In-situ Coupling of Coherent X-ray Diffraction and Nano-indentation of Platinum Particles.

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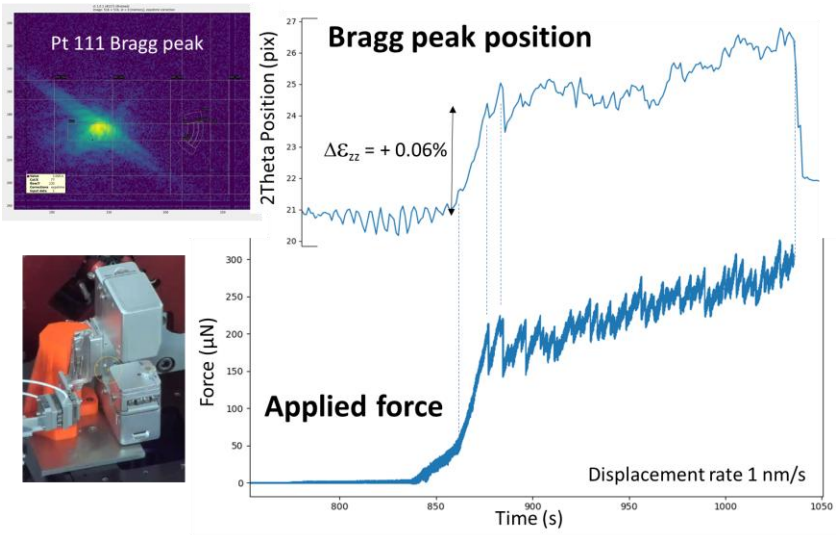
It is common knowledge that the physical and mechanical properties of small objects differ significantly from those of their large counterparts. The mechanical behavior of materials can be determined by their load-displacement curve that allows ranking materials with respect to their yield strength. A great deal of micro- and nano-mechanical tests, set in motion by Uchic et al. [1], were performed to evaluate the mechanical behavior of small-size objects. These experiments confirm the increase of the elastic limit as object size decreases, in other words: "Smaller is Stronger" [2]. The role of dislocation nucleation, multiplication and annihilation as well as the influence of atom diffusion on surfaces and the shape of the nanostructures are still being debated. In addition, because of the close proximity of surfaces, the energy and mobility of defects in individual nano-objects are borne to be very different from what they are in the bulk.

Nevertheless, in situ exploration of dislocation nucleation at the nanoscale remains elusive. We have chosen to use Coherent X-ray Diffraction Imaging in Bragg condition (BCDI) to study the onset of plasticity in nanoparticles. BCDI is highly sensitive to strain and defects making it the ideal technique to study the elastic and plastic response of a nanostructure during mechanical loading [3]. We successfully performed nano-indentation of single-crystalline Pt crystals combining the custom-built AFM "SFINX" and multi-wavelength BCDI [4] that bases on scanning the energy of the incident X-ray beam instead of rocking the sample which induces detrimental vibrations.

The next step will be the use of a nano-indenter from Femtotools to acquire the force-displacement curve during indentation while measuring BCDI. The first promising measurements taken in-situ at the ID01 beamline are presented in this poster.



[1] M.D. Uchic *et al*. Science 305 (2004) 986; [2] J. Greer *et al.* Acta Mat. 53 (2005) 1821, [3] I. Robinson, R. Harder, Nature Materials 8 (2009) 291; [4] S. Yehya *et al.* Nanoscale. 16 (2024) 20670;