Imaging the Shapes of Nanocrystals using Coherent X-ray Diffraction

I. K. Robinson

University of Illinois, Urbana, USA

ABSTRACT

We use X-ray diffraction to examine materials that are crystalline on the nanometer length scale. When the latest synchrotron radiation sources are employed, the coherence of the beam can exceed the grain size in all three spatial dimensions. Because of the finite-size effect, we obtain a broadened diffraction pattern in the immediate vicinity of each of the Bragg reflections. A rocking series allows the diffraction to be recorded in three dimensions. The symmetric part of the diffraction is given by the Fourier transform of the crystal's shape, while the asymmetric part can be shown to be associated with strain. Iterative Fourier transform methods, such as Gerchberg-Saxton-Fienup, are found to be effective at revealing the shapes of the nanocrystals. The methods work because the phase problem in overdetermined, since the measurement is a continuous function of reciprocal space and therefore can be oversampled with respect to the spatial Nyquist frequency. It is expected that an extension of the experimental and computational methods can be applied to reveal the internal strain fields as a fully three-dimensional spatial image.