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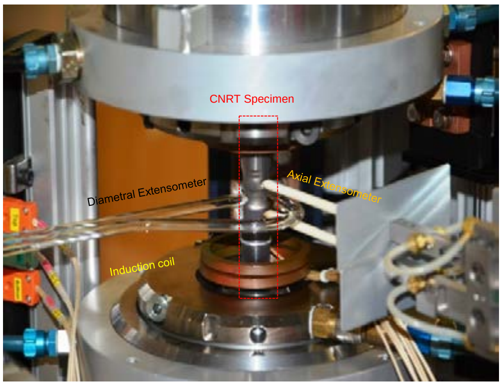
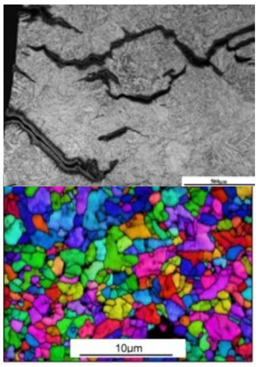
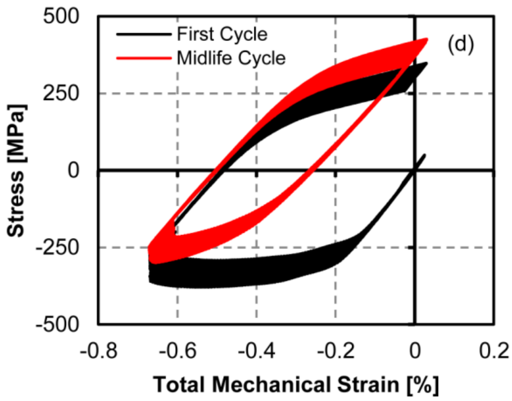
Student Projects

If you are interested in doing a Bachelor or Master thesis in the High Temperature Integrity Group (HTIG), please contact Dr. Hosseini or Prof. Mazza.

The followings pages are only examples and we usually have many interesting projects available. Do not hesitate to write us to get more information on the different topics available. If you wish to visit us directly, you find us in the RH-building, 3rd floor at Empa Dübendorf.





