Keynote Lectures

[KN3] Imaging nanoparticles using coherent diffraction

Ian Robinson

London Centre for Nanotechnology, University College London, London WC1E 6BT UK
Research Complex at Harwell, Didcot, Oxfordshire OX11 0DE, UK

This lecture will examine the physical reasons why nanoparticles differ in structure from the bulk. The reason is fundamentally crystallographic. Each unit cell with a crystal is stabilized by those around it; when cells are removed to create a surface, there is a structural response – in a metal this is an inward relaxation, detectable as strain. Where two surfaces meet along the edge of a crystal, the effect is enhanced. Nanocrystals are in a size range which is dominated by the surface and edge properties. This is visualized as the pattern of strain in the crystallographic structure of the particle. Certain simple properties of nanoparticles can be explained through these structural differences. We use a powerful method of measuring the three dimensional structure of nanocrystals, Coherent X-ray Diffraction, to study these effects. A key experiment will be discussed that uses this method to study the redistribution of strains on the surface of a Au nanocrystal [1]. This pattern in found to change upon application of pressure [2] or adsorption of a chemical layer. Some future perspectives concerning ulratfast imaging with free-electron laser sources [3] will be discussed in conclusion.

References:

[1] Differential stress induced by thiol adsorption on facetted nanocrystals, Moyu Watari, Rachel McKendry, Manuel Voegtli, Gabriel Aeppli, Yeong-Ah Soh, Xiaowen Shi, Gang Xiong, Xiaojing Huang, Ross Harder and Ian Robinson, Nature Materials 10 862-866 (2011)
[2] Coherent Diffraction Imaging of Nanoscale Strain Evolution in a Single Crystal under High Pressure Wenge Yang, Xiaojing Huang, Ross Harder, Jesse N. Clark, Ian K. Robinson and Ho-kwang Mao, Nature Communications (2013)
[3] Ultrafast three dimensional imaging of lattice dynamics in gold nanocrystals J. N. Clark, L. Beitra, G. Xiong, A. Higginbotham, D. M. Fritz, H. T. Lemke, D. Zhu, M. Chollet, G. J. Williams, M. Messerschmidt, B. Abbey, R. J. Harder, A. M. Korsunsky, J. S. Wark and I. K. Robinson, Science (2013)