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In-situ Studies of The Strain Localization in Polycrystals by Electron Microscopy Techniques

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In some polycrystalline metals, the incipient plasticity is marked by the presence of strain localization in slip bands; this mechanism and the propagation of plasticity through the polycrystalline aggregate are not fully understood yet [1-2]. Furthermore, the onset of plasticity is a multi-scale phenomenon. Therefore, the 3DiPolyPlast (3D Incipient Polycrystals Plasticity) project aims at studying these mechanisms by a multi-modal characterization (surface and bulk studies based on electron microscopy and synchrotron techniques) and by Discrete Dislocations simulations, covering. all relevant scales from 50 nm to 500 µm.

Pure polycrystalline nickel (99.99%) has been selected as a model material and in-situ tensile test specimens are prepared by a specific thermomechanical procedure to obtain a microstructure compatible will all the used characterization techniques. The samples are in-situ monotonously tensile strained in the FIB-SEM chamber. At each load state, HR-SEM and HR-EBSD maps are acquired to study the appearance of strain localization, with additional support from DIC technique. Collected information on the local strain and lattice rotation aims at identifying the conditions for strain localization and propagation from grain to grain. Additional TEM studies on foils extracted from specific locations (via FIB-based lift-out technique) enable to further examine the fine structure of slip bands and grain boundaries. 3D-EBSD can also be applied to gain insight into the sub-surface characteristics and compare with bulk information collected from synchrotron-based techniques and simulation results.

Keywords: Strain localization, in-situ tensile testing, slip bands, incipient plasticity,

References:

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