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     DPRED,CMNAME,NDI,NSHR,NTENS,NSTATV,PROPS,NPROPS,COORDS,DROT,
     PNEWDT,CELENT,DFGRD0,DFGRD1,NOEL,NPT,LAYER,KSPT,KSTEP,KINC)
INCLUDE 'ABA_PARAM.INC'
DIMENSION STRESS(NTENS),STATEV(NSTATV),DDSDDE(NTENS,NTENS),
     DDSDDT(NTENS),DRPLDE(NTENS),STRAN(NTENS),DSTRAN(NTENS),
     TIME(2),PREDEF(1),DPRED(1),PROPS(NPROPS),COORDS(3),DROT(3,3),
     DFGRD0(3,3),DFGRD1(3,3)
CHARACTER*8 CMNAME
!***********************************************************************
! Variables defined and used in the UMAT
INTEGER i,j,k,l
REAL*8 d_epsm(3,3),alpha1_i(3,3),alpha2_i(3,3),f_ii,epse_e(3,3),
      alpha1_e(3,3),alpha2_e(3,3),epsp_i(3,3),epsp_e(3,3),f_e,
      sigma_i(3,3),sigma_e(3,3),DTIME,Variabl_i(5),Variabl_e(5),
      epsp_eq_i,epsp_eq_e,KIso_i,KIso_e,d_epsmtan(3,3),pnewdt_e,
      sigmatan_e(3,3),d_sigma_ddepsm(3,3,3,3),epsp_mg_i,epsp_mg_e,
     eps_q_e,sml_depsm,TDROT(3,3),Variabl_e_tan(5),epse_i(3,3)
REAL*8 zero,one,two,MAccur
PARAMETER(zero=0.D0,one=1.D0,two=2.D0,MAccur=1.D-17)
!***********************************************************************
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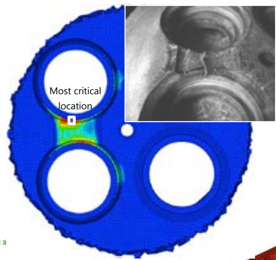
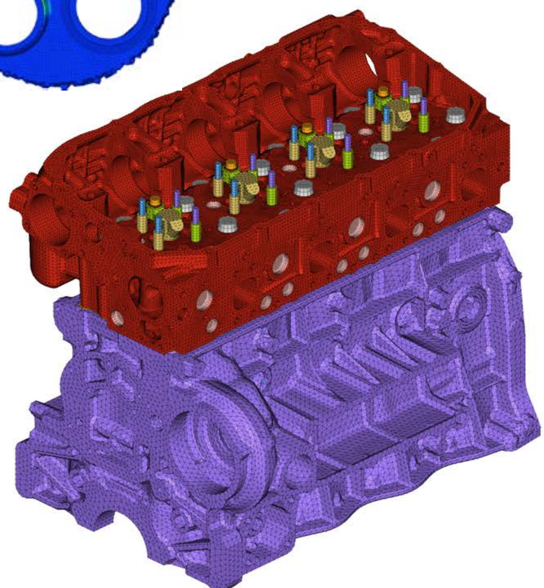
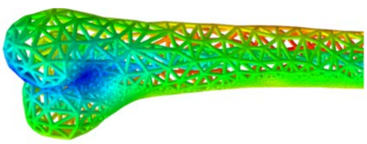
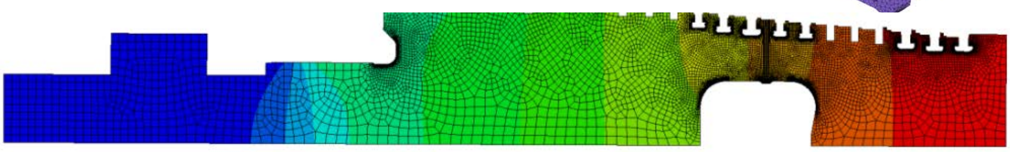






SIMULIA Abaqus

COMSOL



ETH zürich

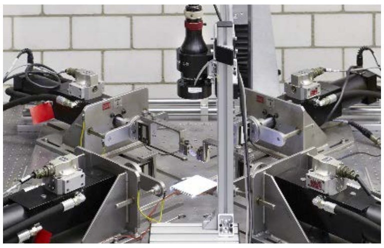
Empa
Materials Science and Technology

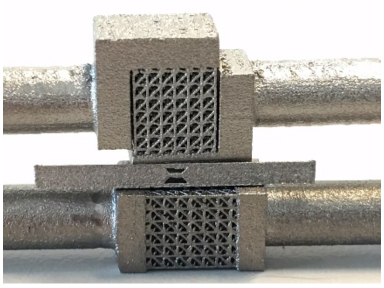
Two master theses:

Constitutive model development and finite element analysis for additive manufactured Ti lattices

Keywords: Modelling, Experiments, additive manufacturing, FEM, DIC, computer tomography, Fatigue

Project's tasks:





- Mechanical characterisation of tiny additive manufactured (AM) spec-imens (gauge section of 0.04mm2),

- uCT analysis for determination of the exact geometry of AM samples

- Development of elastic-plastic constitutive model for the AM Ti

- Employment of developed constitutive model for FE prediction of the behaviour of lattice samples under static and fatigue loads

- Static and fatigue mechanical testing for additive manufactured lattice specimens (cross-section of 7.2x7.2mm2)

- Effectiveness demonstration of FE analyses

Master Thesis:

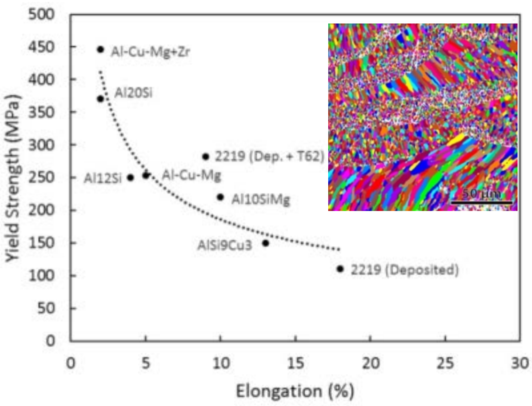
Fatigue and cyclic deformation of a novel high-strength Al alloy fabricated by selective laser melting

