on Accreditation in Global Trade, ILAC/IAF, Berlin, Germany 09-23 thru 25 ⓘ
Wampfler, B./Felber, H.	Im Spannungsfeld verschiedener Kräfte – von der Messunsicherheit bis zur Ökonomie, Gesellschaft Deutscher Chemiker / Empa, Stuttgart, Germany 11-13 thru 14
Weber, M.	Über die Messunsicherheit chemischer Analysen, Tagung der Fachgruppe Arzneimittelkontrolle, Gruppe Pharmazeutischer Analytik der DPhG, Frankfurt a.M., Germany 01-31 ⓘ
Weber, M.	Uncertainty of the Uncertainty in Analytical Chemistry, International Annual Meeting Of Analytical Chemistry, Böhringer Ingelheim GmbH, Günzburg, Germany 03-25 thru 26 ⓘ
Weber, M.	1) Über die Messunsicherheit der Probenvorbereitung, 2) Was sind richtige Resultate, Fachseminar Probenvorbereitung, SACh, Schweizerische Chemische Gesellschaft, Basel 04-08 thru 09 ⓘ
Weber, M.	1) Homogeneity Study of CCQM-P32 or Never Perform Homogeneity Studies on Mondays…, 2) CCQM P32 – a Pilot Study on Anion Calibration Solutions, Inorganic Working Group Meeting of CCQM, BIPM, Paris, France 04-15 ⓘ
Weber, M.	1) Final Results of P32 – Outlook for Key Comparison, 2) Limits in Dealing with Gravimetric Content Values in Comparison Studies, Inorganic Working Group, CCQM, Ottawa, Canada 10-09 thru 10 ⓘ
Weber, M.	Problems in Defining Limits at the Detection Limit – A Case Study in Doping Analysis, Herbstversammlung der Schweizerischen Chemischen Gesellschaft (SChG), Basel 10-16 thru 17 ⓘ
Weber, M.	Materials and Tissues for Medicine – Activities, 3rd Int. Technology Transfer Days BIOMATERIAL 2002, Thüringer Agentur für Technologie und Innovation, Erfurt, Germany 10-24 thru 25 ⓘ
Weber, M.	Was hat Fussball mit Messunsicherheit zu tun - eine Doping-Geschichte, Gesellschaft Deutscher

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Conferences

		Chemiker, Tagung der EURACHEM Deutschland, EURACHEM Deutschland, Stuttgart, Germany 11-14 ⓘ
	Wunderli, S.	Practical Aspects of Isotope Dilution Mass Spectrometry, Workshop Isotope Dilution Mass Spectrometry, BAM, Berlin, Germany 11-11 thru 12 ⓘ
	Wunderli, S./Fortunato, G.	Combined measurement uncertainty in isotope dilution mass spectrometry, Eurachem/Citac-Workshop, Eurachem/Empa, Luzern, (Poster) 06-16 thru 18
	Zinn, M.	Poly(3-hydroxyalkanoate) – a bioplastic with unique properties produced by bacteria, Environmental Biotechnology, University Hong Kong, China 04-25 ⓘ
	Zinn, M.	Tailor-made synthesis of polyhydroxyalkanoate under multiple nutrient limited growth conditions, The 6th International Symposium On Environmental Biotechnology, University Vera Cruz, Mexico 06-09 thru 12
	Zinn, M./Egli, T.	Continuous biosynthesis of tailor-made polyhydroxyalkanoate under simultaneous carbon and nitrogen limited growth conditions, Biopolymers: Limits of Natural Performances and Prospects for Overcoming, Umweltforschungszentrum Leipzig und Halle, Leipzig, Germany 05-30 thru 31 ⓘ
	Zinn, M./Geiger, T./Hany, R.	Funktionalisierte Biopolyester, Funktionspolymere für Systemlösungen, Gesellschaft Deutscher Chemiker, Darmstadt, Germany, (Poster) 03-18 thru 19
	Zinn, M./Geiger, T./Hany, R.	The production of tailored PHAs using dual-nutrient-limited growth conditions, 2nd Czech-Swiss Symposium On Advanced Biotechnology, Lonza, Prag, Czech 11-07 thru 09 ⓘ
	Zinn, M./Geiger, T./Hartmann, R./Hany, R.	Functional polymers from poly[(R)-3-hydroxyalkanoates]: Protection of surfaces from biofouling, International Symposium On Biodegradable Polyesters (ISBP02), Uni Münster, Münster, Germany, (Poster) 09-22 thru 26
	Zinn, M./Hartmann, R./Hany, R./ Geiger, T./Egli, T.	Tailor-made synthesis of bioplastic (poly(hydroxyalkanoate) in Pseudomonas putida (oleovorans), Jahrestagung der Schweizerischen Gesellschaft für Mikrobiologie, Luzern, (Poster) 02-20 thru 21
	Zinn, M./Hartmann, R./ Hany, R./Geiger, T./Schmid, M./ Pletscher, E./Egli, T.	Synthesis of poly([R]-3-hydroxyalkanoate) with a defined portion of unsaturated side-chains in Pseudomonas putida Gpo1, Biopolymers: Limits of natural performances and prospects for Overcoming, Umweltforschungszentrum Leipzig und Halle, Leipzig, Germany, (Poster) 05-30 thru 31
	Zinn, M./Hartmann, R./ Pletscher, E./Geiger, T./ Hany, R./Witholt, B./Egli, T.	Tailored biosynthesis of polyhydroxylkanoate under multiple nutrient limited growth conditions, International Symposium On Biodegradable Polyesters (ISBP02), Uni Münster, Münster, Germany 09-22 thru 26 ⓘ
	Zinn, M./Hartmann, R./ Pletscher,E./Geiger, T./Hany, R./ Witholt, B./Egli, T.	Multiple nutrient limited growth of bacteria as a means to tailor-make polyhydroxylkanoate, VAAM Mini Symposium and Workshop on Biocatalysis, Vereinigung für angewandte und allgemeine Mikrobiologie, ETHZ, Zürich 10-09 thru 11
	Zinn, M./Weilenmann, H.-U./ Witholt, B./Egli, T.	Production of tailor-made PHA in Ralstonia eutropha under multiple nutrient limited growth conditions, Gordon Research Conference on Biodegradable Polymers, Oxford, United Kingdom, (Poster) 07-08 thru 13
	Zinn, M./Witholt, B./Egli, T.	Intracellular degradation of poly(3-hydroxyalkanoate) in Pseudomonas putida (oleovorans), Jahrestagung der Schweizerischen Gesellschaft für Mikrobiologie, Luzern, (Poster) 02-20 thru 21
Functional Fibers and Textiles	Amberg, M.	Vortrag zur Eintrittsvorlesung, Eintrittsvorlesung «Hochschule für Technik und Architektur», HTA Luzern 10-21
	Amberg, M./Geer, J./Keller, M.	Poster zu Vortrag Inverted Cylindrical Magnetron for the Deposition of Ag on Temperature Sensitive Substrates, PSE 2002, Garmisch Patenkirchen, Germany 09-09
	Ammann, F./Furrer, P./ Meyer, K./Herzig U.	6. Textiles Schadenfallmeeting, TexMeet2002, Empa St.Gallen 11-05
	Ernst, U.	The FEFCO BCT Rond Robin Test 2001, FEFCO, Brüssel 03-20
	Ernst, U.	Kurs Weissgrad- und Farbmessungen an Papieren, CEPI-CTS-Instruktion, Empa St.Gallen 09-13
	Fischer, A.	Poster zu Vortrag Synthesis and Characterization of PZT-Thin Films prepared by Single Target Pulsed DC-Magnetron Reactive Sputtering Technique, Garmisch Patenkirchen, Germany 09-09 thru 13

ⓘ invited

Conferences

Protection and Physiology

Fischer, A.	1) Funktionalisierung von Textiloberflächen mittels Plasmatechnik, TWA-Kurs SVTC, STF Zürich, 01-17, 2) Interner Vortrag, Empa in St.Gallen, 01-14
Fischer, A.	Piezofaser – Eine Machbarkeitsstudie, Forschungsmarktplatz, Empa-Akademie, Dübendorf 03-20
Fischer, A.	Metallisierung synthetischer Fäden mittels Plasmatechnik im Rahmen einer Projektevaluation, Uni-Krankenhaus Balgrist, Zürich 03-06
Fischer, A.	Plasmatechnologie an der Empa, 1. Workshop: Implementierung der Nanotechnologie im Textilbereich, Empa St.Gallen 04-26
Fischer, A.	Plasmatechnik an der Empa in St.Gallen, Werksbesichtigung Siemens, Erlangen, Germany 05-24
Fischer, A.	Pulsed DC-Magnetron Reactive Pb-Zr-Ti-O-Target Sputtering, Unaxis Balzers 07-25
Furrer, P.	Einsatz thermoanalytischer Methoden bei der Schadensfallbearbeitung, 10. Symposium für textile Schadensfallanalyse und Mikroskopie, Münchberg, Germany 10-16
Furrer, P.	Methoden der TA (Thermoanalyse), 10. Symposium für textile Schadenfallanalyse und Mikroskopie, Münchberg, Germany 10-15
Harmati, Z.	1) Experience with OX-TRAN (Oxygen Permeability Measurement). 2) Experience with PERMATRAN-W (Water Vapour Permeability Measurement), 8. International MOCON-Conference, Ehlscheid, Germany 02-20 thru 21
Harmati, Z.	1) Kurs Technische Verpackungen: Verpackung chemisch aggressiver Produkte für Transport und Lagerung. 2) Kurs Wechselwirkung zwischen Füllgut und Packstoff, 3. SVI-Lehrgang «Packaging Manager», Kaderschule Zürich 10-28
Harmati, Z.	Kurs Qualitätskontrolle in der Druckindustrie: 1) Sensorisch feststellbare Einflüsse auf Lebensmittelpackstoffe, TGZ Lehrgang Qualitätsmanagement, Empa St.Gallen, 2) Sensorische Prüfmethoden, TGZ Lehrgang Qualitätsmanagement, Empa St.Gallen 10-29
Hufenus, R.	1) Bauen mit Geokunststoffen, 2) Eigenschaften der Geokunststoffe – Prüfung und Qualitätskontrolle, SVG-Fachtagung «Bauen mit Geokunststoffen», Empa Akademie, Dübendorf 03-01
Hufenus, R.	Geosynthetics for reinforcement – resistance to damage during installation, 7th International Conference on Geosynthetics, Nizza, France 09-22 thru 27
Reifler, F.	Information FOBAL (Forschungsprojekt ballistischer Schutz), GR-Symposium «Smarte Bekleidung aus funktionellen Textilien», Bern 03-06
Reifler, F.	SMOG – eine Methode zur Erfassung der Antismell-Wirksamkeit textiler Ausrüstungen, I nternationales Avantex Symposium für Hochtechnologie-Bekleidungstextilien, Frankfurt, Germany 05-14
Rossi, R.	Sweatmanagement – Untersuchung von Kleidungssystemen mit Probanden, GR-Symposium, Ber 03-06
Rossi, R.	Messmethoden der Bekleidungsphysiologie, 7. Empa Textiltagung, Zürich 03-21
Rossi, R.	Das neue Konzept für eine physiologisch optimierte Winterkleidung für die Schweizer Armee, Internationales Avantex Symposium für Hochtechnologie-Bekleidungstextilien, Frankfurt, Germany 05-14
Rossi, R.	Strahlungshitzeschutz von Feuerwehrkleidung mit einer neuen Gliederpuppe, 6. Dresdner Textiltagung, Dresden, Germany 06-20
Rossi, R.	Improving comfort and sweat management, Séminaire de Protection Individuelle (DuPont), Paris 06-25
Weder, M.	Entwicklung von Produkten mit verbessertem Tragekomfort, 7. Empa Textiltagung «Funktionsbekleidung – High-Tech für mehr Komfort», Zürich 03-21
Weder, M.	Outdoor-Aktivitäten geniessen mit optimierter Sport- und Freizeitkleidung, Wissenschaftsapéro Empa Akademie, Dübendorf 08-26

ⓘ invited

	Weder, M.	Physiologische Wirkungsweise von verschiedenen Schichtaufbauten bei Wetter- und Kälteschutzkleidung, 41. Internationale Chemiefasertagung, Dornbirn, Austria 09-18 thru 20
	Weder, M.	Physiologische Eigenschaften von funktionellen Bekleidungssystemen bei tiefen Temperaturen, Herbst-Symposium «Höhere Leistungsfähigkeit im Einsatz durch intelligente Schutz- und Bekleidungsskonzepte», Sayn, Germany 10-16/17

Information, Reliability and Simulation Technology

Acoustics/Noise Abatement	Baschnagel, K.	Lärmarme Konstruktion von Wärmepumpen, ERFA-Tagung Fördergemeinschaft Wärmepumpen, Empa, Dübendorf 02-25
	Baschnagel, K.	Messung der Luftschalldämmung von Fassaden, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
	Baschnagel, K.	Lärmarme Konstruktion von Wärmepumpen, FWS – Lärmschutztagung, Bern, Horw, Winterthur 11-04, 11-12, 11-14
	Baschnagel, K.	Prinzipien der Bauakustik, Lärmschutztagung, Hochschule St.Gallen 11-05
	Baschnagel, K./Buetikofer, R./ Eggenschwiler, K./Hofmann, J./ Emirch, F./Heutschi, K./ Krebs, W./Studer, M./ Thomann, G./Wunderli, J.M.	Einführung in die Akustik, Buwal-Kurs «Akustik/Lärmbekämpfung», Empa, Dübendorf 12-11 thru 13
	Bütikofer, R.	1) Schallübertragung durch Bauteile. 2) Trittschallschutz, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
	Eggenschwiler, K.	1) Lärm von Wärmepumpen – Emission und Immission. 2) Grundlagen der Akustik und Lärmbekämpfung, ERFA-Tagung Fördergemeinschaft Wärmepumpen, Empa, Dübendorf 02-25
	Eggenschwiler, K.	Podiumsdiskussion Fluglärm, Online Fluglärm-Podium www.clax.ch/fluglaerm/podium, Internet 05-02 thru 31
	Eggenschwiler, K.	Akustik von Schulzimmern und Auditorien, Fachtagung «Schallschutz durch gesundes Bauen», Empa-Akademie, Dübendorf 06-04
	Eggenschwiler, K.	Akustik des Fluglärms: dB, Leq und Co., Forumsveranstaltung Aktion für zumutbaren Fluglärm, Uster 06-06
	Eggenschwiler, K.	Fluglärm messen und berechnen, Öffentliche Informationsveranstaltung, Üsslingen, 08-29, Fällanden, 09-16
	Eggenschwiler, K.	Schallfelder in Räumen, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
	Eggenschwiler, K.	Anforderungen an Beschallungsanlagen für Sprache, Light + Sound 2002 – Fachvorträge, Zürich 10-14
	Eggenschwiler, K.	Lärm von Wärmepumpen – Emission und Immission, FWS – Lärmschutztagung, Bern, Horw, Winterthur 11-04, 11-12, 11-14
	Eggenschwiler, K.	Hörbehindertengerechte akustische Gestaltung, Fachtagung 2002 Behindertengerechtes Bauen, Universität Bern 11-07
	Eggenschwiler, K.	Fragen (und Antworten) zum Thema Fluglärm, Öffentliche Informationsveranstaltung, Aathal 11-15
	Eggenschwiler, K.	Akustische Grundlagen zum Fluglärm, Öffentliche Informationsveranstaltung, Zumikon 12-03
	Eggenschwiler, K.	Einführung in die Raumakustik und die raumakustische Simulation, Objekt Semester 1, Empa, Dübendorf 12-09

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Conferences

Emrich, F.	Schallschutznormung in der Schweiz: wohin?, ERFA-Tagung Cercle Bruit, Fachstelle Lärmschutz ZH, Glattbrugg 03-12
Emrich, F.	Berücksichtigung von Flankenübertragungen bei Prognosen für den Schallschutz im Hochbau, Schallschutz durch massives Bauen, Empa-Akademie, Dübendorf 06-04
Emrich, F.	Schallschutz zwischen Innenräumen, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
Heutschi, K.	1) Rechnerische Berücksichtigung von Meteoeffekten auf die Schallausbreitung. 2) Beispiele aus der Praxis, Eisenbahnlärmmessungen in Altdorf. Workshop Meteorologie und Schallausbreitung, Empa-Akademie, Dübendorf 06-25
Heutschi, K.	Messungen mit MLS; Grundlagen und Anwendungshinweise, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
Heutschi, K.	Aktuelle und künftige Methoden zur Schallausbreitung im Freie, Herbsttagung Schweizerische Gesellschaft für Akustik, Sion 11-08 ⓘ
Heutschi, K.	Raumakustik von Räumen mit konkaven Strukturen, Objekt Semester 1, Empa, Dübendorf 12-17
Krebs, W.	Bestimmung der Messunsicherheit, Empa Kurs, Empa-Akademie, Dübendorf 04-17
Krebs, W.	Die Berücksichtigung der Messunsicherheit bei der Beurteilung von Messgrössen, Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
Nguyen, C.H./Pietrzko, S.	Analytical and FEM-investigations with experimental validation of a PZT-actuated vibrating beam and its sound radiation, ISMA 2002, International Conference on Modal Analysis; Noise and Vibration Engineering, Heverlee, Belgium 09-16 thru 18
Nguyen, C.H./Pietrzko, S.	FEM-investigations of pizoelectric-mechanical-acoustic coupling fields, International Congress on FEM Technology; 20th CAD-FEM Users' Meeting 2002, Friedrichshafen, Germany 10-09 thru 10
Pietrzko, St.	Moderne Technologie der Schalldämmung: Aktive geregelte Systeme zur wirksamen Schall- und Schwingungsunterdrückung, (R)evolutionieren adaptive Werkstoffsysteme die Technik?, Empa-Akademie, Dübendorf 06-10
Pietrzko, St.	Active Noise Control of Double Glazed Panel, ACTIVE 2002, The 2002 International Symposium on Active Control of Sound and Vibration, Southampton, United Kingdom 07-15 thru 17
Pietrzko, St.	FLULA – Swiss Aircraft Noise Prediction Program, Acoustics 2002, Innovation in Acoustics and Vibration, Adelaide, Australia 11-13 thru 15
Thomann, G.	Berechnung und Modellierung von Fluglärm, Besuch Ständerat Hofmann (Kt ZH) an der Empa, Dübendorf 01-11
Thomann, G.	Flughafen Zürich Kloten – Die Raumplanung und der Umgang mit Grenzen, Mobilität ohne Grenzen – Mobilität wohin?, Zürich 01-22
Thomann, G.	Flugbetriebsvarianten für den Flughafen Zürich, Resultate der Auswirkungsanalyse, 4. Koordinationssitzung zum Sachplan Infrastruktur der Luftfahrt bezüglich des Flughafens Zürich, Bern 05-28
Thomann, G.	Detailuntersuchungen und Nachtrag zur Variantenstudie Flughafen Zürich, Koordinationsgespräche zum Sachplan Infrastruktur der Luftfahrt bezüglich des Flughafens Zürich, Bern 05-31
Thomann, G.	Beiträge der Empa zum neuen Betriebsreglement des Flughafens Zürich, Besuch der UREK-Kommission des Nationalrats an der Empa, Empa-Akademie, Dübendorf 09-10
Thomann, G.	Fluglärmsimulation, Führung und Schulnachmittag «fhbb» am Flughafen Zürich, Zürich 10-25
Walk, M.	Kenngrössen von Bauakustikmessungen (ISO 717), Bauakustische Messverfahren, Empa-Akademie, Dübendorf 09-03
Wunderli, J.M.	1) Meteorologische Einflüsse auf die Schallausbreitung und ihre Bedeutung für die Immissionen. 2) Mögliche Umsetzung in die Messpraxis. Workshop Meteorologie und Schallausbreitung, Empa-Akademie, Dübendorf 06-25

