Type of presentation: Poster

IT-9-P-2930 Quantitative CBED in a Nano-structured Material

Nakashima P. H.[1], Bourgeois L.[1,2], Etheridge J.[1,2]

[1]Department of Materials Engineering, Monash University, 3800 Victoria Australia, [2]Monash Centre for Electron Microscopy, Monash University, 3800 Victoria, Australia

Email of the presenting author: philip.nakashima@monash.edu

When rapidly quenched to room temperature from just below its melting point, aluminium can form octahedral voids of a few tens of nanometres in size, truncated with {001} facets. For convergent beam electron diffraction (CBED), this presents an interesting scenario that can be thought of as a “CBED sandwich”. For a focussed electron probe incident on a {001} void facet, the resultant CBED pattern is the product of diffraction from two totally coherent slabs of crystal, oriented along <001>, each slab sandwiching the free space in the void. Such a CBED pattern is not only sensitive to the thicknesses of the two slabs but also their separation across the void because the electron waves modified by the first slab of crystal then Fresnel propagate as they traverse the void.

In addition to highly constrained measurements of the thickness of the specimen, the dimension of the void in the beam direction and its position with respect to the entrance and exit faces of the specimen, quantitative CBED is used here to measure bonding-sensitive structure factors on either side of the void.

To investigate the sensitivity of the bonding electron density to the nanoscale geometry and size of these structures, we compare these results with recent work [1] where the same structure factors were measured with sufficient accuracy and precision as to be able to unequivocally determine the bonding electron density in aluminium. Our work takes advantage of the multislice formalism for electron scattering [2], which is conducive to the geometry of the “CBED sandwich” that a void in a metallic foil presents.

References:

[1] P.N.H. Nakashima, A.E. Smith, J. Etheridge, B.C. Muddle, Science 331 (2011), 1583.

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Acknowledgement: The data collected for this work was obtained using the JEOL 2011 TEM in the Monash Centre for Electron Microscopy, funded by the ARC (RIEFP 99). PN thanks the ARC for grant FT110100427.