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MMM Seminar

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3D analysis of micro deformation and damage by X-ray computer tomography

To understand the behaviour of partially ductile materials at microscale before macroscopical failure, micro deformation and damage processes were analysed 3-dimensionally on particle reinforced metal matrix composites (MMC_p) by μCT-experiments and FE simulations.

Subject of these analyses are composites like Cobalt/Diamond and Al/B_4C which are characterised by sufficient attenuation contrast between their phases. Utilising this contrast 3D strain tensor fields and displacement vector fields were sampled by digital image correlation of tomograms which reveal the microstructure in different stages of deformation.

Based on tomograms of a ROI-volume at the undeformed state, FE meshes were generated that map the microstructure close to reality. Using these meshes and the displacement vector fields measured at the volume boundaries, FE simulations of the deformation and damage behaviour were carried out.

In both composites even volume strains below 1% have been found experimentally. The spatial resolution of deformation fields is limited by the characteristic microstructural length which depends on the particle diameter and the particle spacing. The results of the experiments and the simulations are compared on the basis of 3D-strain fields sampled within the analysed microstructural area. Additionally, the impact of microstructural features on the localisation of strain, the initiation of localised damage and the successive failure of the composite materials is discussed.