"Coherent X-ray Diffraction for Materials Research in Nanoscience"

Ian K. Robinson

London Centre for Nanotechnology and Diamond Light Source

In nanoscience, the bulk concepts of lattices and crystal defects must give way to new paradigms that involve a bigger role of the surface. This explains why nanomaterials have new and exciting properties that are exploited in nanotechnologies. This talk will illustrate how coherent X-ray diffraction at a 3rd generation synchrotron source can be used to obtain quantitative three-dimensional maps of the deformation of a crystal from its equilibrium lattice spacing. To invert the diffraction, we have solved the crystallographic 'phase problem' by oversampling using a support-constrained HIO algorithm. We exampined a lead crystal [1], grown on a SiO_2 substrate, and found internal strain arising from its external contacts. Closer examination of the strain distribution, after an important correction for X-ray refraction, shows an expansion of the surface layers of the facetted hemispherical crystal shape over most of the surface of the crystal but suppressed on the (111) facet itself, indicating an orientational variation in surface stress.

[1] "Three-dimensional Mapping of a Deformation Field inside a Nanocrystal", Mark A. Pfeifer, Garth J. Williams, Ivan A. Vartanyants, Ross Harder and Ian K. Robinson, Nature 442 63-66 (2006)