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Conferences

Electronics/Metrology

Anderegg, P.	Umsetzung in Verfahrens-SOP und Prüfbericht. Kurs Bestimmung der Messunsicherheit, Empa, Dübendorf 04-17
Anderegg, P./Brönnimann, R./ Nellen, Ph. N./Sennhauser, U.	Reliable Long-term Monitoring of CFRP Cables in Bridges, 1st International Workshop on Structural Health Monitoring of innovative Civil Engineering Structures, Winnipeg, Canada 09-19 thru 20
Anderegg, P./Brönnimann, R./ Raab, C./Partl, M.	Long-term health monitoring of pavement deformations on an expressway, International Symposium on Force, Mass, Torque, Hardness and Civil Engineering Metrology, IMEKO, Celle, Germany
Brönnimann, R./Anderegg, P./ Nellen, Ph. N./Sennhauser, U.	Reliable Long-term Health Monitoring of CFRP Cables in Bridges. 3rd World Conference of Structural Control, Como, Italy 04-07 thru 12
Flisch, A./Hofmann, J./Obrist, A.	Erstmusterprüfung auf der Basis industrieller Computertomographie, CAT Engineering 2002, Stuttgart, Germany 06-18-20
Flisch, A./Hofmann, J./Obrist, A.	Erstmusterprüfung auf der Basis industrieller Computertomographie. Tagung Fortschrittliche ZfP-Methoden, Empa-Akademie, Dübendorf 09-12 ⓘ
Flisch, A./Hofmann, J./Obrist, A.	Effiziente Volumendigitalisierung mit adaptiver Computertomographie. Fraunhofer IPA Anwenderforum Rapid Product Development, Stuttgart, Germany 09-25
Grossmann, G.	Resultate der Produktionsversuche im Projekt Leadfree. EUREKA Projektsitzung, Fraunhofer ISIT, Itzehoe, Germany 01-18
Grossmann, G.	Bericht/Status Projekt Leadfree, 46. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 04-18
Grossmann, G.	Bleifreies Lot, Swisstronica 2002, OCAG Zürich 04-22 ⓘ
Grossmann, G.	Bleifreies Lot – was erwartet mich? Knowhow Seminar Bleifreies Löten, ESSEMTECH, Aesch 05-23 ⓘ
Grossmann, G.	Results of Comparative Reliability Tests on Lead-free Solder Alloys. 52nd ECDC 2002, San Diego, USA 05-27 thru 06-03
Grossmann, G.	Resultate des Projektes Leadfree. EXACT Meeting, ETH Zürich 06-14 ⓘ
Grossmann, G.	1) Bericht vom Electronic Components & Technology Conference, San Diego, USA. 2) Bericht/Status Projekt Leadfree. 47. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 08-27
Grossmann, G.	No Fear of Lead Free Solder. ECEC 2002, ETH Zürich 09-09 thru 12
Grossmann, G.	Grundlagen des Weichlötens. 8. Fachforum Weichlöten, Regensburg. Germany 11-18 thru 19 ⓘ
Hack, E.	Kurs Unsicherheit von Fitparametern bei Ausgleichsrechnungen, Empa-Akademie, Dübendorf 01-16
Hack, E.	1) Vertrauen in Messergebnisse. 2) GUM: Grundgedanken. 3) GUM: Sieben Schritte zur Messunsicherheit. 4) Kursleitung: Bestimmung der Messunsicherheit, Empa-Akademie, Dübendorf 04-17
Hack, E.	Bildgebende Interferometrie. Tagung Fortschrittliche ZfP-Methoden, Empa-Akademie, Dübendorf 09-12
Hack, E./Krebs, W.	Auswertung: Modellbildung, kombinierte und erweiterte Messunsicherheit. Bestimmung der Messunsicherheit, Kurs Empa-Akademie, Dübendorf 04-17
Held M./Nellen P./Brönnimann R.	Long Term Stability of Aerial Optical Cables with Respect to Gigabit/s Data Rates. SPIE, Photonics Fabrication Europe, Brugge, Belgium 10-28 thru 11-01
Held M./Nellen P./Wosinska L.	Availability Calculation and Simulation of Optical Network Systems. SPIE, Photonics Fabrication Europe, Brugge, Belgium 10-28 thru 11-01 ⓘ
Held, M.	Zuverlässigkeit faseroptischer Systeme, Netze und Komponenten an der Empa. 47. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 08-27

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Conferences

Jacob, P.	Ausfallanalysemethoden: OBIRCH, Backside Polishing, 46. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 04-18
Jacob, P.	OBIRCH im Komplementäreinsatz zur Emissionsmikro-skopie – Geräteerfahrungen, Fallbeispiele und neueste Resultate. Fehlermechanismen bei kleinen Geometrien, Tagung ITG, Oberammergau, Germany 05-07
Jacob, P.	Wenn sonst nichts mehr geht.. Beispiele für erfolgreiche FIB-Untersuchungen in materialwissenschaftlichen und halbleiterspezifischen Gebieten. Einweihungsfeier FIB-Anlagen, Empa, Dübendorf 06-24
Jacob, P.	Defect- and Structure-Weakness Localization on Power Semiconductors Using OBIRCH. International Symposion on the Physical & Failure Analysis of Integrated Circuits, IPFA, Singapore 07-08 thru 12
Jacob, P.	Zusammenfassung IPFA Singapore. 47. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 08-27
Jacob, P.	OBIRCH as a PEM complementary Failure and Weakness Localisation Tool – Examples in Micro- and Power Electronics. 2nd European Workshop on Photonics Failure Analysis, Optoelectronic Techniques for Failure Localisation and Failure Characterisation, Berg/Starnberger See, Germany 10-22
Jacob, P.	Ausfall- und Schwachstellenanalyse mittels OBIRCH und FIB an Leistungshalbleiter-Bauelementen. 31. Kolloquium Halbleiter-Leistungs-Bauelemente und ihre systemtechnische Integration, Freiburg i. B., Germany 10-28
Lüthi, Th.	Bond Quality Control of Aluminium Stabilised Superconductors with Ultrasonic Phased-Array Technology. 8th ECNDT, Barcelona, Spain 06-14 thru 20
Lüthi, Th.	Leitung Tagung Fortschrittliche ZfP-Methoden. Empa-Akademie, Dübendorf 09-12
Lüthi, Th./Weber, P.	Einsatz von Wirbelstrom-Multielementsensoren zum Nachweis von oberflächennahen Fehlern in Bauteilen mit komplexer Geometrie. Tagung Fortschrittliche ZfP-Methoden. Empa-Akademie, Dübendorf 09-12
Nellen, Ph.M.	WAPISMO: Inspektionsroboter für Korrosionsschäden in gusseisernen Trinkwasserleitungen. Wasserversorgung Zürich 02-11 ⓘ
Nellen, Ph.M.	Zuverlässigkeit faseroptischer Systeme, Netze und Komponenten an der Empa. 46. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 04-18
Nellen, Ph.M.	Technische Zuverlässigkeit, Verfügbarkeit und Ausfallanalyse von faseroptischen Netzwerksensoren und – komponenten, FKO-Tagung, Olten 11-26 ⓘ
Nellen, Ph.M./Brönnimann, R./ Sennhauser, U.	Reliability in Fiber Optical Sensor Applications. SPIE Photonics Fabrication Europe, Brugge, Belgium 10-28 thru 11-01 ⓘ
Nellen, Ph.M./Frank, A./ Kennel, A.	High Strain and High Strain Gradients Measured with Fiber Bragg Gratings in Structural Engineering Applications. Optical Fiber Sensors, Portland, USA 05-05 thru 10
Nellen, Ph.M./Held, M.	Reliability and Failure Analysis of Fiber Optical Network Components. SPIE Photonics Fabrication Europe, Brugge, Belgium 10-28 thru 11-01
Nellen, Ph.M./Mauron P./Frank A.	Reliability of Fiber Bragg Gratings for Metrology and Telecommunication. COST270 Meeting, Graz, Austria 04-08 thru 10 ⓘ
Neuenschwander, J.	Anwendung der Phased-Array-Technologie bei der Ultraschallprüfung an langen Supraleiterkablen. Tagung Fortschrittliche ZfP-Methoden. Empa-Akademie, Dübendorf 09-12
Obrist, A./Flisch, A./Hofmann, J.	3D Digitizing based on X-ray Computed Tomography, Scanning 2002, Paris, France 04-24 thru 25 ⓘ
Raab, C./Poulikakos, L.D./ Anderegg, P./Partl, M.N.	Long-term Pavement Performance Monitoring of a Swiss Motorway. 3rd International Conference on Weigh-in-Motion (ICWIM3) in Orlando, Florida, USA 05-13 thru 15
Reiner, J.C.	Zuverlässigkeit ultradünner Gateoxide, Wissenschaftsmarkt, Empa-Akademie, Dübendorf 03-20

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Conferences

	Reiner, J.C.	Projekt Latente ESD-Ausfallmechanismen, 46. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 04-18
	Reiner, J.C.	Latente ESD-Ausfallmechanismen – ein alter Hut? Fehlermechanismen bei kleinen Geometrien, Tagung ITG, Oberammergau, Germany 05-08
	Reiner, J.C.	1) Bericht HL-Tagung Oberammergau. 2) Projektstatus ESD und dünne Oxide. 47. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 08-27
	Reiner, J.C.	1) Novel FIB-based sample preparation technique for TEM analysis of ultra-thin gate oxide breakdown. 2) Failure analysis of ESD damage in the IC core. EUFANET (Workshop of the European Failure Analysis Network), Rimini, Italy 10-07
	Reiner, J.C.	Novel FIB-based sample preparation technique for TEM analysis of ultra-thin gate oxide breakdown, ESREF, Rimini, Italy 10-11
	Reiner, J.C.	A systematic leakage current analysis of gate oxide soft breakdown. International Reliability Workshop 2002, Final Report, Lake Tahoe/CA, USA 10-20
	Sennhauser, U.	Leitung 46. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 04-18
	Sennhauser, U.	Leitung Einweihungsfeier FIB-Anlagen, Empa-Akademie, Dübendorf 06-24
	Sennhauser, U.	Leitung 47. Industriepoolmeeting des Zentrums für Zuverlässigkeitstechnik, Empa-Akademie, Dübendorf 08-27
	Thurner, Ph.	Synchrotron Radiation Micro-Computed Tomography – Grundlagen und Anwendungen in den Bioingenieur-wissenschaften. Tagung Fortschrittliche ZfP-Methoden. Empa-Akademie, Dübendorf 09-12
	Thurner, Ph./Beckmann, F./ Weitkamp, T/Rau, C./ Karamuk, E./Sennhauser, U./ Müller, B.	Tomography Studies of Biological Cells on Polymer Scaffolds. Spring Meeting der European Material Research Society, E-MRS, Strasbourg, France 06-18 thru 21
	Wyss, P./Stampanoni, M./ Thurner, P./Hofmann, J./ Obrist, A./Sennhauser, U. et al.	X-ray Tomographic Microscopy (XTM) at the Swiss Light Source (SLS), Status and Results. SLS User Meeting, Paul Scherrer Institute, Villigen 09-25 thru 26
	Wyss, P./Thurner, P./ Sennhauser, U.	The XTM project and Empa applications. SLS User Meeting, Paul Scherrer Institute, Villigen 09-25 thru 26 ⓘ
Media Technology	Dätwyler, M.	Farbe im digitalen Workflow – Digitales Proofing, Ugra Kurs, St.Gallen 03-19
	Dätwyler, M.	Digitales Proofing, Ugra/Empa, St.Gallen 04-12
	Dätwyler, M.	Colour Management, Colour Management Systeme, Gaschurn, Österreich 06-21
	Dätwyler, M.	Evaluation of digital proofing devices, 29th international iariga Research Conference, Advances in Graphic Arts & Media Technology, Luzern 09-10
	Dätwyler, M	Farbe im digitalen Workflow – Digitales Proofing, Ugra Kurs, St.Gallen 11-15
	Dätwyler, M.	Die Speichertechnologien, 50 Jahre Ugra, Fribourg 12-03
	Dätwyler, M./Heuberger, K./ Schefer, H.	Prospektive Studien: Der Proof, 7. Internationale Internet und Crossmedia-Tagung, Empa-Akademie, Dübendorf 10-22
	Heuberger, K.	Der PDF/X3 Standard, Ugra/Empa, St.Gallen 04-12
	Heuberger, K.	Additional more saturated CIELAB SCID Images, ISO-Arbeitsgruppe WG2, Berlin, Deutschland 05-25
	Heuberger, K.	Systematische Qualitätskontrolle im Workflow der grafischen Industrie, Ugra Kurs, St.Gallen 10-23
	Heuberger, K.	Standardisierung von Prozessen, 50 Jahre Ugra, Fribourg 12-03

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Conferences

	Mourad, S.	Prediction of Monochrome Reflectance Spectra with an extended Kubelka-Munk Model, The 10th Color Imaging Conference, Scottsdale AZ, USA 11-14
	Münch, B.	JPEG2000 – das zukünftige Bilddatenformat?, Empa St.Gallen 01-08
	Münch, B.	Evaluation and Criterias for the Optimal RGB Color Space, IfraExpo 2002, Barcelona, Spain 10-14 thru 18
	Münch, B./Steingrímsson, Ú.	The Gamut Obtainable with Surface Colors, CGIV 2002, University of Poitiers, France 04-02 thru 05
	Münger, K.	Ugra Forschung, Ugra/Empa, St.Gallen 04-12
	Münger, K.	Going Crossmedia, 7. Ugra Fachtagung, Empa-Akademie, Dübendorf 10-22
	Münger, K.	Lehrgang integriertes Umweltmanagement, Umweltlehrgang, St.Gallen 11-26
	Münger, K.	Die grafischen Technologien – ein Ausblick, 50 Jahre Ugra, Fribourg 12-03
	Schefer, H.	Prozessoptimierung mit Crossmedia Publishing, 12. Fachtagung Umweltmanagement in der Druck- und Medienindustrie, Swissotel, Zürich 03-21
	Schefer, H.	Computer-to-Technologien, 7.Ugra-Fachtagung Internet und Crossmedia, Empa-Akademie, Dübendorf 12-02
	Schefer, H.	Digitaldruck. 50 Jahre Ugra, Fribourg, Switzerland 12-03
	Simon, K.	Medientechnik: Relevanz-Rahmenbedingungen-Forschung, ETH Zürich 03-28
	Simon, K.	A Stochastic Interpretation of Kubelka-Munk, 1st Europ. Conf. on Colour in Graphics, CGIV 2002, University of Poitiers, France 04-02 thru 05
	Steiger, W.	Tauglichkeit aktueller Farbmessgeräte für Color Management Systeme, Empa Dübendorf 03-19
	Steiger, W.	Stand des Digitaldruckes im Jahr 2002, Allgemeine Berufsschule Zürich 03-20
	Steiger, W	Datenkompressionen mit JPEG 2000, Ugra/Empa, Dübendorf 04.12
	Steiger, W.	Criterias for judging on newspaper print quality, NAA Newspaper Association of America, Washington, USA 06-05 ⓘ
	Steiger, W.	Adaptive Scheuerung von polymeren Schichten zur Simulation von Computer-to-Plate Platten im Zeitungsoffset, Ringier AG Druckzentrum, Adligenswil 06-11
	Steiger, W.	Advances in graphic arts and media technology. 29th International IARIGAI Research Conference, Luzern 09-08 thru 11
	Steiger, W.	Softproofing mit hochauflösenden TFT-Monitoren als Ersatz für Andruck und Hard Copy Proofs, Empa St.Gallen 11-15
	Steiger, W.	1) Die Aufnahmemedien. 2) Steigende Bedeutung von Bildern in der Gesellschaft. 50 Jahre Ugra, Fribourg 12-03
Sustainable Information Technoloy	Hartmann, F.	Integrated Analysis of Material and Information Flow, EURO-SUSTAIN 2002: Implementing the Integrated Product Policy, Rhodos, Greece 04-02 thru 05 ⓘ
	Hartmann, F.	Integration von Material- und Informationsflusssanalysen, Informationsaustausch Joanneum Research/Graz (Institut für Nachhaltige Techniken und Systeme) –Empa (Sit), Graz, Austria 07-15 thru 16 ⓘ
	Hartmann, F.	1) Integration von Material- und Informationsflusssanalysen; 2) Dynamische Tourenplanung, Informationsaustausch Wuppertal Institut (Arbeitsgruppe Oekoeffizienz und zukunftsfähige Unternehmen) –Empa (Sustec, Sit), Wuppertal, Germany 09-03 thru 04 ⓘ
	Hartmann, F.	Telekommunikation und dynamische Tourenplanung, GOR Workshop: Sustainable Supply Chain Management and Reverse Logistics, Augsburg, Germany 11-14 thru 15 ⓘ
	Hilty, L.	Soziale Auswirkungen der ICT, GI-Workshop, Lüneburg, Germany 01-18 ⓘ

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Conferences

	Hilty, L.	Das Programm «Sustainability in the Information Society», TECAT-Semiar, Empa-Akademie, Dübendorf 02-04
	Hilty, L.	Das Programm Nachhaltigkeit in der Informationsgesellschaft der Empa, Empa@SWICO, Zürich 07-01
	Hilty, L.	Sustainable Development and the Information Society, World Computer Congress 2002, Montreal, Canada 08-18 ⓘ
	Hilty, L.	Informationstechnologie – der Schlüssel zur Nachhaltigkeit? Mensch-Technik-Umwelt, ZHW, Winterthur 09-23
	Hilty, L.	Auswirkungen des Pervasive Computing auf die Gesundheit und die Umwelt, Pressekonferenz 10 Jahre TA Swiss, Bern 09-24
	Hilty, L.	The Environmental Informatics Network of Excellence, Environmental Informatics 2002, Wien, Austria 09-25 ⓘ
	Hilty, L.	Informationstechnologie für eine nachhaltige Entwicklung – Pro und Contra, Wissenschaftsapéro der Empa, Empa-Akademie, Dübendorf 10-28
	Hilty, L.	Technologiefolgenabschätzung (TA) am Beispiel des Pervasive Computing, TECAT-Semiar, Empa-Akademie, Dübendorf 11-04
	Hilty, L.	Das Programm Nachhaltigkeit in der Informationsgesellschaft der Empa, SATW@Empa, Dübendorf 11-28
	Hischier, R.	Methoden und Instrumente für die Erfassung und Bewertung der betrieblichen Umweltbelastungen, Zürich 05-21 ⓘ
	Hischier, R.	Information Society and Sustainability – Possibilities and Limits for the Application of the LCA Method, 17. Diskussionsforum Ökobilanzen, ETH Zürich 09-04 ⓘ
	Köhler, A.	Gesundheitsrisiken durch nichtionisierende Strahlung, 32. BundesÖkologieTreffen, Konstanz, Germany 05-09
	Köhler, A.	Nachhaltige Entwickung und Beschaffung – indirekte Wirkungen, Seminar Perspektiven und Trends im öffentlichen Beschaffungswesen, Bern 09-16
	Wäger, P.	Stoffliches Recycling in der Schweiz – Sind die Grenzen erreicht? Empa und International Solid Waste Association (ISWA), Empa, Dübendorf 04-11
	Wäger, P.	A Simulation System for Waste Management – From System Dynamics Modelling to Decision Support, Integrated Assessment and Decision Support, Lugano 06-24 thru 27
	Wäger, P./Köste, F./Wittmann, J.	Decision Support Facts, Environmental Informatics '02, Vienna, Austria 09-25 thru 27
	Zahl, R.	Network of Excellence on Environmental Informatics, IST2002: Partnerships for the Future, Copenhagen, Denmark 11-04 thru 06
Technological Cooperation	Gilgen, P.W.	«Ökoinventare in deren strategischer Bedeutung», Workshop: «Qualitätssicherung und nutzerorientierte Bereitstellung von Lebenszyklusdaten – Ergebnisse und Perspektiven der BMBF-geförderten Vorstudie», Karlsuhe, Germany 11-18 thru 19
	Pitzurra, O.	Applicazioni di un Metodo di Monitoraggio Microbiologico Ambientale nelle Industrie Alimentari e di Imballaggio, 40° Congresso nazionale della Società italiana di igiene, medicina preventiva e sanità pubblica, Cernobbio, Italia 09-08 thru 11
	Pitzurra, O.	Bacterial fall-out to evaluate the effect of body exhaust gowns in a mixed-ventilation operating theatre with separate operating and anaesthetic areas, (Poster) Edinburgh, England 09-15 thru 18
	Pitzurra, O.	Eigenkontrolle der Luftkeimzahl im Operationssaal CAS, Clean-Air-Service AG, Wattwil 04-25/05-17/11-15/11-29
	Pitzurra, O.	Eigenkontrolle der Luftkeimzahl in der Lebensmittelindustrie, Fachseminar mit Teilnahme der Milchwirtschafts-Inspektoren MIDB, Aktuelle Aspekte der hygienetechnischen Qualitätssicherung in der Lebensmittelindustrie, CAS, Clean-Air-Service AG, Wattwil 05-22

