In-situ multimodal X-ray characterization of local strain distributions in the bulk of metallic samples

Dorte Juul Jensen*[1]

[1]Danmarks Tekniske Universitet = Technical University of Denmark – Denmark

Abstract

By a combination of X-ray techniques, for example absorption contrast tomography (ACT) and diffraction contrast tomography (DCT) or 3D X-ray diffraction (3DXRD), it is possible to map the spatial distribution of plastic strains in the bulk of particle containing metals. The local strains are determined based on the relative change in position of the particles during straining, while the crystallographic orientations of the individual grains are quantified by the diffraction. In this presentation this possibility is illustrated by two examples: In the first example, laboratory X-ray ACT and DCT are combined to map the evolution in local strains during tensile deformation of an Al-Cu alloy. It is shown that there are large variations in the local strains, which to our surprise could not be directly related to neither grain orientation nor grain size. The experimental results are compared to crystal plasticity finite element (CPFEM) simulations, and while good agreement is obtained on the macro scale, there are significant differences on the local scale. This is discussed. In the second example, laboratory X-ray ACT are combined with synchrotron 3DXRD and beam scanning methods to map both the evolution in local strain as well as crystallographic orientations during tensile deformation of commercially pure Al (AA1015). After straining to near fracture, the sample is annealed and the nucleation sites are related to the microstructure and local strain. Most nucleation site are observed to be at grain triple or multi junctions, and it is discussed if the local strain distribution can explain which junctions become active nucleation sites and which do not.

*Speaker