Crystallographic and electronic structures of materials and their transformations are studied through direct imaging of atoms or molecules by high-resolution spectromicroscopy which realizes energy-filtered imaging and electron energy-loss spectroscopy as well as high resolution imaging. It aims to explore new methods for imaging and also obtaining chemical information in thin films, nano-clusters, interfaces, and even in solutions. By combining this with scanning probe microscopy, the following subjects are urgent: direct structure analysis, electron crystallographic analysis, epitaxial growth of molecules, structure formation in solutions, and fabrication of low-dimensional functional assemblies.

**Research Activities (Year 2009)**

**Publications**

**Presentations**
Effects of Electron Channeling on HAADF-STEM Intensity in La₄CuSnO₆

Atomic resolution imaging using the high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) can be applied to analyze atomic structures of materials directly. This technique provides incoherent Z-contrast usually with the atomic number of the constituent elements. In the present work, however, unique contrasts that make intuitively interpreting the HAADF-STEM image to be difficult were observed in double perovskite oxide La₄CuSnO₆. Multislice simulation confirmed that this occurred as an effect of the channeling process of electrons in combination with the effect of Debye–Waller factors. This was confirmed because in the La₄CuSnO₆ crystal, two independent Sn atoms and four independent La atoms in the unit cell had different Debye–Waller factors, and the La columns consisted of pairs of columns with a small separation, whereas the Sn atoms were arranged straight.

Furthermore, the image contrast was examined systematically by multislice simulation on virtual structures in which two atomic La columns in the unit cell were separated by certain distances in a projected plane. As a result, the HAADF intensity did not decrease constantly with the increase in column separation, with the exception of a very thin sample, which could be interpreted by the specific change in the electron-channeling process.

Photochemical Synthesis of Silver Particles in Tween 20/Water/Ionic Liquid Microemulsions

Metal particles of silver (Ag) were synthesized by the photoreduction of silver perchlorate (AgClO₄) in water-in-ionic liquid (ILs: [BMIm] [BF₄], [OMIm] [BF₄]) microemulsions consisting of Tween 20, water and ionic liquids. The time evolution of Ag particle formation by photoreduction using UV-irradiation was investigated by UV–Vis, cryo-TEM, extended X-ray absorption fine structure (EXAFS) and small angle X-ray scattering (SAXS) measurements. The average diameter of the metallic Ag particles prepared in the water-in-[BMIm][BF₄] and water-[OMIm][BF₄] microemulsions was estimated from TEM to be 8.9 and 4.9 nm, respectively, which was consistent with that obtained from the SAXS analysis. Using Guinier plots in a low q-range (<0.16 nm⁻¹), we demonstrated that the average diameter of the water droplets that consisted of aggregates of ionic precursors of AgClO₄ before reduction and Ag particles after reduction, in the microemulsions, was estimated to be about 20–40 nm. The diameter of the water droplets increased as a function of photoreduction time because of the formation of Ag particles and their aggregates.

Grants


Award