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Conferences

Mobility and Environment

Air Pollution/ Environmental Technology

Hofer, P.	Calibration and Training by the Swiss Federal Laboratories for Materials Testing and Research (Empa), Poster RIGA2002 – GAW Workshop for WMO RA VI, Latvia 05-27 thru 30 ⓘ
Buchmann, B.	Measurements and trends of ozone and related compounds and potential of satellite observations, First Swiss-Japanese Seminar, Interlaken 07-01 thru 04 ⓘ
Buchmann, B.	Ozone and Carbon Monoxide Measurements Training on Assessment of Air Quality, JRC, Ispra 09-25 thru 27 ⓘ
Buchmann, B.	Den Quellen anthropogener Luftfremdstoffe auf der Spur, IACETH-Seminar, ETH Zürich 11-04 ⓘ
Buchmann, B./Reimann S./ Stemmler K. Weiss A.	Analysis of halogenated Greenhouse Gases at Jungfraujoch. Workshop on atmospheric Researchat Jungfraujoch, SANW, Davos 09-21 ⓘ
Buchmann, B./Schaub, D./ Weiss, A.	Ozone measurements as a tool for verification of remote sensing activities, First Swiss-Japanese Seminar, Interlaken 06-01 thru 04 ⓘ
Buchmann, B./Weiss, A.	The use of DUP – POLPO, ESA, user symposium, ESA-ESRN, Frascati, Italy 04-23 thru 24 ⓘ
Emmenegger, L.	Emissionsmesstechnik für den Umweltschutz, Zürcher Hochschule Winterthur 06-27 ⓘ
Emmenegger, L.	Emission Monitoring in Switzerland, Cámara de industrias de Costa Rica, San Jose, Costa Rica 11-28 ⓘ
Emmenegger, L./Kägi, R./ Mohn, J./Mohr, M.	Modern Analytical Tools for Particle Emissions of a large Diesel Engine, CEM2002, Odense, Denmark 09-12 ⓘ
Emmenegger, L./Zeyer, K./ Mohn, J.	Extractive FTIR On-line Gas Analysis, r&d in life sciences 2002, Basel, (Poster) 10-17
Gehrig, R.	Measurement Techniques for Compliance Monitoring of Fine particles in Europe, RIGA2002 – GAW Workshop for WMO RA VI, Latvia 05-27 thru 30 ⓘ
Gehrig, R.	Kalibrierung und Überwachung des Volumenstroms beim DIGITEL Schwebstaubsammler im NABEL. Messtechnikertagung des UBA Wien, Innsbruck, Austria 10-15 thru 16 ⓘ
Gehrig, R.	New Indicators for Particulate Matter – Black smoke to PM1, European Perspective on Particulates and Photo-oxodants, Royal Society of Chemistry, London, England 12-11 thru 12 ⓘ
Gehrig, R./Hill, M./Kägi, R.	Contributions of railroad traffic to local PM10 concentrations 11. Internationale Tagung «Verkehr und Umwelt», Poster, Graz, Austria 06-19 thru 21
Hueglin, Ch.	NABEL – Air pollution monitoring network and reseach platform. Workshop on atmospheric Research at Jungfraujoch, Poster, SANW, Davos 09-20
Kaegi, R./Holzer, L./ Kleindieck, S.	Separation of Fine Particles Using Nanomanipulators in the ESEM. Poster, AAAr02, Charlotte, North Carolina 10-07 thru 11
Kaegi, R./Schmatloch, V.	Analysis of wood combustion particles. 6th International Conference on Nanoparticle Measurement, Zürich 08-19 thru 21
Klausen, J./Buchmann. B./ Zellweger. C./Hofer, P.	Data Quality in GAW. Accounts on six years of WCC and QA/SAC activity. Third GAW-CH Conference on Ozone, Radiation and Aerosols, Zürich 10-23 ⓘ
Klausen, J./Hofer, P.	Meta data and GAWSIS, Poster RIGA2002 – GAW Workshop for WMO RA VI, Latvia 05-27 thru 30 ⓘ
Mohn, J./Emmenegger, L.	Potential and limitations of FTIR in semiconductor industries, European Conference on Analytical Chemistry, Dortmund, Germany 09-8 thru 13
Mohn, J./Emmenegger, L.	Wood combustion-Clean Energy, CEM2002, Odense, Denmark (Poster) 09-12
Mohn, J./Emmenegger, L.	Flexible Gasanalytik mittels extraktiver Fouier-Transform-Infrarotspektroskopie. VDI Wissensforum Messtechnik bei Verbrennungsanlagen, München, Germany 11-4 thru 5 ⓘ

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Conferences

Mohn, J./Emmenegger, L./ E. Sandmeier	On-line Gas Analysis for Process Diagnostics in Semiconductor Industries, r&d in life sciences 2002, Basel 10-17
Putaud, J./Gehrig, R. et al.	Physical and chemical characteristics of particulate matter at urban, rural and background sites in Europe, EUROTRAC conference Garmisch-Partenkirchen, Germany 03-10 thru 14
Reimann, S.	Messung von halogenierten Treibhausgasen auf dem Jungfraujoch zur Abschätzung der Europäischen Quellen dieser Substanzen, PSI-Seminar, Villigen 12-20 ⓘ
Reimann, S./Schaub, D./ Weiss, A./Stemmler, K./ Buchmann, B.	Measurements of ozone-depleting and greenhouse active halocarbons at Jungfraujoch to verify compliance with international treaties, First Swiss-Japanese Seminar, Interlaken 06-01 thru 04 ⓘ
Reimann, S./Schaub, D./ Weiss, A./Stemmler, K./ Buchmann, B.	Ambient air measurements of halogenated greenhouse gases at Jungfraujoch as a tool for verification of their emissions, Poster IGAC meeting, Creta, Greece 09-18 thru 25
Reimann, S./Schaub, D./ Weiss, A./Stemmler, K./ Hofer, P.	Estimated emissions of halogenated greenhouse gases by analysis of on-line measurements at a high Alpine station (Jungfraujoch), Poster Conference on Non-CO_2 Greenhouse Gases, Den Haag, The Netherlands 01-21 thru 23
Reimann, S./Schaub, D./ Weiss, A./Stemmler, K./Hofer, P.	Emission estimates of halogenated greenhouse gases by analysis of on-line measurements at a high Alpine station (Jungfraujoch), EUROTRAC conference Garmisch-Partenkirchen, Germany 03-10 thru 14
Reimann, S./Schaub, D./ Weiss, A./Stemmler, K./ Hofer, P./Buchmann, B.	SOGE-A European Network for Measurements of Halogenated Greenhouse Gases for Assessing Their Sources, Poster RIGA2002 – GAW Workshop for WMO RA VI, Latvia 05-27 thru 30
Schaub, D.	Potential Source Regions of Halogenated Greenhouse Gases measured at a High Alpine Site (Jungfraujoch), SOGE-Meeting, Bristol, United Kingdom 01-7 thru 9
Schaub, D.	Emission modelling with trajectory statistics, POLPO workshop, Bologna, Italy 04-15 thru 18 ⓘ
Schaub, D./Reimann, S./ Stemmler, K./Weiss, A.	Potential Source Regions of Halogenated Greenhouse Gases measured at a High Alpine Site (Jungfraujoch), EGS XXVII General Assembly, Nice, France 04-21 thru 26
Schaub, D./Reimann, S./ Stemmler, K./Weiss, A.	Potential Source Regions of Trace Gases Observed at Jungfraujoch, Third GAW-CH Conference on Ozone, Radiation and Aerosols, Zürich 10-23 ⓘ
Schaub, D./Weiss, A./Hofer, P.	On the use of space-borne NO2 measurements from GOME for tracing atmospheric pollution, ProClim: 3rd Swiss Global Change Day, Bern (Poster) 04-04
Ubl, S.	Schadstofftransport in der Troposhaere, aLMo & Luftschadstoff Seminar MeteoSchweiz, Zuerich 10-29 ⓘ
Weiss, A.	Satellite data in recent and future atmospheric research projects of Empa, Meeting «Visite du nouveau directeur du Directorat de'Observation de la Terre de l'ESA en Suisse», Uni Irchel, Zürich 03-27
Weiss, A.	What have we learned from the project POLPO? POLPO workshop, Bologna, Italy 04-15 tru 18 ⓘ
Weiss, A. K.	Ozone and climate variability. Third GAW-CH Conference on Ozone, Radiation and Aerosols, Züric 10-23 ⓘ
Weiss, A. K.	Satellitengestützte Beobachtung hochkonzentrierter Luftschadstoffe (Stickoxide), Fernerkundungsseminar Uni Zürich 11-07 ⓘ
Weiss, A./Schaub, D.	High concentration patches of NO_2 observed in remote locations of Switzerland, IGAC meeting, Creta, Creece, Poster 09-18 thru 25
Weiss, A./Schaub, D./Hofer, P.	The use of space-borne measurements and the ground-based Swiss Monitoring System for tracing atmospheric pollution, EUROTRAC conference Garmisch-Partenkirchen, Germany, Poster 03-10 thru 14
Weiss, A./Schaub, D./Hofer, P	Comparing tropospheric NO2 from GOME with the ground-based Swiss monitoring system, EGS XXVII General Assembly, Nice, France 04-21 thru 26

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EMPA Activities 2002

Conferences

	Weiss, A./Schaub, D./Hofer, P	Modelling the spreading of air pollution with weather models, IEMSS, Lugano 06-24 thru 27
I.C. Engines/Furnaces	Bach, Ch	Erdgasfahrzeuge – Möglichkeiten und Grenzen, Treibstoffe und Fahrzeuge für die 2000 Watt Gesellschaft, Empa-Akademie, Dübendorf 02-25
	Bach, Ch.	Abgasemissionen von Motorfahrzeugen, Pressekonferenz der OcCC, Bern 08-22 ⓘ
	Bach, Ch.	CO_2-Reduktionspotentiale von Erdgas- und Dieselfahrzeugen, UREK-Besuch, Empa, Dübendorf 09-10
	Bach, Ch.	Ist Erdgas ein sinnvoller Treibstoff?, Erdgas als Treibstoff – Weniger Emissionen – umweltbewusst fahren, Münchenstein 09-18 ⓘ
	Bach, Ch.	Moderne Erdgasfahrzeuge – Potentiale für eine nachhaltigere Mobilität, Automotive Day, Biel 11-13
	Bach, Ch.	Emissionen von Diesel- und Benzin-Fahrzeugen, Soll Diesel gefördert werden?, Bern 11-15 ⓘ
	Bach, Ch.	Erneuerbare Energien in der Mobilität, Erneuerbare Energien – Realität und Visionen, Empa-Akademie, Dübendorf 11-15 ⓘ
	Lämmle, Ch.	Prozesssimulation in der Erdgasmotorenentwicklung, 11. Internationales Automobiltechnisches Symposium, Dübendorf 04-19 ⓘ
	Lehmann, U.	Particulate emissions of heavy duty engines on different test cycles, 6th ETH Conference on Nanoparticle-Measurement, ETH Zurich 08-19 thru 20
	Mathis, U.	Influencing parameters of nanoparticle formation, 6th ETH Conference on Nanoparticle-Measurement, ETH Zurich 08-19 thru 20
	Mohr, M.	Wissenswertes aus der Welt der Partikel, Seminar Partikelfilter – Zukunft ist Teamwork (Panolin), Empa-Akademie, Dübendorf 05-16 thru 17 ⓘ
	Mohr, M.	Auswirkung von motorischen Massnahmen auf Anzahl und Grösse der Partikel, Strategien zur Minimierung der Partikelemissionen von Verbrennungsmotoren, München, Germany 06-04 thru 05 ⓘ
	Mohr, M.	Comparison study of PMP instrument candidates at Empa, 6th ETH Conference on Nanoparticle-Measurement, ETH Zürich 08-19 thru 20
	Mohr, M.	Partikel- & NOx-Emissionen von Diesel- & Benzin-PW, UREK-Besuch, Empa, Dübendorf 09-10
	Schmatloch, V.	Reduction of particle emissions from small wood fired furnaces, 6th ETH Conference on Nanoparticle-Measurement, ETH Zurich 08-19 thru 20
	Soltic, P.	1) Partitioning of NOx Emissions for Gasoline Passenger Cars and Light Duty Trucks. 2) Influence of Electric Load on the Exhaust Gas Emissions of Passenger Cars, 11th International Symposium Transport and Air Pollution, Graz, Austria 06-19 thru 21
	Weilenmann, M.	Describing and Compensating Gas Transport Dynamics for Accurate Instantaneous Emission Measurement, 11th International Symposium Transport and Air Pollution, Graz, Austria 06-19 thru 21
Inorganic Analytical Chemistry/ Characterization of Solids	Bleiner, D.	Laser Ablation ICP-MS: a fast freeway to local quantitative microanalysis, Empa, Dübendorf 10-11
	Lienemann, P.	Analytische Chemie, Zürich 02-05
	Lienemann, P.	Kenndaten der Röntgenfluoreszenzspektrometrie, Empa, Dübendorf 04-08 ⓘ
	Senn, M.	Das Schmiedehandwerk nördlich der Schweizer Alpen von keltischer Zeit bis ins Frühmittelalter, Zürich 01-12
	Senn, M.	Les résultats de l'étude archéometallurgique de quelques objets en fer archéologiques dérivant de la Suisse, Villersexel, France 06-02
	Senn, M.	1) Tagesleitung: Braucht die Schweiz ein Zentrum für Archäometallurgie? 2) Wurde dieser Eisennagel in Develier-Courtételle JU geschmiedet?, Empa-Akademie, Dübendorf 07-05
	Senn, M.	Zerstörungsfreie und ortsaufgelöste Analysenmöglichkeiten an archäologischen Eisenobjekten, Sion 11-26 ⓘ

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Conferences

	Senn, M.	Archäologische Eisenwerkstoffe: Beispiele aus der eisenzeitlichen bis frühmittelalterlichen Schweiz, Freiberg, Germany 12-10 ⓘ
	Ulrich, A.	Herkunftsbestimmung mittels Plasmaspektrometrie, Empa, Dübendorf 02-07
	Ulrich, A./Wichser, A.	Metal analysis of diesel vehicle emissions, Zürich 08-19 thru 21 ⓘ
	Zwicky, Ch.	Quantitative or semiquantitative? Labbased WD-XRF- versus mobile ED-XRF-spectrometer on nickel base alloys, Berlin, Germany 06-20
Motor Fuels/ Combustibles	Jäckle, H. W.	Vom Bohrloch zur Zapfsäule, Chur 02-06 ⓘ
	Jäckle, H. W.	FAME als Brenn- und Treibstoffe, Empa Dübendorf 07-23 ⓘ
Organic Chemistry	Gerecke, A.C.	Bromierte Flammschutzmittel und deren Abbauprodukte: Vorkommen in der Umwelt und Belastung des Menschen durch diese endokrin aktiven Substanzen (FLARE), PEAK – Praxisorientierte EAWAG Kurse «Chemische Problemstoffe», EAWAG, Dübendorf 12-03 thru 05 ⓘ
	Heeb, N.V.	Benzol-Analytik im Sekundentakt mittels Chemischer Ionisations-Massenspektrometrie, Treffen Info-Gruppe Emissionsfaktoren, Bern 01-31 ⓘ
	Heeb, N.V.	Sekundäremissionen durch Abgasnachbehandlung potentielle Risiken und ihre Vermeidung, Strategien zur Minimierung der Partikelemission von Verbrennungsmotoren, München, Germany 06-04 thru 05 ⓘ
	Heeb, N.V.	Methane, Benzene and Alkyl Benzene Cold Start Emission Data of gasoline-driven Passenger Cars representing the Vehicle Technology of the last two Decades, 11th International Symposium Transport and Air Pollution, Graz, Austria 06-19 thru 21 ⓘ
	Kohler, M.	Qualitätssicherung der chemischen Analytik von PCB in Fugendichtungen – Dioxin-ähnliche polychlorierte Biphenyle (PCB) in Innenraumluft, Empa-Akademie, Dübendorf 01-28
	Kohler, M.	Brominated flame retardants and their transformation products: Occurrence in the environment and human exposure to these endocrine active components, Workshop «Endocrine disruptors – State of the Art»-Nationales Forschungsprogramm NFP50 – Hormonaktive Stoffe, Universität Zürich 04-23 ⓘ
	Kohler, M.	Bromierte Flammschutzmittel, PEAK – Praxisorientierte EAWAG Kurse «Chemische Problemstoffe», EAWAG, Dübendorf 12-03 thru 05 ⓘ
	Schmid, P.	25 Jahre nach Seveso – sind Dioxine noch ein aktuelles Thema?, BUWAL Seminar, Ittigen-Bern 03-15 ⓘ
	Schmid, P.	Dioxine oder Was haben Hühner, Milch und Manchego mit Seveso zu tun?, Zürich 11-06 ⓘ

Logistics, Controlling and Marketing

Consulting and Information Center	Küttel, O./Spescha, G.	Aktuelle Informationen zum 6. EU-Rahmenprogramm und zu Projektdatenbanken, Empa-Akademie, Dübendorf 01-16 ⓘ
	Schier, J.	Plattform 4M – eine Bibliothek für das Messmittelmanagement auf CD, Metas, Bern-Wabern 08-28 ⓘ
Informatics	Bucher, Ch.	Konzeption und Einführung eines Knowledge-Management-Systems an der Empa, CC eGov – Berner Fachhochschule: Wissensmanagement – Erfahrungsberichte, Bern 11-22 ⓘ
Mechanical Engineering/ Workshop	Honegger, W.	Qualitätssicherung in der Fertigung mittels Härtemessung HV10, Jahrestagung Oberaula, Germany 06-06 ⓘ

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EMPA Activities 2002
Publications

Special Topics

Edelmann, X. — Neue Chancen für die Schweiz in der Standardisierung. SNV-Bulletin 2002, 51(7/8), 73–74

Edelmann, X. — Neue Chancen für die Standardisierung. SMM Schweizer Maschinenmarkt 2002, 103(31), 43–48

Edelmann, X./Barrage, A. (Eds.) — R'02: 6th World Congress on Integrated Resources Management, February 12–15, 2002 in Geneva, Switzerland. St. Gallen: Empa, 2002. 1 CD-ROM. ISBN 3-905555-24-7

Jacomaet, S./Kucan, D./Ritter, A. et.al. — Punica granatum L. (pomegranates) from early Roman contexts in Vindonissa (Switzerland). Vegetation history and archaeobotany 2002, 11(1/2), 79-92 Ⓓ

Meier, U. — Die Empa – von der Materialprüfungsanstalt der Gründerzeit zur Technologieinstitution des 21. Jahrhunderts. L'Empa: du laboratoire d'essai des matériaux de la seconde révolution industrielle à l'institution technologique du XXIe siècle. Die Volkswirtschaft / La Vie économique. 2002, 75(12), 58–60

Schlapbach, L. — Innovation für die Gesellschaft. Vision 2002, 10(2), 6–9

Advanced Materials and Surfaces

Kiyobayashi, T./Züttel, A./Schlapbach, L. et al. — Hydrogen adsorption in carbonaceous materials – how to determine the storage capacity accurately. Journal of alloys and compounds 2002, 330–332, 666–669 Ⓓ

Mauron, Ph./Emmenegger; Ch./Schlapbach, L. et al. — Synthesis of oriented nanotube films by chemical vapor deposition. Carbon 2002, 40(8), 1339–1344 Ⓓ

Schlapbach, L. (guest editor) — Hydrogen as a fuel and its storage for mobility and transport. MRS bulletin 2002, 27(9), 675–676 ◉

Züttel, A./Nützenadel, Ch./Schlapbach, L. et al. — Hydrogen sorption by carbon nanotubes and other carbon nanostructures. Journal of alloys and compounds 2002, 330–332, 676–682 Ⓓ

Züttel, A./Sudan, P./Schlapbach, L. et al. — Hydrogen storage in carbon nanostructures. International journal of hydrogen energy 2002, 27(2), 203–212 Ⓓ

Corrosion/ Surface Protection

Geiger, Th./Hany, R./Zinn, M. — Funktionalisierte Biopolyester. In: Vortragstagung über Funktionspolymere für Systemlösungen der GDCh, Fachgruppe «Makromolekulare Chemie», Darmstadt, Germany, March 18–19, 2002

Geiger, Th./Hartmann, R./Zinn, M./Hany, R. — Functional polymers from poly[(R)-3-hydroxyalkenoates]: protection of surfaces from biofouling. In: Int. symposium on biological polyesters (ISBP 2002), Münster, Gemany, September 22–26, 2002

Guseva, O./Brunner, S./Richner, P. — Analysis of the environmental parameters for aircraft coatings. In: 6th Int. aerospace corrosion control symposium (IACC2002), Amsterdam, The Netherlands, October 9–11, 2002. Publ. in: Macromolecular symposia 2002, 187(1), 883–893

Kucera, V./Tidblad, J./Faller, M. et al. — Heavy metals release by corrosion of structural materials: results from UN/ECE ICP materials. In: 15th Int. corrosion congress (ICC), Granada, Spain, September 22–27, 2002, 10 p.

