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New Views of Materials Through Aberration-Corrected STEM

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Monday 25 February, 2008, 11.00 a.m. – 12 noon
Law Lecture Theatre L4, Bldg 12

Abstract

This talk will review our experiences with aberration-corrected STEM from the initial installation of a Nion 3rd order corrector on the 100 kV HB501UX in 2001 to the anticipated benefits of the 5th order corrected Nion UltraSTEM, which is due to be installed later this year. Improving resolution by more than a factor of two brings benefits far beyond just resolution. The smaller, sharper probe brings increased signal to noise ratio giving single atom sensitivity for both imaging and EELS. The increased aperture diameter results in a much decreased depth of field. Structural information can now be extracted in three dimensions by optical sectioning, with sub-Ångström lateral resolution and a depth resolution of a few nanometers. Furthermore, the bright field detector gives a simultaneous, aberration-corrected phase contrast image with high signal, giving complementary information to that in the Z-contrast image.

These benefits will be illustrated by several case studies in different areas of materials. In catalysis, single atom sensitivity in 3D enables a link to catalytic activity through density functional calculations. The high activity of nanophase gold clusters on titania can be quantitatively explained. In semiconductors, individual Hf atoms have been located within a $Si/SiO_2/HfO_2$ gate dielectric structure to a precision of 0.1 x 0.1 x 1 nm, and the perturbed electronic structure linked by density functional theory to macroscopic device properties. Column-by-column compositional mapping of InAsP quantum wires coupled to elasticity calculations explains their growth morphology and optical properties. In Si nanowires individual gold atoms have been imaged *inside* the wire in several substitutional and interstitial configurations, with number densities that are in order of calculated formation energies.

This research was sponsored by the Office of Basic Energy Sciences, Division of Materials Sciences and Engineering, US Department of Energy. Collaborations with M. F. Chisholm, M. Varela, A. R. Lupini, A. Y. Borisevich, W. Luo, S-H. Oh, D. Kumar, S. N. Rashkeev, P. Werner, N. D. Zakharov, S. Molina, S. H. Overbury, K. van Benthem, P. D. Nellist, O. L. Krivanek, N. Dellby, M. F. Murfitt, Z. S. Szilagyi, H. M. Christen, S. F. Findlay, L. J. Allen, T. Ben, D. L. Sales, J. Pizarro, P. L. Galindo, D. Fuster, Y. Gonzalez, L. Gonzalez, K. Sohlberg, A. Marinopoulos and S. T. Pantelides are gratefully acknowledged.

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Visitors are most welcome: Please note that there is a designated Visitors Car Park (N1) clearly ground-marked by white paint and tickets, at a cost of $1.4/hour for up to 3 hours, available from a dispensing machine. This high-rise carpark is located on the following Clayton Campus Map, Ref. B2.

Printable version of the Clayton campus map (pdf 833 kb) (Please right click to open link)