nanocrystalline nature. The results cast light on the nature of pressure amorphization, and provide a potential route for the synthesis of new nano-materials.

Keywords: amorphization under pressure, X-ray diffuse scattering, diamond anvil high-pressure apparatus

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HR-TEM imaging of the carbon networks

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Identification of individual C-C bonds is an ultimate goal of the carbon nanostructure characterization. We have been developping a high sensitivity transmission electron microscopy (TEM) which enables us to visualize a single C-C bond. A TEM equipped with an aberration corrector allows a higher spatial resolution without increasing its tension (the accelerating voltage). Then we have achieved the resolution of 0.14 nm, which corresponds to a typical C-C distance, at a moderate accelerating voltage (120kV). This merits a lot to realize the visualization of carbon atomic chain such as the alkyl chain without electron irradiation damage (1). Here we show some examples for atomic-level characterization of carbon nanostructures. The C_{60} fullerene molecule has been successfully identified its structure and orientation at a single-molecular basis (2). Also the active topological defects have been eventually caught red-handed (3). The technique can be widely applicable to visualize a biological activity, at an atomic level, for which any conformation change of the C-C bonds is responsible. The cis-/trans-isomerization of retinal molecules have been successfully visualized (4).

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Keywords: electron microscopy, carbon nanotube, defects

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Image contrast in atomic resolution high-angle annular dark-field images

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High-angle annular dark-field scanning transmission electron microscopy (HAADF or Z-contrast) is remarkably sensitive to the atomic number (Z). Quantitative HAADF imaging holds enormous potential for extracting chemical information in parallel with information on the atomic structure. To date, comparisons between experimental and theoretical HAADF images have been based on image contrast or scaling by an arbitrary amount. Such comparisons are only semi-quantitative and place severe limitations on identifying the origins of any contrast mismatch between experiments and simulations. In this presentation, we demonstrate that the HAADF detector can measure the incident beam intensity to normalize Z-contrast images onto an absolute intensity scale. We report on a practical approach that ensures that the detector is sufficiently linear over the intensity range of interest. Limitations of the current generation of HAADF detectors, such as scintillator heating and intensity saturation, will be discussed in the context of the probe intensity measurements. By normalizing the atomically resolved signal to the incident probe, we demonstrate quantified HAADF imaging of a $SrTiO_3$ single crystal as a function of sample thickness. Experimental images are compared with Bloch wave image simulations that incorporate thermal diffuse scattering. Provided that spatial incoherence in the probe is taken into account in the simulations, exellent agreement is found between simulation and experiment. The electron energy-loss spectroscopy (EELS) log-ratio method was used for determination of the local thickness. We will discuss how thickness determination by EELS can be combined with information from the HAADF background to provide improved estimates of the thickness.

Keywords: STEM, electron microscopy techniques, analytical electron microscopy

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In aberration corrected STEM, shrinking some dimensions expands others

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Crystallography is usually associated with coherent elastic scattering. Having atomically localised inelastic information, however, can allow the solving of crystal structures particularly when crystals are nanometres in size. A particular advantage of the STEM geometry is that inelastic signals, in particular electron energy loss spectroscopy (EELS), are localised and the high angle annular dark field image can be collected simultaneously with the spatially resolved spectroscopic information. Aberration correctors have improved the spatial resolution of EELS as well as significantly improving the signal-to-noise in both imaging and spectroscopy. Results on atomically resolved EELS data will be presented where light has been shed on a periodic structure. Necessarily the sample is only a few tens of nanometres thick in the beam direction but many structures are spatially of similar or smaller scale in one of the other dimensions as well. Systems that will be discussed include silicon/metal di-silicide interfaces and silicon nanowires. In addition to using these two dimensional projections of nanostructures, the three dimensional shape of nano-crystals is of crucial importance for heterogeneous catalysis. Conventional tomographic techniques are not expected to get down to the atomic scale. An alternative approach will be presented with data on the shape of gold nano-particles.

Keywords: aberration correction, HAADF, EELS

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Development of new electron diffraction microscope for diffractive imaging

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