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Leuenberger-Minger, A.U./ Buchmann, B./Faller, M./ Richner, P./Zöbeli, M.	Dose-response functions for weathering steel, copper and zinc obtained from a four-year exposure programme in Switzerland. Corrosion science 2002, 44(4), 675–687 Ⓓ
	Leuenberger-Minger, A.U./ Faller, M./Richner, P.	Runoff of copper and zinc caused by atmospheric corrosion. Materials and Corrosion 2002, 53(3), 157–164 Ⓓ
	Michel, F./Geiger, Th. et al.	Funori, ein japanisches Festigungsmittel für matte Malerei. Zeitschrift für Kunsttechnologie und Konservierung ZKK 2002, (2)
	Nagel, M./Frater, G./ Hansen, H.-J.	Novel, short and repeatable two-carbon ring expansion reactions. Chimia 2002, 56(7–8), 352 Ⓓ
	Nagel, M./Hansen, H.-J.	From phenols to azulenes: an extended and versatile route to polyalkylated azulenes with variable substitution at the seven- and five-membered ring. Synlett 2002, (5), 692–696 Ⓓ
	Nagel, M./Hansen, H.-J./ Frater, G.	Short and versatile two-carbon ring expansion reactions by thermo-isomerization: novel straightforward synthesis of (±)muscone, nor- and homomuscones, and further macrocyclic ketones. Synlett 2002, (2), 280–284 Ⓓ
	Nagel, M./Hansen, H.-J./ Frater, G.	A novel, short and repeatable two-carbon ring expansion reaction by thermo-isomerization: easy synthesis of macrocyclic ketones. Synlett 2002, (2), 275–279 Ⓓ
	Schicker, M.	Prävention und Entfernung von Graffiti. Applica 2002, 109(6), 16–24
	Schicker, M.	Korrosionsschutz in Abwasseranlagen durch organische Beschichtungen – Teil 3. KA-Betriebs-Info 2002, 32(1), 1050–1052; –Teil 4. KA-Betriebs-Info 2002, 32(2), 1074–1075
	Sidler, Th.	Schadenfälle an Fenstern, Fensterläden und anderen Holzbauteilen. Applica 2002, 109(7), 12–17
High Performance Ceramics	Clemens, F./Buchser, W.J./ Graule, T.J.	Silicon carbide fibre extrusion – manufacturing and tensile strenght of fine sintered SiC fibres. In: 10th Int. ceramics congress & 3rd forum on new materials (CIMTEC 2002), Florence, Italy, July 14–18, 2002, part K, vol. 5, p. 39–46
	Clemens, F./Buchser, W.J./ Graule, T.J.	Shaping silicon carbide powder in fibres by extrusion process. In: 2nd Int. conference on shaping of advanced ceramics (Shaping II), Gent, Belgium, October 24–26, 2002, p. 351–358
	Clemens, F./Graule, T.J.	Thin wall ceramic tubes by extrusion of thermoplastic – ZrO_2 compounds. In: 7th Conference and exhibition of the European ceramic society (ECerS), Brugge, Belgium, September 9–13, 2001. Publ. in: Key engineering materials 2002, vol. 206–213, 4 p. Ⓓ
	Clemens, F./Mathewson, A.	Computing fibers for smart textiles. In: 2002 conference of the int. centre of excellence for wearable electronics and smart fashion products (ICEWES), Cottbus, Germany, December 10–11, 2002, 11p.
	Graule, T.J.	Ein Werkstoff mit glänzender Zukunft. Technica 2002, 51(25–26), 16–21
	Herzog, A./Vogt, U.	Short fiber reinforced reaction bonded silicon nitride (RBSN) by precursor route. Advanced engineering materials 2002, 4(11), 877–880 ◉
	Herzog, A./Vogt, U.	A new approach to short fibre reinforced reaction bonded silicon nitride. In: 26th Annual conference on composites, advanced ceramics, materials, and structures, Cocoa Beach, FL, USA, January 13–18, 2002. Publ. in: Ceramic engineering and science proceedings 2002, 23(3), 19–26
	Herzog, A./Vogt, U./Woetting, G.	Short fibre reinforced RBSN. In: 7th Conference and exhibition of the European ceramic society (ECerS), Brugge, Belgium, September 9–13, 2001. Publ. in: Key engineering materials 2002, vol. 206–213, p. 923–928 Ⓓ
	Holtappels, P./Vogt, U./ Schindler, H.J./Gut, B.	Perovskite synthesis by spray pyrolysis. In: 5th European solid oxide fuel cell forum, Lucerne, Switzerland, July 1–5, 2002, vol. 1, p. 101–107
	Holtappels, P./Braun, B. et al.	Simulation of gasoline and diesel fuelled, various sized SOFC power generation systems for mobile applications. In: 5th European solid oxide fuel cell forum, Lucerne, Switzerland, July 1–5, 2002, vol. 2, p. 1175–1183
	Klingner, R.	Keramisierung von Holz über die Infiltration von SiO_2-Sol. Diplomarbeit zur Erlangung des akademischen Grades Diplom-Holzwirt an der Universität Hamburg, Fachbereich Biologie. Empa Dübendorf, April 2002, 94 p. Empa report no. 257

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Krauss, G./Kübler, J./Trentini, E. Preparation and properties of pressureless infiltrated SiC and AlN particulated reinforced metal ceramic composites based on bronze and iron alloys. Materials science and engineering A 2002, 337(1–2), 315–322 Ⓓ

Kübler, J. Fracture toughness of ceramics using the SEVNB method; from a preliminary study to a standard test method. Publ. in: Fracture resistance testing of monolithic and composite brittle materials. Eds.: J.A. Salem, G.D. Quinn and M.G. Jenkins, ASTM STP 1409, p. 93–106

Kübler, J. Fracture toughness of ceramics using the SEVNB method; a joint VAMAS/ESIS round robin. Publ. in: Fracture mechanics of ceramics, vol. 13. Eds.: R.C. Bradt et al., Kluwer Academic Publishers, 2002, p. 437–445.

Kübler, J./Clemens, F./Aquino, E./Graule, T.J. Correlation between properties of extruded ZrO_2-rods in the green and sintered states In: 10th Int. ceramics congress & 3rd forum on new materials (CIMTEC 2002), Florence, Italy, July 14–18, 2002, part A, vol.1, p. 701–708

Lube, T./Danzer, R./Kübler, J. et al. Strength and fracture toughness of the ESIS silicon nitride reference material. In: 14th European conference on fracture: Fracture mechanics beyond 2000 (ECF 14), Krakow, Poland, September 8–13, 2002, vol.2, p. 409–416

Lugovy, M./Orlovskaya, N./Kübler, J. et al. Crack bifurcation features in laminar specimens with fixed total thickness. Composites science and technology 2002, 62(6), 819–830 Ⓓ

Morrell, R./Kübler, J. Fractography of advanced ceramics – The CEN pre-standard. In: Int. conference on fractography of advanced ceramics, Stara Lesna, Slovakia, May 13–16, 2001. Publ. in: Key engineering materials 2002, vol. 223, p. 19–26 Ⓓ

Müller, R./Vital, A. et al. Non-agglomerated fumed silica nanoparticles. Chemie Ingenieur Technik 2002, 74(5), 543–544 Ⓓ

Orlovskaya, N.A./Kübler, J./Lugovy, M. et al. High toughness ceramic laminates by design of residual stresses. In: Symposium on advanced fibers, plastics, laminates and composites, Boston, MA, USA, November 26–30, 2001, Materials research society symposium proceedings, vol. 702, p. 325–330

Rambert, S./McEvoy, A.J./Holtappels, P./Vogt, U. Sprayed thin-film electrolyte in anode-supported cells. In: 5th European solid oxide fuel cell forum, Lucerne, Switzerland, July 1–5, 2002, vol. 1, p. 76–81

Thünemann, M. Poröse SiC-Keramiken mittels präkeramischer Polymere – Herstellung und Eigenschaften. Diplomarbeit der Fachhochschule Münster, Fachbereich Chemieingenieurwesen. Empa Dübendorf, August 2002, 61 p.

Vital, A./Klotz, U.E./Graule, T.J. et al. Synthesis of spherical, non-aggregated silica nanoparticles. In: NATO advanced research workshop on nanostructured materials and coatings for biomedical and sensor applications, Kiev, Ukraine, August 4–8, 2002, 8 p.

Vital, A./Vogt, U. High-performance Si-N-O fibres: pilot-scale productiuon, characterization and applications. In: 7th Conference and exhibition of the European ceramic society (ECerS), Brugge, Belgium, September 9–13, 2001. Publ. in: Key engineering materials, vol. 206–213, 2002, p. 1173–1176 Op

Vital, A./Vogt, U. Amorphous silicon-oxynitride submicron fibres. In: 26th Annual conference on composites, advanced ceramics, materials, and structures, Cocoa Beach, FL, USA, January 13–18, 2002. Publ. in: Ceramic engineering and science proceedings 2002, 23(3), 355–360

Vogt, U./Herzog, A./Graule, T.J./Klingner, R./Zimmermann, T. Porous ceramics derived from wood. In: 7th Conference and exhibition of the European ceramic society (ECerS), Brugge, Belgium, September 9–13, 2001. Publ. in: Key engineering materials 2002, vol. 206–213, p. 1941–1944 Ⓓ

Vogt, U./Herzog, A./Klingner, R. Porous SiC ceramics with oriented structure from natural materials. In: 26th Annual conference on composites, advanced ceramics, materials, and structures, Cocoa Beach, FL, USA, January 13–18, 2002. Publ. in: Ceramic engineering and science proceedings 2002, 23(4), 219–226

Vogt, U./Herzog, A./Klingner, R./Graule, T.J. Porous SiC ceramics via carbothermal reduction from pyrolysed wood. In: 10th Int. ceramics congress & 3rd forum on new materials (CIMTEC 2002), Florence, Italy, July 14–18, 2002, part B, vol.2, p. 493–500

Wegmann, M. Microextrusion of barium titanate for PTCR applications. PhD thesis submitted to the university of Strathclyde, department of mechanical engineering, materials and metallurgy group, Glasgow, UK, June 2002, 245 p.

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Materials Technology

Wegmann, M./Hendry, A./Clemens, F./Graule, T.J. — Extrusion of ultra-small $BaTiO_3$ PTCR elements. In: 10th Int. ceramics congress & 3rd forum on new materials (CIMTEC 2002), Florence, Italy, July 14–18, 2002, part D, vol.4, p. 597–606

Wegmann, M./Hendry, A./Clemens, F./Graule, T.J. — Miniature $BaTiO_3$ PTCR elements fabricated by extrusion. In: 2nd Int. conference on shaping of advanced ceramics (Shaping II), Gent, Belgium, October 24–26, 2002, p. 321–326

Aeberhard, M./Rohr, L./Michler, J. et al. — Schichtzusammensetzung – quantitativ und qualitativ. Metalloberfläche mo 2002, 56(2), 46–51

Beffort, O. — Hoch belastete Bauteile aus MMC leben länger. MM Maschinenmarkt 2001, 107(51/52), 48–49

Beffort, O. — Metallmatrix-Verbundwerkstoffe: Eigenschaften, Anwendungen und Bearbeitung. In: 6. Int. IWF-Kolloquium über Feinstbearbeitung technischer Oberflächen. Institut für Werkzeugmaschinen und Fertigung IWF an der ETH Zürich, April 18–19, 2002, p. 43–52

Büchler, M./Margadant, N./Siegmann, S. et al. — Determination of the integrity of thermally sprayed coatings with a new laterally resolving electrochemical technique. In: Int. thermal spray conference (ITSC 2002), Essen, Germany, March 4–6, 2002, p. 402–407

Keller, T./Margadant, N./Siegmann, S. et al. — Characterisation of thermally sprayed metallic NiCrAlY deposits by multiple small-angle scattering. Applied physics A – materials science & processing 2002, 74(suppl.1), S975–S977 Ⓓ

Keller, T./Wagner, W./Margadant, N./Siegmann, S. et al. — Volumetric and size characterization of void morphologies in thermally sprayed metallic deposits using scattering techniques. In: Int. thermal spray conference (ITSC 2002), Essen, Germany, March 4–6, 2002, p. 91–95

Kleiner, S. — Magnesium und seine Legierungen. In: 6. Int. IWF-Kolloquium über Feinstbearbeitung technischer Oberflächen. Institut für Werkzeugmaschinen und Fertigung IWF an der ETH Zürich, April 18–19, 2002, p. 19–28

Leparoux, S./Vaucher, S./Beffort, O. — Influence of SiC-particle size on microwave sintering of metal matrix composites. In: 5. Werkstofftechnisches Kolloquium, Chemnitz, Germany, October 24–25, 2002, p. 13–19

Leparoux, S./Vaucher, S./Beffort, O. — Evaluation of microwave-assisted processing of compacted metal/ceramic powder mixtures. In: Materialica 2002, Munich, Germany, September 30–October 2, 2002, 8 p.

Margadant, N./Bürki, G./Siegmann, S. — Towards fracture mechanics of thermally sprayed metallic coatings using indentation technique for edge chipping on a micron scale. In: Int. thermal spray conference (ITSC 2002), Essen, Germany, March 4–6, 2002, p. 610–616

Moser, B. — Deformation and fracture of continuous alumina fibre reinforced aluminium composites. PhD thesis submitted to the Swiss Federal Institute of Technology Lausanne (EPFL), dissertation no. 2532, 102 p. Empa report no. 258

Payling, R./Chapon, P./Aeberhard, M./Michler, J. et al. — Surface, thin films and coatings. In: Glow discharge plasmas in analytical spectroscopy, eds.: Marcus, R.K., Broekaert, J.A.C. Chichester: Wiley, 2003, p. 231–252

Payling, R./Chapon, P./Michler, J./Aeberhard, M. et al. — Characterising the radio frequency plasma source for glow discharge optical emission spectroscopy. ISIJ international 2002, 42(suppl.), S101–S105 Ⓓ

Payling, R./Michler, J./Aeberhard, M. — Quantitative analysis of conductive coatings by radiofrequency-powered glow discharge optical emission spectrometry: hydrogen, d.c. bias voltage and density corrections. Surface and interface analysis 2002, 33(6), 472–477 Ⓓ

Schneider, P./Siegmann, S./Hitzek, R. — Hochtemperatur-Verschleissverhalten von thermisch gespritzten Hartmetallschichten für Ventilspindeln in Dampfturbinen. In: Int. thermal spray conference (ITSC 2002), Essen, Germany, March 4–6, 2002, p. 306–311

Schwaller, P./Stauss, S./Michler, J./Rohr, L. et al. — Mechanical properties of small devices: from nanoindentation to reverse analysis. In: 3rd Korea-Switzerland joint symposium on new materials and process issues in MEMS and nano-technologies, Jeju Island, Korea, June 19–20, 2002, p. 141–149

Siegmann, S./Brown, C.A. — Einfluss der Haftgrundvorbereitung auf die entstehende Topographie und Schichthaftung; ein dreidimensionales Fraktalanalyse-Verfahren. In: 2. GTV Kolloquium über thermisches Spritzen, Luckenbach, Germany, June 21, 2002, p. 21–31

Siegmann, S./Halter, K./Wielage, B — Vacuum plasma sprayed coatings and freestanding parts of Ni-Ti shape memory alloy. In: Int. thermal spray conference (ITSC 2002), Essen, Germany, March 4–6, 2002, p. 357–361

