IN SITU 3D MAPPING OF LOCAL STRESS AND CRYSTAL DEFECT STRUCTURES DURING MICRO-MECHANICAL TESTING BY n3D-XRD-CT

Thomas Edward James Edwards, EMPA, Feuerwerkerstrasse 39, 3602 Thun, Switzerland
thomas.edwards@empa.ch
Xavier Maeder, EMPA, Feuerwerkerstrasse 39, 3602 Thun, Switzerland
Szilvia Kalácska, Mines Saint-Etienne, Univ Lyon, CNRS, UMR 5307 LGF, France
Nicolò Maria Della Ventura, EMPA, Feuerwerkerstrasse 39, 3602 Thun, Switzerland
Jon Wright, European Synchrotron Radiation Facility, 38000, Grenoble, France
Johann Michler, EMPA, Feuerwerkerstrasse 39, 3602 Thun, Switzerland

Key Words: 3D strain mapping, micropillar, micro-tensile, in situ synchrotron mechanical testing.

Crystal orientation and local elastic strain/stress evolution were mapped in 3D during in situ loading of single and bi-crystalline metallic micromechanical testpieces. The novel application of the nano-beam 3D-XRD computed tomography technique in micromechanics (~150 nm spatial resolution) at ESRF ID11, enabled the measurement of the 3D arrangement of the geometrically necessary dislocation (GND) density and the local stress states in pure metal and alloy model systems (FCC, BCC & HCP) loaded in both microcompression (Cu, 316L, Mo) and microtension geometries (Mg). Post-mortem TEM analysis provides insights into the total number and real distribution of dislocations in the system, to better understand the meaningfulness of the measured GND arrays, thought to be characteristic of strain transfer at the bicrystal boundaries.

3D-XRD datasets were compared to ex-situ FIB 3D-HR-EBSD slice-and-scan, seeking to learn more about the progressive accumulation of dislocations and useful plastic strain, relative to local stress states during loading.