Experimental Study of Correlated Fluctuation SAXS in Single Particle Imaging

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XFELs provide a unique opportunity to develop single-molecule-based imaging methods, because ultrafast pulses can minimise radiation damage of illuminated molecules. Although the FEL pulses are very brilliant, single-molecule diffraction imaging still suffers from extremely weak diffraction signals that cannot beat detector noise. On the other hand, the sample delivery of single molecules is also practically challenging. A promising solution is to collect diffraction from multiple molecules at one time to increase the signal-to-noise ratio for the measurements. An idea was developed to make use of angular fluctuation of diffraction intensity from snapshot diffraction patterns, and to extract single-molecule information [1]. This idea in 2D has been experimentally realised [2,3]. A 3D version method was proposed [4], and we aim to demonstrate it using synchrotron light source.

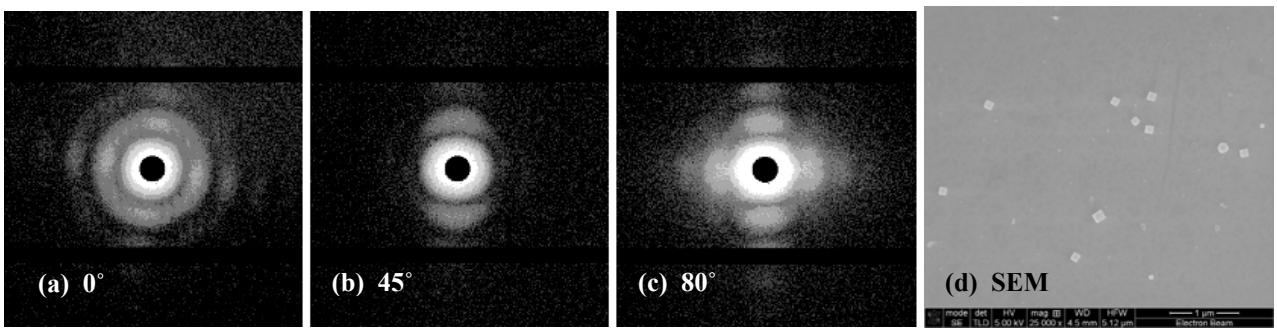

Figure 1: Experimental diffraction patterns of Pd cubes deposited on Si_3N_4 flat windows. X-ray beam incidence relative to normal of sample plane varies from 0 to 80 degrees: (a)-(c). Thick and black horizontal lines result from dark pixels of the detector. The SEM image (d) shows part of a sample window prepared by electrospray of suspending solution of ~50 nm Pd cubes. The cubes are oriented on the normal axis, and randomly oriented and distributed on sample plane.

The key of the method is to use flat sample windows to orient particles at one dimension along the normal while random on other dimensions, and to measure diffraction patterns at different angles between beam axis and the normal. Our test object is 3D Pd nano cubes, and use small angle scattering setup at PETRAIII beamline P10. The photon energy is 8 keV. The nano particles are randomly oriented on sample window (see Fig. 1d), and the SAXS-like pattern in Fig. 1a (at normal beam incidence) shows intensity fluctuations. Different measuring angles reveal information at different pairs of points in reciprocal space (Fig. 1a-c). We collected a complete data set of good quality from samples at tilt angles ranging from 0 to 80 degrees. Angular correlations on the SAXS ring at different q ranges in the patterns is used for the reconstruction of single cube [3]. The data analysis is in progress.

References

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