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Thoma, K./Rollier, St./ Uebelhart, J./Roos, S./ Rehmann, H./Michler, J.	Kugellager Komponenten aus Siliziumnitrid – eine Vergleichsstudie. Tribologie und Schmierungstechnik 2002, 49(4), 34–39
	Vaucher, S./Beffort, O. et al.	Matrix chemistry optimisation of Al/Altex composites preserving both fibres and matrix alloy integrity. Materials science and technology 2002, 18(5), 495–500 ◉
	Vaucher, S./Mann, St. et al.	Molecule-based magnetic nanoparticles: synthesis of cobalt hexacyanoferrate, cobalt pentacyanonitrosylferrate, and chromium hexacyanochromate coordination polymers in water-in-oil microemulsions. Nano letters 2002, 2(3), 225–229 Ⓓ
nanotech@surfaces	Bielmann, M./Schwaller, P./ Ruffieux, P./Gröning, O./ Schlapbach, L./Gröning, P.	AgO investigated by photoelectron spectroscopy: evidence for mixed valence. Physical review B 2002, 65(23), 235431–1/5 Ⓓ
	Gröning, O./Ruffieux, P./ Gröning, P./Schlapbach, L. et al.	Prospects and limitations of carbon nanotube field emission electron sources. Chimia 2002, 56(10), 553–561 Ⓓ
	Nilsson, L.O./Gröning, O./ Gröning, P./Schlapbach, L. et al.	Microscopic characterization of electron field emission. Journal of vacuum science and technology B 2002, 20(1), 326–337 Ⓓ
	Ruffieux, P./Gröning, O./ Bielmann, M./Schlapbach, L./ Gröning, P. et al.	Supramolecular columns of hexabenzocoronenes on copper and gold (111) surfaces. Physical review B 2002, 66(7), 73409-1/4 Ⓓ
	Ruffieux, P./Gröning, O./ Bielmann, M./Schlapbach, L./ Gröning, P. et al.	Hydrogen adsorption on sp^2-bonded carbon: influence of the local curvature. Physical review B 2002, 66(24), 245416–1/7 Ⓓ
Polymers/Composites	Brunner, A.J./Bohse, J.	Acoustic emission standards and guidelines 2002: a comparative assessment and perspectives. E-journal of nondestructive testing & ultrasonics : NDT.net 2002, 7(9)
	Farshad, M.	ADAP – Neues Rechenprogramm für die Dimensionierung und statische Analyse von Rohrleitungen. Gas-Wasser-Abwasser 2002, 82(4), 241–249
	Farshad, M.	1) Beulwiderstand der Rohrleitungen, 11 p. 2) Statische Berechnung von thermoplastischen Rohrleitungen, 15 p. In: Kunststoffrohre richtig planen, berechnen und verlegen, Seminar für Ingenieure und Planer, Kandersteg, Switzerland, November 26–27, 2002
	Farshad, M.	Kurs Qualitätssicherung bei FE-Analysen. In: Tagung für Fachleute aus der Industrie, ETH Zürich, Switzerland, 2002, 74
	Farshad, M./Rossini, P./Flüeler, P.	CFK-Zugelemente verankern. Materialprüfung 2002, 44(5), 179–185 ◉
	Flüeler, P.	1) Zeitabhängigkeit der Kunststoffrohr-Eigenschaften, 6 p. 2) Abdichtung von tief liegenden Eisenbahntunnels durch die Alpen – neues Evaluationsverfahren für Abdichtungssysteme, 9 p. 3) Werkstoffkunde der Kunststoffe, 10 p. In: Kunststoffrohre richtig planen, berechnen und verlegen, Seminar für Ingenieure und Planer, Kandersteg, Switzerland, November 26–27, 2002
	Flüeler, P./Farshad, M.	Bruchzähigkeit von Kunststoffrohren. In: Kunststoffrohre richtig planen, berechnen und verlegen, Seminar für Ingenieure und Planer, Kandersteg, Switzerland, November 26–27, 2002, 7 p.
	Flüeler, P./Löwe, Ch./ Farshad, M. et al.	The sealing of deep-seated Swiss alpine railway tunnels – new evaluation procedure for waterproofing systems. In: 9th Int. conference on durability of building materials and components, Brisbane, Australia, March 17–20, 2002, 9 p.
	Huber, Ch./Kokil, A./ Caseri, W.R./Weder, Ch.	Two alternative, convenient routes to bis(diphenylacetylene) platinum(0). Organometallics 2002, 21(18), 3817–3818 Ⓓ
	Kornmann, X./Thomann, R./ Mülhaupt, R. et al.	High performance epoxy-layered silicate nanocomposites. Polymer engineering and science 2002, 42(9), 1815–1826 Ⓓ
	Kornmann, X./Thomann, R./ Mülhaupt, R. et al.	Synthesis of amine-cured, epoxy-layered silicate nanocomposites: the influence of the silicate surface modification on the properties. Journal of applied polymer science 2002, 86(10), 2643–2652 Ⓓ
	Kramer, H.	Fahrbahnübergänge Typ 'Finger'. In: Arbeitstagung der Brückeningenieure der kantonalen Strassenverwaltungen, Basel, Switzerland, October 24–25, 2002, 8 p.

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Surface and Joining Technology

Löwe, Ch./Weder, Ch. — Oligo(p-phenylene vinylene) excimers as molecular probes: deformation-induced color changes in photoluminescent polymer blends. Advanced materials 2002, 14(22), 1625–1629 Ⓓ

Löwe, Ch./Weder, Ch. — Synthesis and properties of photoluminescent 1,4-Bis-(α-cyano-4-methoxystyryl)benzenes. Synthesis 2002, (9), 1185–1190 Ⓓ

Rietmann, Ph./Flüeler, P./ Zwicky, P. — Prüfverfahren für Abdichtungssysteme. Tunnel 2002, 21(1), 26–34; Test methods for sealing systems (in Chinese). Tunnel 2002, (10), 13–15

Snedeker, J.G./Rogelj, J./ Farshad, M. et al. — 1) Finite element models of abdominal organs for use in trauma research, p. 194. 2) Time-dependent material properties of the porcine kidney capsular membrane, p. 200. In: 4th World congress on biomechanics, Calgary, Canada, August 4–9, 2002

Burkhard, G./Zigerlig, B. / Boretius, M. — Spanen mit definiert angeordneten Diamant- oder cBN-Körnern. IDR Industrie Diamanten Rundschau 2002, 36(2), 116–120

Ernst, K.-H./Fasel, R./Kuster, Y. — Supramolecular chiral films. In: 47th Annual meeting of SPIE, complex mediums III: beyond linear isotropic dielectrics, Seattle, WA, USA, July 8–10, 2002. SPIE proceedings series, vol. 4806, p. 248–256

Fasel, R./Aebi, Ph. — X-ray photoelectron diffraction: probing atom positions and molecular orientation at surfaces. Chimia 2002, 56(10), 566–572 Ⓓ

Galli, C./Collaud Coen, M./ Hauert, R./Katanaev, V.L./ Gröning, P./Schlapbach, L. — Creation of nanostructures to study the topographical dependency of protein adsorption. Colloids and surfaces B: biointerfaces 2002, 26(3), 255–267 ◉

Gross, Th./Unger, W.E.S./ Patscheider, J. — Quantitative surface chemical analysis of stainless steel 1. 4301 using surface science instruments XPS spectrometers: report on an interlaboratory comparison. Surface and interface analysis 2002, 33(5), 426–432 Ⓓ

Hauert, R./Hug, P. — Adhäsion als Grenzflächenproblem. In: 16. Int. symposium swissbonding 02, Rapperswil, Switzerland, May 27–29, 2002, 9 p.

Hertel, T./Fasel, R./Moos, G. — Charge-carrier dynamics in single-wall carbon nanotube bundles: a time-domain study. Applie physics A – materials science & processing 2002, 75(4), 449–465 Ⓓ

Janczak-Rusch, J./Zigerlig, B. / Klotz, U.E./Elsener, H.-R./ Brem, F./Kübler, J./Blugan, G. — Joining of Si_3N_4/TiN ceramics with steel components using particle reinforced active brazing alloys. In: 6th Int. conference on joining ceramics, glass and metal (Joining 2002), Munich, Germany, September 30–October 1, 2002, p. 41–48

Janovec, J./Grman, D./ Patscheider, J. et al. — Role of $M_{23}C_6$ carbide precipitation and phosphorus grain boundary segregation in intergranular fracture and corrosion of 18Cr-12Ni austenitic stainless steel. Canadian metallurgical quarterly 2002, 41(3), 357–364 Ⓓ

Klotz, U.E./Wilcock, I./ Henderson, M.B. et al. — Interdiffusion in hipped bi-metallic turbine discs. In: 15th Int. congress on electron microscopy (ICEM 15), Durban, South Africa, September 1–6, 2002, p. 693–694

Klotz, U.E./Zgraggen, M./ Von Trzebiatowski, O./ Schindler, H.J. et al. — Eigenspannungsmessungen an einem geschweissten Kastenprofil. Materialwissenschaft und Werkstofftechnik 2002, 33(9), 544–549 ◉

Klotz, U.E./Zigerlig, B. / Elsener, H.-R./ Janczak-Rusch, J. — Microstructure investigations and thermodynamic modelling of a particle reinforced active brazing alloy. In: 6th Int. conference on joining ceramics, glass and metal (Joining 2002), Munich, Germany, September 30–October 1, 2002, p. 142–149

Patscheider, J./Hauert, R. — Nanokomposite Hartstoffbeschichtungen. Coating 2002, 35(6), 204–208

Patscheider, J./Hauert, R. — Moderne Hartstoffschichten – verbesserte Eigenschaften durch Nanostrukturierung. In: 6. Int. IWF-Kolloquium über Feinstbearbeitung technischer Oberflächen. Institut für Werkzeugmaschinen und Fertigung IWF an der ETH Zürich, April 18–19, 2002, p. 43–52

Roth, M./Woodtli, J. — Bruch der Antriebswelle eines Sessellifts. Zeitschrift für Metallkunde 2001, 92(12), 1335–1338 Ⓓ

Woodtli, J./Kieselbach, R. — Failure in prestressed tendons. In: 14th European conference on fracture: Fracture mechanics beyond 2000 (ECF 14), Krakow, Poland, September 8–13, 2002, 8 p.

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Zigerlig, B. /Elsener, H.R./ Piazza, D./Kiser, M. — Brazing, welding and design aspects of a multifunctional titanium-alumina ceramic component for a space application. In: 6th Int. conference on joining ceramics, glass and metall, Munich, Germany, September 30–October 1, 2002, p. 66–73

Materials and Systems for Civil Engineering

Applied Physics in Building

Binder, B. — Component testing for industrial clients. Example 1: multiple glazing with incorporated PCM. In: Workshop 5 «Energy performance assessment of building components», presented at the joint 3rd EPIC and 23rd AIVC conference on energy efficient and healthy buildings in sustainable cities (EPIC 2002 AIVC), Lyon, France, October 23–26, 2002, 6 p.

Binz, A./Simmler, H./ Ghazi Wakili, K./et al — Vakuum-Dämmung im Baubereich vip-bau.ch. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 113–122

Brunner, C.U./Frank, Th. et al — Gebäude mit hohem Glasanteil, Energieeffizienz und Behaglichkeit. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 259–266

Büchli, R. — Massnahmen im Bereich der Bauphysik. In: 15. Fortbildungskurs Holzbau: Erneuern, Umnutzen, Verstärken von Holzkonstruktionen (Empa/HSR-Tagung 2002), Hochschule Rapperswil, Switzerland, May 23, 2002, 6 pp.

Frank, Th. — Outdoor component performance testing and evaluation. In: Workshop 5 «Energy performance assessment of building components», presented at the joint 3rd EPIC and 23rd AIVC conference on energy efficient and healthy buildings in sustainable cities (EPIC 2002 AIVC), Lyon, France, October 23–26, 2002, 6 p.

Frank, Th. — Neue CEN-Normen für den Wärmeschutz des Fensters. Fassade – Façade 2002, (4), 11–15

Frank, Th. — Bauphysikalische Nachweise bei Dachkonstruktionen. In: 34. SAH-Fortbildungskurs «Dächer – Leistungsfähig und ausdrucksstark mit Holz», Weinfelden, Switzerland, November 6–7, 2002, p. 37–45

Ghazi Wakili, K. — Feuchteadaptive Dampfbremsen. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 147–153

König, N./Anton, H./ Ghazi Wakili, K. et al. — Determination of the thermal resistance of walls (masonry) in dry and moist state and a conversion procedure to get the appropriate design value. Final technical report of the EU moist masonry project (project no. 1423, contract no. SMT4-CT98-2211 / DG 12 – HIAS), November 2001, 112 p.

Manz, H./Xu, W./Seymour, M. — Modelling smoke and fire in a hotel bedroom. In: 8th Int. conference on air distribution in rooms Roomvent 2002), Copenhagen, Denmark, September 8–11, 2002, 4 p.

Manz, H./Schälin, A. — Numerische Strömungsberechnung (CFD): Anwendungsbeispiele in der Bauphysik. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 303–313

Schwarz, D./Nussbaumer, Th. — Eine Wand, die schmilzt – Speicherung von Solargewinnen in einer Paraffin-Latentspeicher-Wand. ¨ tec21 2002, 128(24), 7–13

Center for Energy and Sustainability in Buildings (ZEN)

Bertschinger, H. (Redaktion)/ Zimmermann, M. (Redaktion) — Energie- und Umweltforschung im Bauwesen. 12. Schweizerisches Status-Seminar, organisiert durch Empa ZEN, Zentrum für Energie und Nachhaltigkeit im Bauwesen an der Empa Dübendorf und durchgeführt an der ETH Zürich, September 12–13, 2000, 479 p.

Jochem, E./Favrat, D./ Zimmermann, M./ Richter, K. et al. — Steps towards a 2000 Watt-society. Developing a white paper on research & development of energy-efficient technologies. Pre-study of PSI, WSL, Empa, and EAWAG, December 2002, 187 p.

Zimmermann, M. — Erneuerbare Energien in der 2000-Watt-Gesellschaft. In: Schweizer Energiefachbuch 2003, p. 66–170.

CFRP in Structural Engineering

Lees, J.M./Winistörfer, A./ Meier, U. — External prestressed carbon fiber-reinforced polymer straps for shear enhancement of concrete. Journal of composites for construction 2002, 6(4), 249–256 ◉

Ⓘ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Meier, U. — 1) Strengthening and stiffening of historic wooden structures with CFRP. Vol. 2, p. 967–974. 2) Multifunctional use of carbon-fibre composites in construction: present situation and trends. Vol. 2, p. 1643–1648. In: Intl. conference on FRP composites in civil engineering (CICE 2001), Hong Kong, December 12–15, 2001

Meier, U. — The use of composites in public works. In: 4th Int. conference of composites in architecture and civil construction – innovative solutions in civil construction (Arquimacom' 2002), Sao Paulo, Brazil, November 19–21, 2002, 10 p.

Meier, U. — The development of composites and its utilisation in Switzerland. In: 1st Int. conference on advanced polymer composites for structural applications in construction (ACIC 2002), Southampton, UK, April 15–17, 2002, paper 1.2, p. 23–31

Meier, U./Stöcklin, I. — Advanced solutions for post-strenghtening with carbon-fibre reinforced polymers (CFRP). In: Structural concrete in Switzerland, a collection of 35 publications, published by fib-Switzerland on the occasion of the 1st fib-congress (fib 2002), Osaka, Japan, October 13–19, 2002, p. 48–50

Meier, U./Stöcklin, I. — Bonding of carbon fibre reinforced plastic (CFRP) strips on concrete with stress gradients and process control. In: 16th Int. symposium on structural design and engineering around adhesive bonding (Swiss Bonding 02), Rapperswil, Switzerland, May 27–29, 2002, p.189–196

Meier, U./Stöcklin, I./Terrasi, G.P. — Making better use of the strength of advanced materials in structural engineering. In: Int. conference on FRP composites in civil engineering (CICE 2001), Hong Kong, December 12–15, 2001, vol. 1, p. 41–48

Meier, U./Stöcklin, I./Terrasi, G.P. — Making better use of the outstanding properties.– beyond the basics. In: 6th World pultrusion conference, Prague, Czech Republic, April 4–5, 2002, 7 p.

Meier, U./Stöcklin, I./Terrasi, G.P. — Civil engineers can make better use of the strength of carbon fibre reinforced polymers. In: Int. IASS symposium on lightweight structures in civil engineering, Warsaw, Poland, June 24–28, 2002, p. 775–778

Stöcklin, I./Meier, U. — Strengthening of concrete structures with prestressed and gradually anchored carbon fibre reinforced plastic (CFRP) strips. In: 1st Int. conference on bridge maintenance, safety and management (IABMAS 2002), Barcelona, Spain, July 14–17, 2002, 8 p.

Ulaga, T./Vogel, Th./Meier, U. — The premature failure of CFRP laminate-strengthened concrete structures: experimental and theoretical findings, and conclusions for dimensioning. In: 1st Int. conference on bridge maintenance, safety and management (IABMAS 2002), Barcelona, Spain, July 14–17, 2002, 9 p.

Vogel, Th./Ulaga, T. — Strengthening of a concrete bridge and loading to failure. Structural engineering international 2002, 12(2), 105–110

Winistörfer, A./Meier, U. — CFK-Zugglieder im Brückenbau. In: 20. Int. Klebtechnik Symposium über Verbindungstechnik im Bauwesen, Rosenheim, Germany, January 31–February 1, 2002, 15 p.

Winistörfer, A./Meier, U. — Advanced composite tendon system. In: Materials week 2002, Munich, Germany, September 30–October 2, 2002, 7 p.

Winistörfer, A./Meier, U. — CFRP tendons for active shear enhancement purposes. In: 1st Int. conference on bridge maintenance, safety and management (IABMAS 2002), Barcelona, Spain, July 14–17, 2002, 8 p.

Winistörfer, A./Meier, U. — Externe Vorspannung mit CFK-Elementen In: Konferenz über nachträgliche statische Verstärkung von Bauteilen mit Kohlefaserprodukten, Universität für Bodenkultur, Vienna, Austria, February 18, 2002, 15 p.

Concrete/ Construction Chemistry

Holzer, L./Jenni, A./Zurbriggen, R. — Eine in-situ ESEM-Studie über mikrostrukturelle Veränderungen polymervergüteter Mörtel während der Wasserlagerung. In: 3. Tagung über Bauchemie von der Forschung bis zur Praxis, Würzburg, Germany, September 27–28, 2002. Publ. in: GDCh-Monographie 24, p.156–159

Jenni, A./Herwegh, M./Holzer, L. et al. — Polymerverfilmung in zementären Systemen. In: 3. Tagung über Bauchemie von der Forschung bis zur Praxis, Würzburg, Germany, September 27–28, 2002. Publ. in: GDCh-Monographie 24, p. 92–97

Kaufmann, J. — Study of ice formation with ultrasonic pulse transit time measurement. In: Int. Rilem workshop on frost damage in concrete, Minneapolis, MN, USA, June 28–30, 2002, Rilem proceedings PRO 25, p. 161–172

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Kaufmann, J.	A qualitative sequential frost deicing salt damage model on experimental data. In: 2nd Int. Rile workshop on frost resistance of concrete – from nano-structure and pore solution to macroscopic behaviour and testing, Essen, Germany, April 18–19, 2002, Rilem proceedings PRO 24, p. 197–204
	Kaufmann, J./Winnefeld, F.	Influence of addition of ultrafine cement on the rheological properties and strength of portland cement paste. In: Fifth triennial congress on the challenges of concrete contruction, Dundee, UK, September 5–11, 2002, p. 827–836
	Kreppelt, F./Weibel, M./ Zampini, D./Romer, M.	Influence of solution chemistry on the hydration of polished clinker surfaces – a study of different types of polycarboxylic acid-based admixtures. Cement and concrete research 2002, 32(2), 187–198 Ⓓ
	Moser, K.	Vom Zementmörtel zum belegreifen Unterlagsboden. In: 14. KBS Unterlagsboden-Fachtagung," Lenzburg, Switzerland, January 16, 2002, 16 p.
	Moser, K./Edvardsen, C.	Engineering design methods for service life prediction. In: 9th Int. conference on durability of building materials & components, Brisbane, Australia, March 17–21, 2002, 10 p.
	Pfiffner, M./Holzer, L.	Schädigungsmechanismen der Betonkorrosion in Tunnelbuwerken. Forschungsauftrag ASTRA 1999/145 (53/99) auf Antrag des Bundesamtes für Strassen (ASTRA). UVEK/ASTRA report no. 1030, December 2002, 40 p.
	Romer, M.	Steam locomotive soot and thaumasite – a case study. In: First int. conference on thaumasite in cementitious materials, Garston, UK, June 19–21, 2002, 5 p.
	Romer, M./Holzer, L./Pfiffner, M.	Swiss tunnel structures: concrete damage by formation of thaumasite. In: First int. conference on thaumasite in cementitious materials, Garston, UK, June 19–21, 2002, 9 p.
	Thalparpan, P./Moser, K./ Phillips, M.	Bauen auf bewegtem Boden. tec21 2002, 128(17), 19–24
	Winnefeld, F.	Rheological behavior of portland cement pastes during early hydration. In: 24th Annual int. conference on cement microscopy, San Diego, CA, USA, April 8–11, 2002, p. 18–31
Energy Systems/ Building Equipment	Binz, A./Haas, A./ Althaus, H.-J. et al.	MINERGIE und Passivhaus-Standard. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 69–76
	Dorer, V.	Ventilation concepts for sustainable buildings. In: World renewable energy congress VII, Cologne, Germany, June 29–July 5, 2002, 6 p.
	Dorer, V./Pfeiffer, A./Hartmann, P.	Abluftsysteme mit Abwärmenutzung. Gebäudetechnik 2002, 4(5), 40–43
	Dorer, V./Pfeiffer, A./Hartmann, P.	Energieeffiziente und bedarfsgerechte Abluftsysteme mit Abwärmenutzung. ZEN Info 2002, (7), 3–5
	Dorer, V./Pfeiffer, A./Hartmann, P.	Energieeffiziente und bedarfsgerechte Abluftsysteme mit Abwärmenutzung. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 451–458
	Gubler, D./Moser, A./ Sprecher, P./Rüegg, T.	REinforced EXhaust System: validated CFD computations of the capture efficiency of REEXS. In: 8th Int. conference on air distribution in rooms (Roomvent 2002), Copenhagen, Denmark, September 8–11, 2002, 4 p.
	Haas, A./Althaus, H.-J./ Zimmermann, M.	A standard for sustainable buildings. In: 3rd Int. sustainable building conference (Sustainable Building 2002), Oslo, Norway, September 23–25, 2002, 6 p.
	Haas, A./Binz, A./Viridén, K.	Passivhäuser nach SIA 380/1. Gebäudetechnik 2002, 4(1), 34–39
	Haas, A./Dorer, V.	Luftheizung im Passivhaus. Gebäudetechnik 2002, 4(5), 44–49
	Haas, A./Dorer, V.	Luftheizung im Passivhaus – Aspekte der Wärme- und Luftverteilung im Passivhaus. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 95–102
	Haas, A./Weber, A./ Dorer, V. et al.	COMIS v3.1 simulation environment for multizone air flow and pollutant transport modelling. Energy and buildings 2002, 34(9), 873–882 ◉

