Investigation of strain and defects in microcrystals using coherent x-ray diffraction

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The mechanical properties of small objects deviate strongly from the bulk behaviour, as soon as their size becomes comparable or smaller to the dislocation mean free path (typically a few microns). For instance, their elastic limit increases when their size is reduced. On the another hand, nanostructures are exposed to strong constraints, such as that imposed by epitaxial relations with a substrate. Altogether, there is a clear need (supported by industrial interests) for a better understanding of the fundamental phenomena that govern the mechanical properties of materials at the nanometre scale.

To this purpose, diffraction of coherent X-rays is very useful to study the structure of individual crystalline objects, as it captures the information about the exact displacement field of the atoms with respect to a perfect lattice: elastic strain as well as crystal defects (such as stacking faults and dislocations) induce strong distortions of the fine structure of the intensity distribution around a Bragg position.
I will show a couple of our recent experimental and simulated results to show what information we can obtain with this technique. In particular, while most groups invest a lot of effort in the reconstruction of a real space image of the crystal, we show that valuable information about the crystal structure can be deduced from the Bragg peak fine structure in reciprocal space. This approach becomes important when the sample cannot be rocked, preventing from a 3D measurement of the Bragg spot.

In order to perform *in situ* mechanical loading during synchrotron experiments, we have developed a compact Atomic Force Microscope that can be mounted on a diffractometer. Recent results will be shown.

References

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3. Ren Zhe *et al*, J. Synchrotron Rad. (2014), accepted.