Type of presentation: Invited

IT-11-IN-1935 Atomic Resolution Electron Diffractive Imaging and 3D

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Electron diffractive imaging promises sub-angstrom resolution imaging in 3D. Key to electron diffraction imaging is coherent electron diffraction using a parallel beam for selected area diffraction. Lateral coherent length as large as ~500 nm in FEG TEM has been reported [1].
The principle of phase retrieval is based on finding solutions based on a set of constraints. One of the constraints is the object support. The phase retrieval is carried out iteratively. For electron diffractive imaging, use of phases recorded in electron images at the beginning of iteration helps with a number of experimental issues[2]. Sub-Å resolution imaging has been demonstrated for a number of materials, including carbon nanotubes[3], CdS[2], CeO2 [4], Si [5] and TiO2 [6]. Accurate phase retrieval at nm resolution was recently demonstrated by Yamasaki et al [9]. Electron diffractive imaging can also be easily extended to medium and low energy electrons [7, 8]. Dronyak and his co-workers experimentally determined the morphology of a single MgO nanocrystal using the measure 3D Bragg diffraction peak [10]. 3D reconstruction resolving atoms was reported by Chen et al. [12] using experimental STEM image data [13].
Here we report a new method of 3D reconstruction using Fienup's hybrid input-output (HIO) algorithm. Electron diffraction patterns are centered in 3D reciprocal space in a single axis tilt series. For the 3D sample data, the computational cost increase dramatically in order to achieve higher resolution result. We overcome this challenge by GPU-acceleration. Simulation.3D structure of Au icosahedron is reconstructed from calculated diffraction patterns including missing angles and noise in order to test the algorithm performance. Experimental implementation and its challenge will be discussed.

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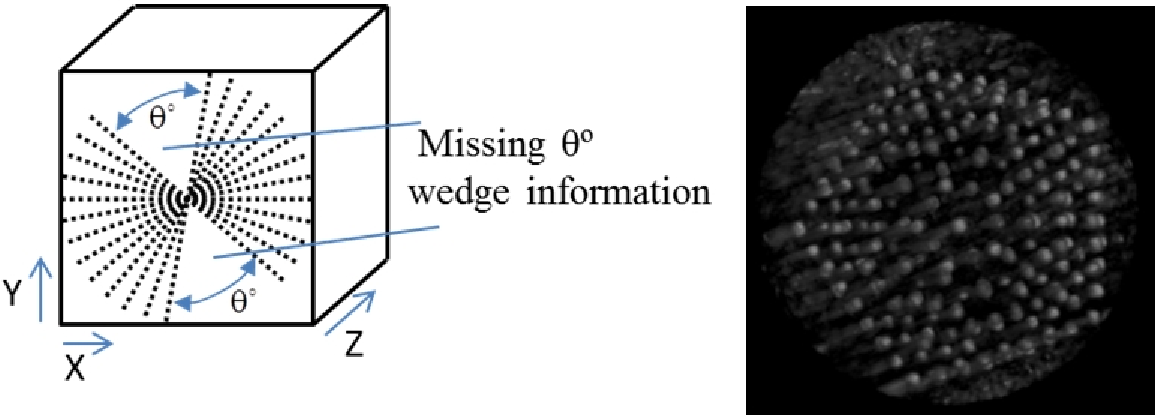

Fig. 1: Figure 1, left, a schematic illustration of sampling in reciprocal space as used in a single axis tilt series of electron diffraction patterns. Right, reconstructed 3D image using GPU accelerated HIO algorithm from simulated diffraction patterns of an icosahedron nanoparticle with 1.2 Å information limit and 25º missing wedge and simulated noise.