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Haas, A./Zimmermann, M.	ZEN-Standard für ökologisch nachhaltiges Bauen – Wirtschaftsbauten. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 223–230
	Häusler, P./Koschenz, M./ Weber, R. et al.	Lüftung- und Abgassystem (LAS) für Niedrigenergiehäuser. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 435–442
	Koschenz, M.	The building structure as an energy storage. In: Concrete architecture – design and construction, ed: Fröhlich, B. Basel: Birkhäuser, 2002, p. 74–76.
	Koschenz, M./Lehmann, B.	Die Gebäudestruktur als Energiespeicher. Deutsche Bauzeitschrift 2002, 50(3), 84–86
	Lehmann, B./Koschenz, M.	Gebäude- und Systemsimulation. Gebäudetechnik 2002, 4(5), 19–25
	Pfeiffer, A./Koschenz, M./ Schwarz, H.J.	tabscal – Das Dimensionierungsprogramm für thermoaktive Bauteilsysteme. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 297–302
	Roulet, C.-A./Pfeiffer, A./ Weber, A. et al.	Effect of chemical composition on VOC transfer through rotating heat exchangers. Energy and buildings 2002, 34(8), 799–807 ◉
	Ruegg, M./Weber, R./ Pfeiffer, A. et al.	Local ventilation with REinforced EXhaust Systems (REEXS): optimising the capture range in a test cabin. In: 8th Int. conference on air distribution in rooms (Roomvent 2002), Copenhagen, Denmark, September 8–11, 2002, 4 p.
	Weber, A./Koschenz, M./ Holst, St. et al.	TRNFLOW: integration of COMIS into TRNSYS TYPE 56. In: The joint 3rd EPIC and 23rd AIVC conference on energy efficient and healthy buildings in sustainable cities (EPIC 2002 AIVC), Lyon, France, October 23–26, 2002, p. 801–806
	Weber, A./Koschenz, M./ Holst, St. et al.	TRNFLOW: integration von COMIS im TRNSYS TYPE 56. In: TRNSYS meeting, Stuttgart, Germany, February 22, 2002, 5 p.
	Weber, R.	Hochisolationsleitungen. Schlussbericht Vorstudie, im Auftrag des Bundesamtes für Energie. Empa Dübendorf, December 2001, 23 p.
Road Engineering/ Sealing Components	Hean, S./Partl, M.	Verhalten von Silent-Joint; Laboruntersuchungen und Objektzustände. In: Fachtagung über Fahrbahnübergänge Silent-Joint, Empa Dübendorf und Fachhochschule Bern, Switzerland, June 20–21, 2002, 11 p.
	Hean, S./Partl, M.	Fahrbahnübergänge aus Polymerbitumen; Praktische Empfehlungen und Neuentwicklung. In: ASTRA Arbeitstagung der Brückeningenieure der kantonalen Strassenverwaltungen, Basel, Switzerland, October 24–25, 2002, 4 p.
	Hochuli, A./Sayir, M./ Poulikakos, L.D./Partl, M.	Measuring the complex modulus of asphalt mixtures by structural wave propagation. In: 26th Annual meeting of the Association of Asphalt Paving Technologists (AAPT), Clearwater Beach, FL, USA, March 19–21, 2001. Publ. in: Journal of the Association of Asphalt Paving Technologists 2001, vol. 70, p. 646–674
	Hugener, M.	1) Die neue schweizerische Anforderungsnorm für Polymermodifizierte Bitumen. Strasse und Verkehr 2001, 87(12), 534–539. 2) La nouvelle norme suisse SN 670 210 pour les bitumes modifiés par des polymères. Route et trafic 2001, 87(12), 540–545
	Hugenschmidt, J.	Concrete bridge inspection with a mobile GPR system. Construction and building materials 2002, 16(3), 147–154 ◉
	Hugenschmidt, J.	A one-to-one comparison between radar results and reality on a concrete bridge. In: 9th Int. conference on ground penetrating radar (GPR 2002), Santa Barbara, CA, USA, April 29–May 5, 2002, SPIE proceedings series, vol. 4758, 6 p.
	Jönsson, M./Partl, M./Flisch, A.	Comparison of different compaction methods using X-ray computer tomography. Empa Dübendorf, March 2002, 81 p. Empa research report no. 113/12
	Neubauer, O./Partl, M.	Volumetrische und mechanische Optimierung von Splittmastixasphalt. Forschungsauftrag VSS 1996/034 (18/96) auf Antrag des Schweizerischen Verbandes der Strassen- und Verkehrsfachleute (VSS). UVEK/ASTRA report no. 1018, September 2002, 172 p.

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Partl, M./Hean, S.	Practical aspects of interaction between mastic asphalt and waterproofing components in bridge and tunnel construction. In: 4th European symposium on performance of bituminous and hydraulic materials in pavements (Bitmat4), Nottingham, UK, April 11–12, 2002, p. 57–63
	Partl, M./Hean, S./ Poulikakos, L.D.	Asphaltic plug joint characterization and performance evaluation. In: 9th Int. conference on asphalt pavements (ISAP 2002), Copenhagen, Denmark, August 17–22, 2002, 14 p.
	Partl, M./Piber, H.	Rilem – Interlaboratory tests on performance prediction of pavements. In: 9th Int. conference on asphalt pavements (ISAP 2002), Copenhagen, Denmark, August 17–22, 2002, 16 p.
	Partl, M./Sybilski, D. et al.	Rilem research activities on performance testing and evaluation of bituminous materials. In: 12th Int. conference on functional rehabilitation and safety of road network, org. by Società Italiana Infrastrutture Viarie (SIIV), Parma, Italy, October 30–31, 2002, vol 1, p. 14–34
	Poulikakos, L.D./Sayir, M./ Partl, M.	Long-term field characterisation of polymer modified bitumen using a new torsional dynamic resonance rheometer. In: 4th European symposium on performance of bituminous and hydraulic materials in pavements (Bitmat4), Nottingham, UK, April 11–12, 2002, p. 263–268
	Raab, Ch./Partl, M.	Besondere Aspekte des Schichtenverbunds von Belägen. Strasse und Verkehr 2002, 88(4), 141–145
	Raab, Ch./Poulikakos, L.D./ Anderegg, P./Partl, M.	Long-term pavement performance monitoring of a Swiss motorway. In: 3rd Int. conference on weigh-in-motion (ICWIM3), Orlando, FL, USA, May 13–15, 2002, p. 335–340
	Stimolo, M.	Practical utilization of thermography in road construction and in waterproofing systems. In: 24th International conference on thermal infrared sensing for diagnostics and control (Thermosense XXIV), Orlando, FL, USA, April 1–5, 2002. SPIE proceedings series, vol. 4710, p. 299–306
	Stimolo, M.	Utilizzo della termografia ad infrarossi nel rilevamento di difetti nel rivestimento stradale dei ponti. In: 12th Int. conference on functional rehabilitation and safety of road network, org. by Società Italiana Infrastrutture Viarie (SIIV), Parma, Italy, October 30–31, 2002, vol. 2, p. 428–438
	Takahashi, S./Partl, M.	Improvement of mix design for porous asphalt. Road materials and pavement design 2001, 2(3), 283–296
Strength and Technology	Müller, H.R./Zetterholm, S.	Results of extreme long duration of a relaxation test (42 years) on prestressing steel. In: First fib-con gress (fib 2002), Osaka, Japan, October 13–19, 2002, 5 p.
	Kieselbach, R.	Schäden an Druckbehältern. Publ. in: Systematische Beurteilung technischer Schadensfälle, ed.: Lange, G.; Weinheim: Wiley-VCH, 5. Aufl., 2001, p. 388–405.
	Kovacs, G.	Reducing stationary vibrations on continuously circulating monocable. In: Congress of OITAF/NACS (Int. organization for transportation by rope – North American continental section), Girdwood, AK, USA, September 15–20, 2002, 10 p.
Structural Engineering	Bergamini, A.	Nondestructive testing of stay cables – field experience in South East Asia. In: 3rd World conference on structural control (3WCSC), Como, Italy, April 7–12, 2002, 8 p.
	Bergamini, A./Motavalli, M.	Laboratory and field investigation of cable systems at Empa. In: Structural concrete in Switzerland, a collection of 35 publications, published by fib-Switzerland on the occasion of the 1st fib-congress (fib 2002), Osaka, Japan, October 13–19, 2002, p. 44–47
	Czaderski, Ch.	Shear strengthening with prefabricated CFRP L-shaped plates. In: Towards a better built environment, IABSE symposium, Melbourne, Australia, September 11–13, 2002, 11 p.
	Czaderski, Ch.	Shear strenghtening with prefabricated CFRP L-shaped plates. In: First fib-congress (fib 2002), Osaka, Japan, October 13–19, 2002, session 11, p. 299–308
	Czaderski, Ch./Motavalli, M.	Shear strengthening with prefabricated CFRP L-shaped plates – Test beams S1 to S6, Empa Dübendorf, August 2002, 78 p. Empa research report no. 116/7
	Feltrin, G.	Temperature and damage effects on modal parameters of a reinforced concrete bridge. In: 5th European conference on structural dynamics, Munich, Germany, September 2–5, 2002, vol. 2, p. 373–378
	Feltrin, G.	Einfluss von Schädigungen und Umwelteinwirkungen auf die dynamischen Eigenschaften einer Brücke. In: 5. Ziegler Symposium über Bauwerksdynamik und Erschütterungsmessungen, Empa Akademie, Dübendorf, Switzerland, July 6, 2002, 7 p.

Ⓘ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Feltrin, G./Motavalli, M. — Vibration based damage detection on a highway bridge. In: First int. Conference on bridge maintenance, safety and management (IABMAS'02), Barcelona, Spain, July 14–17, 2002, p. 347 ff

Gsell, D. — Nicht axialsymmetrische Wellenausbreitung in anisotropen zylindrischen Strukturen. PhD thesis submitted to the Swiss Federal Institute of Technology Zürich (ETHZ), dissertation no. 14733, 2002, 128 p.

Gsell, D./Dual, J. — Simulation of elastic wave propagation in cylindrical structures including excitation by piezoelectric transducers. Ultrasonics 2002, 40(1–8), 181–186 Ⓓ

Maeck, J./Feltrin, G./ De Roeck, G. — Vibration based damage identification on a concrete highway bridge. In: First European workshop on structural health monitoring, Cachan-Paris, France, July 10–12, 2002, p. 1024–1033

Motavalli, M. — Experimental facilities and activities of the department of structural engineering at Empa, Switzerland. In: 3rd World conference on structural control (3WCSC), Como, Italy, April 7–12, 2002, 7 p.

Schubert, S. — Untersuchungen zur passiven Dämpfung nichtlinearer Seilschwingungen. Diplomarbeit der TU Dresden, Fakultät Bauingenieurwesen. Empa Dübendorf, August 2002, 61 p.

Weber, F. — Dämpfung von Seilschwingungen mit geregeltem magnetorheologischem Dämpfer. In: 5. Ziegler Symposium über Bauwerksdynamik und Erschütterungsmessungen, Empa Akademie, Dübendorf, Switzerland, July 6, 2002, 7 p.

Weber, F./Feltrin, G./ Motavalli, M./Aalderink, B.J. — Cable vibration mitigation using controlled magnetorheological fluid dampers: a theoretical and experimental investigation. In: Int. Conference on design and dynamic behaviour of footbridges (Footbridge 2002), Paris, France, November 20–22, 2002, p. 94 ff

Weber, F./Guzzella, L./Onder, C. — Modelling of a pressure wave supercharger including external exhaust gas recirculation. Proceedings of the institution of mechanical engineers, part D, journal of automobile engineering 2002, 216(D3), 217–235 Ⓓ

Wood

Creemers, J./de Meijer, M./ Zimmermann, T./Sell, J. — Influence of climatic factors on the weathering of coated wood. Holz als Roh- und Werkstoff 2002, 60(6), 411–420 ◉

Finger, A./Meili, M. — Dauerhaftigkeit von offenen Holzbrücken (Durability of non covered timber bridges). Empa Dübendorf, November 2002, 94 p. Empa research report no. 115/49

Fonti, P. — Investigations into ring shake of chestnut. PhD thesis submitted to the Swiss Federal Institute of Technology Zürich (ETHZ), dissertation no. 14732, 2002. Examiner: Jürgen Sell, Empa Dübendorf, Wood laboratory.

Graf, E. — Holzbrütende Insekten – forstliche Bedeutung und mögliche Schutzmassnahmen. Zürcher Wald 2002, 34(1), 4–8

Graf, E. — Durability requirements regarding different wood and wood based products – current state of the art in the various signatory countries. In: 4th Workshop and 5th management committee meeting on environmental optimisation of wood protection – current advances in timber protection (COST action E22), Tuusula, Finland, June 2–4, 2002, 16 p. (proceedings available at www.bfafh.de/COST22.htm)

Graf, E. — Unübertroffen: Bauteile aus dauerhaftem Holz. Der Landbote 2002, 22. November, 3

Graf, E./Barkhoff, M./ Hamberg, R. et al. — The use of insect hormones as non-neurotoxic insecticides in wood preservatives. In: 33th Annual meeting of the int. research group on wood preservation (IRG 33), Cardiff, UK, May 20–25, 2002, 39 p.

Hofer, P./Richter, K./Werner, F. — Der Gebäudepark der Schweiz als Holzlager und CO_2-Senke. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 185–190

Jungmeier, G./Werner, F./ Richter, K. et al. — Allocation in LCA of wood-based products. Experiences of Cost Action E9 – Part I: Methodology. International journal of life cycle assessment 2002, 7(5), 290–294 ◉

Jungmeier, G./Werner, F./ Richter, K. et al. — Allocation in LCA of wood-based products. Experiences of Cost Action E9 – Part II: Examples. International journal of life cycle assessment 2002, 7(6), 369–375 ◉

Kropf, F./Sell, J. — Langjährige Freibewitterung von Fensterkanteln mit Aussenschichten aus wärmebehandeltem Holz. Holzforschung Schweiz 2002, 10(1), 32–36

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Künniger, T. Erneuerung von Holzkonstruktionen. Schweizer Holzzeitung 2002, (28–30), 4–5

Künniger, T./Richter, K. Oekobilanz von Konstruktionen im Garten- und Landschaftsbau. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 191–198

Künniger, T./Werner, F./ Richter, K. Oekologische Bewertung von Kies, Zement und Beton in der Schweiz (Kurzfassung). Empa Dübendorf, May 2002, 66 p. Empa research report no. 115/45

Meili, M. Neue Holzwerkstoffe eröffnen zukunftsträchtige Dimensionen. Kommunal Magazin 2002, 20(3), 42–43

Nay, M. Kann Wachstum von Algen und Pilzen an wärmegedämmten Fassaden verhindert werden? Bauphysik 2002, 24(1), 39–40

Nay, M./Raschle, P. Wie lassen sich Algen und Pilze an Fassaden verhindern? In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 131–138

Niemz, P./Graf, E./Lanz, B. Einfluss der Erdlagerung auf Rotbuchenholz. Holz-Zentralblatt 2002, 128(17), 216

Podgorski, L./Arnold, M./ Hora, G. A reliable artificial weathering test for wood coatings. In: 3rd Int. woodcoatings congress, The Hague, The Netherlands, October 28–30, 2002, paper 13, p. 1–15

Pöhler, E./Fischer, A./ Graf, E./Sell, J. Holzschutz und Mikrobiologie im Bauwesen an der Empa: Mögliche Realisierungsmodelle für eine Weiterführung. Empa Dübendorf, March 2002, 61 p. Empa research report no. 115/46

Raschle, P. Möglichkeiten und Grenzen antibakterieller Wirkstoffe und Textilien. Textilveredlung 2001, 36(9/10), p.16–21

Raschle, P. Die Klosterkirche Müstair – Wandbilder und die Mikroorganismen. Publ. in: Die mittelalterlichen Wandmalereien im Kloster Müstair, Grundlagen zu Konservierung und Pflege. Veröffentlichung des Instituts für Denkmalpflege an der ETH Zürich, Band 22, p. 151–154 (Zürich: vdf Hochschulverlag AG, 2002)

Raschle, P. Damit keine Pilze aus den Mauern schiessen. Schimmelpilze in Wohnräumen: Massnahmen zur Vorbeugung und Bekämpfung. Schweizerischer Hauseigentümer 2002, 84(2), 17

Reichart, I./Hischier, R./ Werner, F. LCA and decision making – conclusions from a review and a case study about paper recycling. In: 12th Annual meeting of SETAC Europe, Vienna, Austria, May 12–16, 2002, poster

Richter, K Oekologische Beurteilung der Holzverwendung: Von Oekobilanzen zur Modellierung von Kohlenstoff-Flüssen. In: Forstwissenschaftliche Tagung über Waldumbau im globalen Wandel, Göttingen, Germany, October 9–11, 2002, p. 51–52

Richter, K. Oekologische Beurteilung von Holzwerkstoffen. tec21 2002, 128(13), 7–11

Richter, K./Schirle, M.A. Behaviour of 1K PUR adhesives under increased moisture and temperature conditions. In: Int. symposium on wood based materials, COST action E13: wood adhesion and glued products, Vienna, Austria, September 19–20, 2002, p. 149–154

Risi, W. Verhalten von bewitterten Dreischichtplatten. Holz-Zentralblatt 2002, 128(122), 1444

Schirle, M.A./Caseri, W.R. Les mystères des mécanismes de collage. 1ère partie. La revue polytechnique 2002, (12), 689–690

Schirle, M.A./Richter, K. Interaction of 1K PUR adhesives and different wood surface parameters. In: Int. symposium on wood based materials, COST action E13: wood adhesion and glued products, Vienna, Austria, September 19–20, 2002, p. 137–147

Sell, J./Graf, E. Massnahmen im Bereich des Holzschutzes. In: 15. Fortbildungskurs Holzbau: Erneuern, Umnutzen, Verstärken von Holzkonstruktionen (Empa/HSR-Tagung 2002), Hochschule Rapperswil, Switzerland, May 23, 2002, 5 p.

