

## Press release

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Empa researchers investigate synthetic additives for high performance concrete

### **„Tailor-made“ polymers for the industry**

**In co-operation with industry, Empa investigates polymers, which improve the flow characteristics of concrete. Molecules with a size of only a few nanometers can improve the quality of exposed concrete and open up new architectural construction possibilities.**

It is difficult to imagine that small particles hardly larger than a millionth part of a millimeter can have an effect on enormous building structures, beautify them or even make their construction at all possible. For some decades now, in the preparation of concrete, chemical additives are added to the mixture of cement and water. These improve the flow characteristics of the concrete and allow it to harden within a useful time frame. In the last 15 years the search for a new generation and composition of these chemical additives has been intensive.

#### **That «good-natured concrete»**

Empa is now trying to determine the structure, affects and actions of polymers produced by the world's largest chemical concern BASF. This knowledge will enable industrial chemists to optimize additives purposefully. Empa project managers, Frank Winnefeld and Lorenz Holzer from the Laboratory «Concrete/Construction Chemistry» point to the difficulties of these ventures: «We want a high performance concrete, which flows like honey into the casings and yet hardens within a useful period of time.» A great challenge is, that most polymers react extreme sensitively to different compositions of cement - and the cements available from the different manufacturers are often clearly varied. Therefore, adds Winnefeld, a universally applicable polymer additive is the sought goal. And how does the research benefit the construction industry? «A 'good-natured concrete' with better flow characteristics allows for new architectural structures and increases the quality of exposed concrete finish», according to the Empa specialist. At the same time, there is an increase in the life span of the concrete.

The functional principle of the tiny polymers is examined at Empa with the atomic force microscope. Innumerable polymer molecules accumulate on the cement particle surface. Since the molecules are negatively charged, the cement components repel each other and distribute themselves uniformly in the mixture water-cement-additives mixture – and the material liquefies.

#### **Polymer additives and futuristic architecture**

Empa's efforts, however, go even further. «We want also to understand, how and why certain additives react with which cement», Winnefeld explains. For that purpose, and for the first time in this research field, cryo-electron microscopy is utilized. On this special microscope at the ETH Zurich, cement suspensions a few nanometers large, are shock frozen under high pressure within a few milliseconds. This temperature shock

preserves the structure of the suspension and thus permits an exact investigation of the polymers. Empa researchers hope to achieve soon a better understanding of the actions of various polymers, and thus make them as concrete additives more attractive to the industry.

Empa's Laboratory „Concrete/Construction Chemistry“ has been all times very actively cooperating with industry, and in particular with those Swiss companies dealing in construction chemistry. Thus, for example, Empa engineers worked together Swiss additive producers Sika and Elotex, and together with cement producer Holcim several projects were successfully carried out. The partnership with BASF led, two years ago, to improved polymer concrete and cement additives, which are already available in construction. Possible further projects with the German chemistry concern are being discussed presently. The successful industrial partnerships illustrate once more Empa's function as a bridge between research and practical application, and the speedy and efficient conversion of compiled knowledge into economically and socially useful innovations.

Together with others, mostly Swiss research groups in industry and at universities Empa transfers its know-how in the field of construction chemistry to the National Research Network «CEMNET@ch». At a recent workshop in early September at the Empa Academy in Dübendorf, the subject of improving the characteristics of mortar and concrete by polymers came also under discussion. The regular knowledge exchange with experts from industry as well as with research institutions like the ETH Lausanne, and the resultant networking is a further reason why Swiss concrete additives research occupies a worldwide leading position. Thanks to new polymer additives and exposed concrete of top quality, well known architects such as Herzog & de Meuron may soon have new abilities to realize building projects containing futuristic forms.

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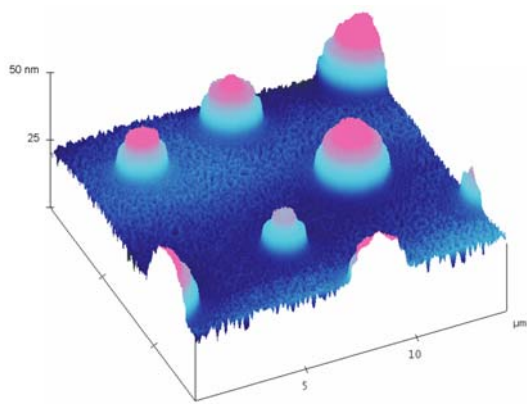
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Self hardening concrete fills even complex cavities without need of compaction.



Adsorption of a Polycarboxylate additive on a mica surface – made visible with the Empa atomic force microscope.