Coherent diffraction imaging using Crystal Truncation Rods

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We have used crystal truncation rod (CTR) ptychography at Diamond's I13-1 beamline to obtain spatial images of the height distribution crystalline interfaces. The method was first published by Hoydoo You's group at Argonne's MSD [C. Zhu et al. Applied Physics Letters 106 101604 (2015)]. After several years of development, in-line ptychography is now running very reliably at I-13. Bragg diffraction, and the corresponding momentum transfer, is needed to see strains at interfaces, such as caused by dislocations. CTRs probe the surface/interface morphology. To adapt the standard ptychography method to the Bragg case, we use an exactly horizontal fixed-angle 30-degree scattering geometry, making use of I-13's capability to change the beam energy with a single macro to select the Bragg condition. For data analysis using the standard ptychography code, two changes are required, a horizontal flipping of the data to account for the reflection and a 1/sin(15) stretch of the horizontal image to view the structure in the coordinate frame of the sample face. Importantly, all the expertise of the ptychographic reconstruction, such as probe simulation, probe position correction, multi-mode energy bandwidth (longitudinal coherence) compensation remain available in the Bragg mode. We have used the method to image the interface between thin MBE-grown films and $SrTiO_3$ substrates. The images from the thin films show linear structures consistent with misfit dislocations at the interface.