Steiger, R. 1) Erneuern, Umnutzen, Verstärken von Bauwerken, 6 p. 2) Zustandserfassung und Zustandsbeurteilung, 18. p. In: 15. Fortbildungskurs Holzbau: Erneuern, Umnutzen, Verstärken von Holzkonstruktionen (Empa/HSR-Tagung 2002), Hochschule Rapperswil, Switzerland, May 23, 2002

Ⓘ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Steiger, R. (Redaktion) — 15. Fortbildungskurs Holzbau: Erneuern, Umnutzen, Verstärken von Holzkonstruktionen (Empa/HSR-Tagung 2002), Hochschule Rapperswil, May 23, 2002

Steiger, R. — Fibre reinforced plastics (FRP) in timber structures – investigations and developments In: 3rd Eurowood technical workshop, Espoo, Finland, June 19–21, 2002, 9 p

Steiger, R./Richter, K./Graf, E./Finger, A. — SIA 265: Die neue Schweizer Holzbaunorm. Holzforschung Schweiz 2002, 10(1), 31

Turkulin, H./Richter, K./Sell, J. — Adhesion of water-borne acrylic and hybrid paint on wood treated with primers. Surface coatings international part B: Coatings transactions 2002, 85(B4), 274–280 Ⓓ

Turkulin, H./Sell, J. — Investigations into photodegradation of wood using microtensile testing. Holz als Roh- und Werkstoff 2002, 60(2), 96–105 ◉

Turkulin, H./Sell, J. — Durability of wooden facades. In: Int. conference on wood in construction industry – prospectives of reconstruction, Zagreb, Croatia, April 19, 2002, p. 83–92

Werner, F. — Interdependencies between LC-modelling and the use of LCA in product design-related decision situations – with special emphasis on the influence of cognitive models and values on the modelling of reuse & recycling and other end-of-life options. PhD thesis submitted to the Swiss Federal Institute of Technology Zürich (ETHZ), dissertation no. 14750, 2002, 342 p.

Werner, F./Althaus, H.-J./Richter, K. — Post-consumer wood in environmental decision-support tools. Schweizerische Zeitschrift für Forstwesen 2002, 153(3), 97–106

Werner, F./Scholz, R.W. — Ambiguities in decision-oriented life cycle inventories. International journal of life cycle assessment 2002, 7(6), 330–338 ◉

Widmann, R. — Qualitätssicherung im Schweizer Systemhausbau. Holz-Zentralblatt 2002, 128(33), 450

Winzeler, R./Hofer, P./Althaus, H.-J./Richter, K. — Evaluation der ökologischen Datenbank und Bewertungsmethodik des Programms OGIP, schwerpunktmässig bezüglich Holzbauteilen und Holzkonstruktionen. In: 12. Schweizerisches Status-Seminar «Energie- und Umweltforschung im Bauwesen», ETH Zürich, Switzerland, September 12–13, 2002, p. 167–173

Materials and Systems for Protection and Wellbeing of the Human Body

Biocompatible Materials

Achermann, E. — MUSAC – a tool for evaluating measurement uncertainty. Hamburg: Kovac, 2002. 178 p. (Forschungsergebnisse der Programmentwicklung, vol. 13)

Bruinink, A./Jaschki, A./Scharnweber, D. et al. — Effects of surface coating of titanium on human bone cell performance. In: Symposium on tissue engineering science: critical elements in the research development continuum, May 19-23, 2002 Myconos-Greece. Bryn Mawr, PA: Aegean Conferences, 2002. p. 45. (Aegean Conferences Series, vol. 4)

Bruinink, A. /Yu, D./Maier, P. — Short-term assay for the identification of neurotoxic compounds and their liver derived stable metabolites. Toxicology in vitro 2002, 16(6), 637–770 Ⓓ

Elison, S.L.R./King, B./Rösslein, M. et al. — Traceability in chemical measurement : workshop draft, June 2002. 33 p. (Eurachem/CITAC guide) www.measurementuncertainty.org/mu/misc/lectures/Traceability_Jun02.pdf

Felber, H./Weber, M./Rivier, C. — Final report on key comparison CCQM-K8 of monoelemental calibration solutions. Metrologia 2002, 39, Techn. Suppl., 08002 Ⓓ

Feller, U./Felber H. — Referenzmesssysteme in Chemie und Biochemie. MetINFO 2002, 9(3), 4–7

Kaiser, J.P. — Assessment of non-biodegradable materials in the organic biodegradable matter. In: R'02: 6th World Congress on Integrated Resources Management, February 12–15, 2002 in Geneva, Switzerland. St. Gallen: Empa, 2002. 5 p.

Meyer, V.R. — Minimizing the effect of sample preparation on measurement uncertainty. LC GC North America 2002, 20, 106–112 Ⓓ

Meyer, V.R. — Minimizing the effect of sample preparation on measurement uncertainty. LC GC Europe 2002, 15, 398–404

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Meyer, V.R.	Ob «traceable» oder rückführbar: Analysenresultate müssen vergleichbar sein. Chemische Rundschau 2002, 55(15), 16
	Meyer, V.R.	The purity of laboratory chemicals with regard to measurement uncertainty. Analyst 2002, 127, 825–829 Ⓘ
	Meyer, V.R.	Wie rein sind Laborchemikalien? Schweizerische Laboratoriums-Zeitschrift 2002, 59, 191–193
	Weber, M.	Wenn Doping-Analysen über Karrieren entscheiden. Laborscope 2002, 29(4/5), 36–39
	Weber, M./Rösslein, M.	Von Toleranzen und Ignoranzen im Dopingnachweis. Neue Zürcher Zeitung 2002, 48, 71
	Wunderli, S. et al.	CCQM-K24 key comparison: Cadmium amount content in rice. Geel, Belgium : Institute for Reference Materials and Measurements, 2002. 19 p. www.bipm.org/pdf/final_reports/QM/K24/CCQM-K24.pdf
Functional Fibers and Textiles	Ernst, U.	FEFCO's Round Robin Tests 2001 on BCT. www.fefco.org (Technical Section)
	Hufenus, R.	Eigenschaften der Geokunststoffe – Prüfung und Qualitätskontrolle. In: Bauen mit Geokunststoffen: Fachtagung der Empa-Akademie und des SVG, Dübendorf 1. März 2002: Tagungsmappe. Dübendorf: Empa-Akademie, 2002. 12 p.
	Hufenus, R.	Die Eigenschaften von Geokunststoffen und ihre Überprüfung. Strasse und Verkehr 2002, 88(10), 388–399
	Hufenus, R.	Long-term behavior of geosynthetics for reinforcement. Technical textiles/Technische Textilien 2002, 45(1), E26-E30
	Hufenus, R. et al.	Anforderungen an Geokunststoffe mit den Aufgaben Bewehren und Schützen = Exigences relatives aux fonctions de renforcement et de protection pour géosynthétiqus. Bern: Eidg. Departement für Umwelt, Verkehr, Energie und Kommunikation, Bundesamt für Strassen, 2002, 153 p. (Forschungsauftrag VSS)
	Hufenus, R./ Rüegger, R./ Flum, D.	Geosynthetics for reinforcement: resistance to damage during installation. In: Proceedings of the 7th International Conference on Geosynthetics 7 ICG-Nice 2002, France, 22–27 Sept. 2002. Lisse: Balkema Publ., 2002, vol. 4, p.1387–1390
	Niederstadt, R./Ellmann, R./ Reifler, F.A. et al.	SMOG – a method to measure the anti-smell properties of textile finishings. In: Proceedings of Avantex, 13.–15. Mai 2002, Frankfurt. Frankfurt: Messe Frankfurt, 2002. 4 p.
	Reifler, F.A./Ritter, A./ Ellmann, J. et al.	SMOG – eine Methode zur Erfassung der Antismell-Wirksamkeit. Textilveredlung 2002, 37(11/12), 5–9
Protection and Physiology	Ampuero, J./Derler, S.	Skin friction management, an emerging apparel and textile science. In: Proceedings of Avantex, 13.–15. Mai 2002, Frankfurt. Frankfurt: Messe Frankfurt, 2002. 8 p.
	Derler, S./Kausch, F./Huber, R.	Wirksamkeit und Dauerhaftigkeit von Antirutschbehandlungen für elastische Bodenbeläge: Bericht zum Forschungsprojekt 201'036. St.Gallen: Empa, 2002. 67 p. (Report Empa No.259)
	Rossi, R.	Messmethoden der Bekleidungsphysiologie. In: 7. Empa Textiltagung Funktionsbekleidung – High-Tech für mehr Komfort: Proceedings. St.Gallen: Empa, 2002.
	Rossi, R.	Mesures de la protection contre la chaleur radiante de vêtements de protection. Fil d'Ariane, le journal de l'Ecole nationale supérieure des arts et industries textiles 2002, (8), p. 3
	Rossi, R./May, H.	New concept for a physiologically optimised winter clothing for the Swiss army. In: Proceedings of Avantex, 13.–15. Mai 2002, Frankfurt. Frankfurt: Messe Frankfurt, 2002. 6 p.
	Rossi, R./May, H.	Optimierte Winterbekleidung für die Schweizer Armee. Technische Rundschau 2002, 94(24), 20–22¨
	Selm, B.	Gestickte Strukturen heilen chronische Wunden. Bioworld 2002, (1), 10–11
	Weder, M.	Entwicklung von Produkten mit verbessertem Tragekonfort. In: 7. Empa Textiltagung Funktionsbekleidung – High-Tech für mehr Komfort, Zürich, 21.3.2002: Proceedings. St.Gallen: Empa, 2002.
	Weder, M.	Physiologische Eigenschaften von funktionellen Bekleidungssystemen bei tiefen Temperaturen. In: Proceedings. Herbst-Symposium D-Sayn.

Ⓘ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

	Weder, M./Frei, G./Becker, C./ Richards, M./Gross, R. et al.	Physiologische Wirkungsweise von verschiedenen Schichtaufbauten bei Wetter- und Kälteschutzkleidung. In: 41. Internationale Chemiefasertagung, A-Dornbirn: Proceedings.13 p.

Information, Reliability and Simulation Technology

Acoustics/Noise Abatement	Baschnagel, K./Bütikofer, R./ Eggenschwiler, K./Emrich, F./ Heutschi, K./Krebs, W.	Bauakustische Messverfahren. Bauakustik-Kurs, Empa Akademie, Dübendorf, Switzerland, September 3, 2002.
	Eggenschwiler, K.	Akustische Raumgestaltung in Schulzimmern und Vortragsälen (Akustik von Schulzimmern und Auditorien). In: Fachtagung Schallschutz durch massives Bauen, Empa Akademie, Dübendorf, Switzerland, June 4, 2002, publ. in: Massiv-Focus no. 3, p. 27 ff
	Eggenschwiler, K./Heutschi, K./ Wunderli, J.M. et al.	Meteorologie und Schallausbreitung. Workshop, Empa Akademie, Dübendorf, Switzerland, June 25, 2002
	Eggenschwiler, K./ Karg, S./Norman, D.	Beschallungsanlagen, Höranlagen und Raumakustik. Hrsg.: Schweizerische Fachstelle für behindertengerechtes Bauen, October 2002, 26 p.
	Emrich, F.	Berücksichtigung von Flankenübertragungen bei Prognosen für den Schallschutz im Hochbau. In: Fachtagung Schallschutz durch massives Bauen, Empa Akademie, Dübendorf, Switzerland, June 4, 2002, publ. in: Massiv-Focus no. 3, p. 19–26
	Heutschi, K.	Lärmschirme an Strassen – Akustische Quellenhöhe bei der Berechnung der Hinderniswirkung. Forschungsauftrag ASTRA 2000/411 auf Antrag des Bundesamtes für Strassen (ASTRA). UVEK/ ASTRA report no. 1016, August 2002, 46 p.
	Nguyen, C.H./Pietrzko, S.J.	Analytical and FEM-investigations with experimental validation of a PZT-actuated vibrating beam an its sound radiation. In: Int. conference on noise and vibration engineering (ISMA 2002), Leuven, Belgium, September 16–18, 2002, p. 157–166
	Nguyen, C.H./Pietrzko, S.J.	FEM-investigations of piezoelectric-mechanical-acoustic coupling fields. In: 20th CAD-FEM Users´ Meeting – Int. congress on FEM technology, Friedrichshafen, Germany, October 9–11, 10 p.
	Pietrzko, S.J./Bütikofer, R.	Flula – Swiss aircraft noise prediction program. In: Acoustics 2002 – innovation in acoustics and vibration, the Australian acoustical society annual conference, Adelaide, Australia, November 13–15, 2002, 8 p.
	Seba, B./Pietrzko, S.J.	Active noise control of a double-glazed panel. In: Int. symposium on active control of sound and vibration (Active 2002), Southampton, UK, July 15–17, 2002, 8 p.
	Studer, M./Eggenschwiler, K./ Baschnagel, K. et al.	Wärmequelle Luft für Retrofitwärmepumpen. Untersuchung im Rahmen des Forschungsprogramms Umgebungswärme, Kälte, Abwärme, im Auftrag des Bundesamtes für Energie. Schlussbericht, Mai 2002, 94 p.
Electronics/Metrology	Anderegg, P./Brönnimann, R./ Raab, Ch./Partl, M.	Long-term health monitoring of pavement deformations on an expressway. In: Joint int. conference on force, mass, torque, hardness and civil engineering metrology in the age of globalization (IMEKO TC3/ TC5/TC20), Celle, Germany, September 24–26, 2002, VDI-Berichte 1685, p. 141–146
	Anderegg, P./Nellen, Ph.M./ Brönnimann, R./Sennhauser, U.	Reliable long-term health monitoring of CFRP cables in bridges. In: First int. workshop on structural health monitoring of innovative civil engineering structures (SHM ISIS 2002), Winnipeg, Canada, September 19–20, 2002, p. 75–83
	Baccaglioni, G./Blau, B./ Neuenschwander, J. et al.	Production and qualification of 40 km of Al-stabilized NbTi cable for the ATLAS experiment at Cern. In: 7th Int.conference on magnet technology, Geneva, Switzerland, September 24–28, 2001. Publ. in: IEEE transactions on applied superconductivity 2002, 12(1), 1215–1218 Ⓓ
	Blau, B./Campi, D./ Neuenschwander, J. et al.	The CMS conductor. In: 7th Int.conference on magnet technology, Geneva, Switzerland, September 24–28, 2001. Publ. in: IEEE transactions on applied superconductivity 2002, 12(1), 345–348 Ⓓ
	Folch, R./Blau, B./ Neuenschwander, J. et al.	Continuous EB welding of the reinforcement of the CMS conductor. In: 7th Int.conference on magnet technology, Geneva, Switzerland, September 24–28, 2001. Publ. in: IEEE transactions on applied superconductivity 2002, 12(1), 372–375 Ⓓ
	Grossmann, G.	Grundlagen des Weichlötens. In: Achtes Fachforum Weichlöten, Regensburg, Germany, November 18–19, 2002, 29 p

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Grossmann, G./Nicoletti, G./ Solèr, U. — Results of comparative reliability tests on lead-free solder alloys. In: 52nd Electronic components and technology conference (ECTC 2002), San Diego, CA, USA, May 28–31, 2002, p. 1232–1237

Grossmann, G./Tharian, J./ Fleischer, W. — No fear of lead-free solder. In: 21st Int. conference on electrical contacts (ICEC 2002), Zürich, Switzerland, September 9–12, 2002, p. 303–308

Hack, E. — Kombinierter Einsatz von Scherografie und Thermografie zur Charakterisierung thermo-mechanischer Beanspruchung. Technisches Messen 2002, 69(5), 213–216 ◉

Hack, E. — Mehrwellenlängen-Scherografie für die zerstörungsfreie Prüfung und Dehnungsmessung. Technisches Messen 2002, 69(10), 432–436 ◉

Jacob, P. — Microstructure device modifications by FIB: what a device designer should consider when asking for FIB repair support. In: Int. conference on micro- and nanoengineering (MNE 2002), Lugano, Switzerland, September 16–19, 2002, p. 334–335

Jacob, P. — Defect- and structure-weakness-localization on power semiconductors using OBIRCH (Optical Beam Induced Resistivity Change). In: 9th Int. symposium on the physical & failure analysis of integrated circuits (IPFA 2002), Singapore, July 8–12, 2002, p. 152–156

Lüthi, Th./Flisch, A./ Hofmann, J./Obrist, A./ Wirth, J. — First article inspection based on industrial x-ray computed tomography. In: 4th Int. workshop on advances in signal processing for nondestructive evaluation of materials, Québec, Canada, August 7–10, 2001. Publ. in: Topics on nondestructive evaluation series (TONE), vol. 6, p.159–164

Lüthi, Th./Neuenschwander, J./ Blau, B. — Bond quality control of aluminium stabilised superconductors with ultrasonic phased-array technology. In: 8th European conference on non-destructive testing (ECNDT), Barcelona, Spain, June 17–21, 2002, 8 p.

Nellen, Ph.M./Brönnimann, R. — Faseroptische Nerven (Teil 1). Sensor report 2002, 17(3), 17–19

Nellen, Ph.M./Brönnimann, R. — Faseroptische Nerven (Teil 2). Sensor report 2002, 17(4), 21–23

Neuenschwander, J./Blau, B./ Horvath, I.L./Lüthi, Th. et al. — Bond and electron beam welding quality control of the aluminium stabilized and reinforced CMS conductor by means of ultrasonic phased-array technology. In: 7th Int. conference on magnet technology, Geneva, Switzerland, September 24–28, 2001. Publ. in: IEEE transactions on applied superconductivity 2002, 12(1), 1199–1202 Ⓓ

Obrist, A./Flisch, A./ Hofmann, J./Lüthi, Th./ Thurner, Ph./Wyss, P. — 3D digitising based on x-ray computed tomography: state of the art and evolution In: Congrès numérisation 3D (scanning 2002), Paris, France, April 24–25, 2002, 10 p.

