"Coherent X-ray Diffraction Imaging of Excitations in Metal Nanoparticles"

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The physical reason why nanoparticles differ in structure from the bulk is fundamentally crystallographic. As with all surfaces, the missing-neighbour unit cells, which become removed to create a surface, cause a structural response. In a metal this is an inward relaxation, detectable as crystal strain. Where two surfaces meet along the edge of a crystal, the effect is enhanced. Nanocrystals are in precisely the size range which is dominated by these surface and edge properties. This results in a pattern of strain which follow the crystallographic structure of the particle. Certain simple properties of nanoparticles can be explained through these structural differences. Coherent X-ray Diffraction can be used to study these effects within the three dimensional structure of nanocrystals. A key experiment will be discussed that uses this method to study the redistribution of strains on the surface of a Au nanocrystal by adsorption of a chemical layer [1]. Ultrafast imaging with free-electron laser sources allows visualization of the strain patterns in vibrating crystals [2].

[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] 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 341 56 (2013)