Measuring vacancy concentrations, chemical bonding and lattice contraction around nanovoids in aluminium by QCBED

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Keywords: Quantitative CBED, Chemical Bonding, Nanostructures, Crystal Defects

A multislice approach [1] to quantitative convergent-beam electron diffraction (QCBED) has been developed to permit the measurement of chemical bonding-sensitive structure factors local to nanostructures embedded within inhomogeneous, multi-phased nano-structured materials.

We apply this method to investigating vacancy concentrations, crystal lattice contraction and chemical bonding around a nanovoid in 99.9999+% pure aluminium (see Fig. 1 for an illustration of CBED through a nanovoid in aluminium). We are not only able to experimentally measure structure factors around these nanovoids with sufficient precision to resolve chemical bonding information, but in the process of doing so, can also measure vacancy concentrations around the nanovoids and the associated degree of contraction by the aluminium host lattice as a function of vacancy concentration. The latter results match DFT modelling of lattice contraction versus vacancy concentration.

Figure 1. CBED through a void and the neighbouring matrix in aluminium. (a) An image of the region under investigation showing the nanovoid at location A and uninterrupted matrix at B. (b) A schematic of the electron beam passing through overlapping parallel facets of the nanovoid at A and through uninterrupted matrix at B. (c) The resulting CBED pattern from A through the nanovoid. (d) The CBED pattern from the uninterrupted volume of matrix at B. Note that both patterns have 4mm symmetry but have very different intensity distributions.


The authors acknowledge the use of the instruments and scientific and technical assistance at the Monash Centre for Electron Microscopy, a Node of Microscopy Australia, and The Frederick Seitz Materials Research Laboratory at the University of Illinois at Urbana-Champaign. This work was funded by the Australian Research Council (FT110100427 & DP210100308).