Reiner, J.C./Gasser, Ph./ Sennhauser, U. — Novel FIB-based sample preparation technique for TEM analysis of ultra-thin gate oxide breakdown. Microelectronics reliability 2002, 42(9–11), 1753–1757 Ⓓ

Sennhauser, U./Jacob, P. — FIB – ein Mikroskop als Werkbank. GIT Fachz. Lab. 2002, 46(10), 1158–1159

Sennhauser, U./Jacob, P. — FIB – ein Mikroskop als Werkbank. GIT inspect 2002, (2), 63–64

Terrasi, G.P./Bättig, G./ Brönnimann, R. — Pylons made of high-strength spun concrete and prestressed with carbon fibre reinforced plastic for high power transmission lines. International journal of materials & product technology 2002, 17(1–2), 32–45 ◉

Media Technoloy

Dätwyler, M. — CD-Herstellung – ein Erfahrungsbericht. Ugra-Mitteilungen 2002, (2), 15–16

Dätwyler, M./ Kurz, K./ Steiger, W./ Simon, K. — Qualitätskriterien für den Digitalproof. Critères de qualité pour l'épreuvage numérique. St.Gallen: Ugra, 2002. 35 p. (Ugra-Bericht/Rapport Ugra 124/2)

Dätwyler, M./Schläpfer, K. — Der Proof im digitalen Workflow. St.Gallen: Ugra, 2001. 31 p. (Ugra-Bericht 124/1)

Frischknecht, P. — Crossmedia in der Praxis. Ugra-Mitteilungen 2002, (2), 21–22

Heuberger, K.J. — Von PDF nach PDF/X. Ugra-Mitteilungen 2002, (2), 11–14

Mourad, S./ Emmel, P./Simon, K. — Prediction of monochrome reflectance spectra with an extended Kubelka-Munk model. In: Tenth Color Imaging Conference: Color science and engineering, Scottsdale, Arizona 2002: final program and proceedings. Springfield, VA: Society for Imaging Science & Technology, 2002. p. 298–304

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Reber, K.	Analoge Fotografie – eine aussterbende Spezies? Ugra-Mitteilungen 2002, (2), 3–6
	Schefer, H.	Workflow in der Verpackungsbranche. – Ugra-Mitteilungen 2002, (2), 17–19
	Schläpfer, K.	Farbmetrik in der grafischen Industrie. 3. Aufl. St.Gallen: Ugra, 2002. 257 p.
	Schläpfer, K.	Jubiläumsausgabe 50 Jahre Ugra = Edition de jubilé 50 ans Ugra. Ugra-Mitteilungen 2002, (1), 1–31
	Schläpfer, K.	Die neue Farbabstandsformel CIE2000. Ugra-Mitteilungen 2002, (3), 16–18
	Schläpfer, K.	Vom Lochstreifen zum Flash-Speicher: Geschichte der Datenspeciherung in der grafischen Industrie = De la bande perforée à la mémoire flash: histoire de la sauvegarde des donnés dans l'industrie graphique. Ugra-Mitteilungen 2002, (3), 3–12
	Simon, K.	A stochastic interpretation of Kubelka-Munk. In: Conference proceedings: CGIV'2002, First European Conference on Colour in Graphics, Imaging, and Vision, April 2–5, 2002, University of Poitiers, France. Springfield: Society for Imaging Science and Technology, 2002. p. 468–472
	Steiger, W.	Hoch, tief oder flach? = En relief, en creux ou à plat? Ugra-Mitteilungen 2002, (3), 19–21
	Trachsler, B.	Was steht im ICC-Profil. – Ugra-Mitteilungen 2002, (2), 7–10
Sustainable Information Technology	Hartmann, F./Hilty, L.	Integration von Material- und Informationsflussananlysen (IMI). In: Einsatz von OR-Verfahren zur techno-ökonomischen Analyse von Produktionssystemen: Workshop der GOR-Arbeitsgruppe OR im Umweltschutz. Frankfurt/M: Peter Lang, 2002. – p. 69–74
	Hartmann, F./Hilty, L.	Integrated analysis of material and information flows. In: Euro-Sustain 2002, 2–5 April 2002, Rhodes, Greece: Implementing the integrated product policy: highlights. Thessaloniki: Aristotle University, 2002. p. 22–23
	Hilty, L.	Sustainable development and information technology. Environmental impact assessment review 2002, 22(5), 445–447
	Hilty, L.	Sustainable development and the information society. In: Human choice and computers: IFIP 17th World Computer Congress-TC9 Stream … August 25-30, 2002, Montréal, Québec, Canada / ed. by K. Brunnstein et al. Boston: Kluwer, 2002. p. 305–315
	Hilty, L./Ruddy, Th.	Resource productivity in the information age. Futura/Finnish Society for Future Studies 2002, 21(2), 76–84
	Hischier, R./Hilty, L.	Environmental impacts of an international conference. Environmental impact assessment review 2002, 22(5), 543–557
	Reichart, I./ Hischier, R.	Are electronic directories more eco-efficient than print directories? In: R'02: 6th World Congress on Integrated Resources Management, February 12–15, 2002 in Geneva, Switzerland. St. Gallen: Empa, 2002. 1 CD-ROM. ISBN 3-905555-24-7
	Wäger, P.A./Hilty, L.	A simulation system for waste management: from system dynamics modelling to decision support. In: Integrated assessment and decision support: proceedings of the 1st biennial meeting of the International Environmental Modelling and Software Society iEMSs, 24–27 June 2002, University of Lugano, Switzerland. Manno: IDSIA, 2002. Vol. 1, p. 174–179
	Zurkirch, M./Reichart, I.	Environmental impacts of telecommunication services. In: The ecology of the new economy / eds.: J. Park, N. Roome. Sheffield: Greenleaf, 2002. p.130–149
Technological Cooperation	Robledo, C.	Aspectos sociales en LULUCF/CDM: documento para el Foro Latinoamericano de Bosques. In: Proceedings of the seminar in Quito.
	Robledo, C. et al.	Carbon, forests and people: towards the integrated management of carbon sequestration, biodiversity and sustainable livelihoods.
	Robledo, C.	Environmental shares in support of sustainable forest management in Colombia.
	Robledo, C.	Es lebe die Erhaltung der Tropenwälder! Aber … wie? Wald-International Newsflash 2002, (5) www.diskussionsforen.ch/Waldforum/newsflash%20Oktober%2002.htm
	Robledo, C. et al.	Valoración de bienes y servicios forestalen en el proyecto OIMT 54/99 Rev 1(F). – www.itto.or.jp

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

Mobility and Environment

Air Pollution/ Environmental Technology

Brönnimann, S./ Buchmann, B./Wanner, H. — Trends in near-surface ozone concentrations in Switzerland: the 1990s. Atmospheric Environment 2002, 36(17), 2841–2852 Ⓓ

Emmenegger; L./ Aufdenblatten, S./Mohr, M./ Mohn, J./Kägi, R. — Modern analytical tools for particle emissions of a large diesel engine. In: 5th Int. conference o emission monitoring, Odense, Denmark, September 11, 2002, 8 p.

Emmenegger; L./Zeyer, K./ Mohn, J. — Extractive FTIR on-line gas analysis. Chimia 2002, 56(7–8), 332 Ⓓ

Gehrig, R./Hill, M./ Kägi, R./Kobler, J. — Contributions of railway traffic to local PM_{10} concentrations – a preliminary field study. In: 11th Int. symposium on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 2. Publ. in: VKM-THD Mitteilungen, Heft/Volume 81, 2002, p. 267–272

Gehrig, R./Hüglin, Ch./ Devos, W./Hofer, P./Kobler, J. — Contribution of road traffic to ambient fine particle concentrations (PM10) in Switzerland. International journal of vehicle design 2001, 27(1–4), 55–64 ◉

Heldstab, J./Gehrig, R./ Hill, M. et al. — PM10-Emissionen des Verkehrs, Statusbericht Teil Schienenverkehr. Hrsg.: BUWAL, 2002, Umwelt-Materialien Luft Nr. 144, 48 p.

Klausen, J. (Redaktion) — RIGA 2002 – GAW workshop for WMO RA VI (Europe) on status and trends of global atmospheric watch, Riga, Latvia, May 27–30, 2002, 93 p.

Klausen, J./Zellweger, C./ Buchmann, B./Hofer, P. — Data quality in GAW – accounts on six years of WCC and QA/ SAC activity. In: 3rd GAW-CH conference on ozone, radiation and aerosols, Zürich, Switzerland, October 23. Publ.: Swiss Agency for the Environment, Forests and Landscape SAEFL/BUWAL, Environmental documentation Air no. 153, p. 45–48

Mavrocordatos, D./Kägi, R./ Schmatloch, V. — Fractal analysis of wood combustion aggregates by contact mode atomic force microscopy. Atmospheric Environment 2002, 36(36–37), 5653–5660 Ⓓ

Mohn, J./Emmenegger; L. — Potential and limitations of FTIR gas analysis in semiconductor industries. In: 12th European conference on analytical chemistry (Euroanalysis 12), Dortmund, Germany, September 8–13, 2002, p. 170

Mohn, J./Emmenegger; L./ Sandmeier, E. — On-line gas analysis for process diagnostics in semiconductor industries. Chimia 2002, 56(7–8), 330 Ⓓ

Reimann, P./Schaub, D./ Weiss, A./Stemmler, K./ Hofer, P. — Estimated emissions of halogenated greenhouse gases by analysis of on-line measurements at a high alpine station (Jungfraujoch). In: 3rd Int. Symposium on non-CO2 greenhouse gases (NCGG-3), Maastricht, Netherlands, January 21–23, 2002, p. 571–572

Ruprecht, E./Schröder, S.S./Ubl, S. — On the relation between NAO and water vapour transport towards Europe. Meteorologische Zeitschrift 2002, 11(6), 395–401 ◉

Schaub, D./Reimann, S./ Stemmler, K./Weiss, A./ Buchmann, B./Hofer, P. — Potential source regions of trace gases observed at Jungfraujoch. In: 3rd GAW-CH conference on ozone, radiation and aerosols, Zürich, Switzerland, October 23. Publ.: Swiss Agency for the Environment, Forests and Landscape SAEFL/BUWAL, Environmental documentation Air no. 153, p. 37–40

Schürmann, A./Mohn, J./ Bachofen, R. — N_2O emissions from snow-covered soils in the Swiss Alps. Tellus-series B 2002, 54B(2), 134–142 Ⓓ

Staehelin, J./Mäder, J./ Weiss, A.K./Appenzeller, Chr. — Long-term ozone trends in Northern mid-latitudes with special emphasis on the contribution of changes in dynamics. Physics and chemistry of the earth 2002, 27(6–8), 461–469 ◉

Weiss, A. — Ozone and climate variability. In: 3rd GAW-CH conference on ozone, radiation and aerosols, Zürich, Switzerland, October 23. Publ.: Swiss Agency for the Environment, Forests and Landscape SAE FL/BUWAL, Environmental documentation Air no. 153, p. 65–68

Weiss, A./Schaub, D./Hofer, P. — Modelling the spreading of air pollution with weather models. In: 1st Biennal meeting of the int. environmental modelling and software society, Lugano, Switzerland, June 24–27, vol. 3, p. 527–531

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

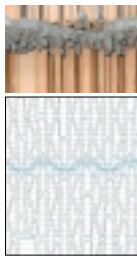
	Weiss, A./Schaub, D./ Petritoli, A./Bonasoni, P.	DUP-POLPO – Pollution Hot Spot Monitoring from GOME, applied to the Po-basin. Dübendorf: Empa Air Pollution/ Environmental Technology Laboratory, September 2002. Part I: Data visualisation tool – manual, 18 p.; Part II: Case study collection, 52 p.; Part III: User handbook, 58 p.
	Weiss, A.K./Staehelin, J./ Appenzeller, Chr. et al.	Chemical and dynamical contributions to ozone profile trends of the Payerne (Switzerland) balloon soundings. Journal of geophysical research-atmospheres 2002, 106(D19), 22685–22693 Ⓓ
I.C. Engines/Furnaces	Bach, Ch.	Erdgas als Treibstoff. Gas-Wasser-Abwasser 2002, 82(6), 379–384
	Bach, Ch./Boulouchos, K./ Guzzella, L.	Antriebssysteme für Automobile der Zukunft. Bulletin ETH Zürich 2002, (287), 20–23
	Devaux, Ph./Weilenmann, M.	Influence of the human driver on vehicles emissions of chassis dynamometer tests. Final report, version 3 of work-package 310, task 3143 of the ARTEMIS project. Empa Dübendorf, November 2002, 48 p., Empa R&D project no. 201697a
	Lehmann, U.	Potential der Bio-Ethanol Beimischung im Benzin und Diesel-Treibstoff. Empa Dübendorf, September 2002, 40 p., Empa R&D project no. 202672
	Lehmann, U./Mohr, M.	Influence of different configurations of a catalyst and a trap on particulate emission of a diesel passenger car. International journal of vehicle design 2001, 27(1-4), 228–241 ◉
	Mohr, M./Aufdenblatten, S./ Lutz, Th. et al.	Charakterisierung der Partikelemission von modernen Verbrennungsmotoren. MTZ Motortechnische Zeitschrift 2002, 63(11), 962–974
	Oser, M./Nussbaumer, T./ Schweizer, B./Mohr, M./Figi, R.	Reduction of particulate emissions by staged combustion. In: 12th European conference and technology exhibition on biomass for energy, industry and climate protection, Amsterdam, The Netherlands, June 17–21, 2002, 6 p.
	Oser, M./Nussbaumer, Th./ Müller, P. /Mohr, M./Figi, R.	Aerosolbildung bei der Holzverbrennung und Beeinflussung der Staubemissionen durch gestufte Verbrennung. In: 7. Holzenergie-Symposium, ETH Zürich, Switzerland, October 18, 2002, p. 35–51
	Schmatloch, V.	Reduction of particle emissions from small wood fired furnaces. In: 6th ETH conference on nanoparticle-measurement, Zürich, Switzerland, August 19–21, 2002, 8 p.
	Soltic, P./Weilenmann, M.	Nachführung der Emissionsgrundlagen Strassenverkehr – Ergänzung der Messdaten auf das Bezugsjahr 2000, Benzin: Personen- und Lieferwagen. 6 Teilberichte: Standardprogramm, Emissionen in Abhängigkeit der Meereshöhe, Einfluss elektrischer Verbraucher auf die Emissionen, Aufteilung der NO_x Emissionen, Emissionen und Verbrauch bei Eco-Drive, und Kaltstartemissionen. Im Auftrag des BUWAL. Empa Dübendorf, October 2002, 109 p., 18 p., 22 p., 19 p., 18 p., 35 p., Empa R&D project no. 201209, 201209a-c, 201209e-f
	Soltic, P./Weilenmann, M.	Influence of electric load on the exhaust gas emissions of passenger cars. In: 11th Int. symposiu on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 1. Publ. in: VKM-THD Mitteilungen, Heft/Volume 81, 2002, p. 179–186
	Soltic, P./Weilenmann, M.	Partitioning of NO_x emissions for gasoline passenger cars and light duty trucks. In: 11th Int. symposium on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 2. Publ. in: VKM-THD Mitteilungen, Heft/Volume 81, 2002, p. 49–56
	Weilenmann, M./Bach, Ch./ Rüdy, C.	Aspects of instantaneous emission measurement. International journal of vehicle design 2001, 27(1–4), 94–104 ◉
	Weilenmann, M./Forss, A.-M./ Heeb, N.V.	Nachführung der Emissionsgrundlagen Strassenverkehr – Ergänzung der Messdaten auf das Bezugsjahr 2000. Teilbericht: Winterkaltstart von Zweirädern (winter cold start of two-wheelers). Im Auftrag des BUWAL. Empa Dübendorf, January 2002, 32 p. Empa R&D project no. 202114a
	Weilenmann, M./Soltic, P./ Ajtay, D.	Describing and compensating gas transport dynamics for accurate instantaneous emission measurement. In: 11th Int. symposium on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 1. Publ. in: VKM-THD Mitteilungen, Heft/Volume 81, 2002, p. 155–162
Inorganic Analytical Chemistry/ Characterization of Solids	Bahranowski, K./Serwicka, E.M./ Zwicky, Ch. et al.	Reduced charge Al-pillared montmorillonites: on the possibility of controlling the pillar density. Geologica carpathica 2002, 53(2), 99–102 ◉
	Devos, W./Moor, Ch.	Determination of 14 trace element concentrations in two Dillinger Hüttenwerke Portland cement reference materials by sector field and quadrupole ICP-MS. Journal of analytical atomic spectrometry 2002, 17(2), 138–141 Ⓓ

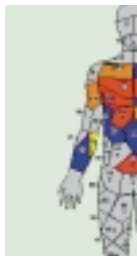
Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)

Publications

	Fasnacht, W.	The tuyeres from the copper smelting site of Agia Varvara- Almyras, Cyprus: A puzzle of 498 pieces. Cu+: bulletin du groupe de travail international sur la paléométallurgie des cuivres et des minerais associés 2002, (2), 9–11
	Müller, B./Ulrich, A. et al.	P, As, Sb, Mo, and other elements in sedimentary Fe/Mn layers of Lake Baikal. Environmental
	Senn, M./Lienemann, P./ Bührer, Th.	Archäologische Eisenverhüttung im Experiment – Messungen von Reaktionsparametern und Reaktionsprodukten. Bergknappe 2002, 26(3), 18–25
	Zwicky, Ch.	Identifikation von Korallen. Publ. in: Schmid-Sikimic, B.: Mesocco Coop (GR), Eisenzeitlicher Bestattungsplatz im Brennpunkt zwischen Süd und Nord. Universitätsforschungen zur prähistorischen Archäologie 2002, (88), 225–227
Motor Fuels/ Combustibles	Andrade, A.P./Neuenschwander, P./Hany, R. et al.	Synthesis and characterization of novel copoly(ester-urethane) containing blocks of poly-((R)-3-hydroxyoctanoate) and poly-[(R)-3-hydroxybutyrate]. Macromolecules 2002, 35(13), 4946–4950 Ⓓ
	Andrade, A.P./Witholt, B./ Hany, R. et al.	Preparation and characterization of enantiomerically pure telechelic diols from mcl-poly[(R)-3-hydroxyalkanoates]. Macromolecules 2002, 35(3), 684–689 Ⓓ
	Banerjee, D./Hany, R./ Rentsch, D. et al	Chemical reactivity of aqueous aluminium nanoclusters. Geochimica et cosmochimica acta 2002, 66(suppl.1), A48 Ⓓ
Organic Chemistry	Collaud Coen, M./Keller, B.A./ Gröning, P./Schlapbach, L.	Functionalization of graphite, glassy carbon, and polymer surfaces with highly oxidized sulfur species by plasma treatments. Journal of applied physics 2002, 92(9), 5077–5083 Ⓓ
	Geiger, E./Hug, P./Keller, B.A.	Chromatic transitions in polydiacetylene Langmuir-Blodgett films due to molecular recognition at the film surface studied by spectroscopic methods and surface analysis. Macromolecular chemistry and physics 2002, 203(17), 2422–2431 Ⓓ
	Heeb, N.V./Forss, A.-M./ Saxer, C.J./Wilhelm, P.	Methane, benzene and alkyl benzene cold start emission data of gasoline-driven passenger cars representing the vehicle technology of the last two decades. In: 11th Int. symposium on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 1. Publ. in: VKM-THD Mitteilungen, Heft/ Volume 81, 2002, p. 171–178
	Heeb, N.V./Forss, A.-M./ Weilenmann, M.	Pre- and post-catalyst-, fuel-, velocity- and acceleration-dependent benzene emission data of gasoline-driven EURO-2 passenger cars and light duty vehicles. Atmospheric Environment 2002, 36(30), 4745–4756 Ⓓ
	Heeb, N.V./Forss, A.-M./ Bach, Ch./Schweizer, Th.	Velocity-dependent benzene emission factors of three-way catalyst passenger cars and light duty vehicles from time-resolved exhaust gas analysis. International journal of vehicle design 2001, 27(1–4), 296–305 ◉
	Kohler, M./Zennegg, M./ Waeber, R.	Coplanar polychlorinated biphenyls (PCB) in indoor air. Environmental science & technology 2002, 36(22), 4735–4740 Ⓓ
	Saxer, C.J./Forss, A.-M./ Heeb, N.V.	Temperature-dependent methane, benzene and alkyl benzene cold start emissions of 3 conventional passenger cars (EURO-0) . In: 11th Int. symposium on transport and air pollution, Graz, Austria, June 19–21, 2002, vol. 2. Publ. in: VKM-THD Mitteilungen, Heft/Volume 81, 2002, p. 35–40
	Schmid, P./Gujer, E./Degen, S./ Zennegg, M. et al.	Levels of polychlorinated dibenzo-p-dioxins and dibenzofurans in food of animal origin. The Swiss dioxin monitoring program. Journal of agricultural and food chemistry 2002, 50(25), 7482–7487 Ⓓ
	Schmid, P./Gujer, E./ Zennegg, M./Studer, Ch.	Temporal and spatial trends of PCDD/F levels in cow's milk in Switzerland. In: 22nd Int. symposium on environmental halogenated organic pollutants and POPs (Dioxin'2002), Barcelona, Spain, August 12–16, 2002, 3 p.
	Zennegg, M./Schmid, P./ Gujer, E./Kuchen, A.	PCDD, PCDF; and dioxine-like PCB in fish from Swiss lakes. In: 22nd Int. symposium on environmental halogenated organic pollutants and POPs (Dioxin'2002), Barcelona, Spain, August 12–16, 2002, 4 p

Ⓓ = peer reviewed (Science Citation Index SCI)
◉ = peer reviewed (Science Citation Index Expanded SCIE)





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