Keywords: Experiments, Additive manufacturing, Constitutive model, microstructural investigation

Description:

Additive manufacturing (AM) of Al alloys is interesting with regard to light-weight constructions e.g. in aerospace technology. However, the currently available Al alloys for AM processes either have rather poor strength and ductility or they contain high-levels of expensive elements like Sc. Therefore, we have recently developed a nano-precipitation strengthened Al-Mg-Zr alloy that could be easily fabricated by selective laser melting (SLM) and which showed both high strength and ductility [1]. The aim of the present project is to study the cyclic deformation and fatigue properties of this novel Al alloy fabricated by SLM and to correlate the fatigue-induced damages with the alloy microstructure.

[1] J. Croteau et al., Acta Materialia 153 (2018) 35-44



Project's tasks:

- Fabrication of samples by selective laser melting and heat treatment

- Mechanical experiments (fatigue testing),

- Analysis of experimental data and constitutive modelling

- Microstructural investigation and determination of fatigue crack initiation and growth mechanisms

ETH zürich

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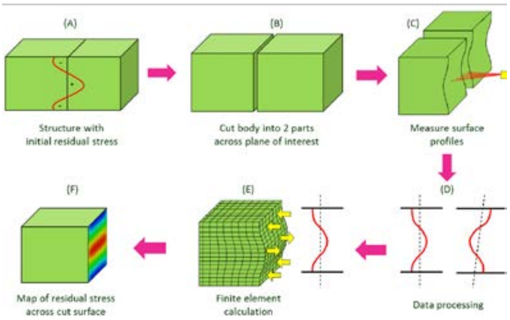
Materials Science and Technology

Master Thesis:

Measurement of residual stress distribution in additive manufactured parts via contour method

Keywords: Experiments, modelling, additive manufacturing, contour method, FEM, Confocal microscopy

The fast temperature transient and solidification during additive manufacturing processes such as SLM induce high level of residual stresses within the built structures. There are various destructive and non-destructive methods to quantify the existing residual stresses. One of promising approach is the contour method, which includes cutting the structure using wire-electrical discharge machining. The residual stresses at the generated free surface relaxes and cause distortion of the free surface. By measuring the surface distortion and use of FEA, it is possible to back calculate the initial residual stress. This project aims to evaluate the effectiveness of this method for measurement of residual stress within an additive manufactured part. The projects tasks include EDM cutting, surface profile measurement using confocal microscopy and elastic finite element analysis.



Contour method infographic (www.stressmap.co.uk)

Master Thesis:

Warm severe plastic deformation (SPD) for tensile and fatigue strength improvement of pure Ti

Keywords: Constrained groove pressing, Tensile and fatigue testing, microstructural characterisation

The strain-hardening accompanied with plastic deformation increases the alloys strength, but often decreases the ductility. Severe plastic deformation processes impose large amount of shear strain under a compressive hydrostatic stress state and enable the formation of ultrafine-grained structures with new physical and mechanical properties, including simultaneous enhancement of strength and ductility. Constrained groove pressing (CGP) is a metal SPD process which involves repetitive shear deformation under plane strain deformation conditions by utilizing alternate pressings with asymmetrically grooved and flat dies. While room temperature SPD is viable for many FCC materials, warm SPD might be exploited for HCP materials with limited room temperature deformability (e.g. Ti). This project aims to exploit the possibility of using warm CGP process for fabrication of nanostructured Ti material with enhanced tensile and fatigue beaviour. For a successful effectivness demonstration, the apporach will be further exploited for fabrication of high strength Ti implant as a replacement for Ti6Al4V (Al and V are toxic additives used for strength improvements).