

## **SMALLER IS STRONGER: IN-SITU LAUE DIFFRACTION**

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Plasticity in single crystal micron sized pillars has gained considerable interest since the development of the micro compression technique and the observation of a “smaller is stronger” effect with decreasing pillar diameter. Plastic deformation is often observed as individual slip events that are reflected in discrete strain bursts. Large scattering among the data is reported, where pillars of similar orientation are deforming according to different slip systems, sometimes shearing-off or barrelling. To address the scattering among the data, to understand the mechanism behind the increase in strength in terms of existing or new theories, one needs information on the microstructural details of the sample before, during and after deformation.

An in-situ micro compression device has been developed at the Swiss Light Source (SLS) allowing the continuous measurement of time-resolved white beam Laue diffraction patterns during compression of micron-sized pillars, capturing the initial microstructure and the changes in microstructure during deformation. Former measurements have for instance demonstrated the presence of initial strain gradients and their role on the deformation mechanisms activated during compression (PRL, 99(2007)145505) or evidenced classical type-II hardening in spite of higher yield stresses (APL 92(2008) 71905). On the other hand, Laue analysis also evidenced for some pillars the presence of microstructural characteristics (such as a low angle grain boundary) precluding them from the realm of single crystal plasticity and thus allowing for a reduction of the scatter among measurements, since these pillars no longer belong to the domain of the statistically unknown (APL 91(2007)131909).

Here we provide an overview of former results and present a new series of in-situ Laue diffraction experiments performed on Cu, Ni, Au and Al pillars with diameters between 1 to 10 micron, made in different laboratories using different FIB procedures. The results emphasize (1) microstructural defects that do not belong to the single crystal domain, (2) evolution of the microstructure during compression evidencing the complex boundary conditions of a micro-compression technique, and (3) the increase in strength when the pillar diameter gets smaller. The results will be discussed in terms of existing and new developing dislocation based theories addressing “smaller is stronger”.