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EXPERIMENTAL CHARACTERIZATION OF MICRO PLASTICITY AND DISLOCATION MICROSTRUCTURES

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In order to gain a deeper understanding of the mechanisms responsible for plastic deformation at the micron and sub-micron scale, the experimental investigation of the evolution of local strain fields and dislocation microstructure during deformation is of great interest. Therefore, specifically designed mechanical tests on single and oligocrystalline microsamples were performed and combined with SEM, EBSD, TEM and X-ray microdiffraction techniques. In the present work, microsamples were studied under different loading conditions: compression, bending, and torsion. The samples for bending and compression experiments were fabricated out of 1-4µm thick Ag thin films epitaxially grown onto Si wafer substrates. Via conventional cleanroom processing they were shaped into microbeams and micropillars. The size of the beams ranges from 10µm x 5µm up to 40µm x 20µm, whereas the pillars are 0,5µm up to 5µm in diameter. In both cases the load was applied using a nanoindenter system. Au wires having 15 to 60 µm in diameter were used for torsion experiments. In contrast to the compression and bending samples, the Au wires were polycrystalline and have been heat treated to form a pronounced bamboo microstructure.

To study the microstructural changes due to plastic deformation various methods with high lateral resolution were applied. The main tools for bending and compression in this context are EBSD and TEM. The micro-wires were cut by FIB at selected cross sections and the analyzed via micro Laue diffraction and EBSD. Comparative measurements of deformed an initial microstructures allowed both to display the distribution of the dislocation density and strain gradients and an estimation of their absolute values. The results will be discussed with respect to the influence of crystal orientation and loading condition on the evolution of local strain fields and dislocation microstructure.