Type of presentation: Oral

IT-2-O-3488 Linking Thickness, Channelling and Secondary X-ray signals in Atomic Resolution Scanning Transmission Electron Microscopy

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Quantification of EDX signals at atomic resolution can be treated by separation into two components; the scattering of electrons prior to ionisation and the subtleties of X-ray generation, emission and collection. Significant progress has recently been made concerning the first of these factors, with Forbes[1] showing that consideration of both elastic and thermal scattering is required to explain anomalous contrast variations. However, true quantification requires a similarly detailed approach to the X-ray side of the system, with proportionality between signal and composition dependent on a multitude of factors including scattering cross-section, X-ray Fluorescence yield, Adsorption and detector geometry. Kotula has demonstrated a reference based approach[2], scaling signals to averages from areas of known chemistry and Kothleitner recently showed the use of a ‘non-channelling’ (off-axis) approach to scale signals for quantification[3]. Both of these approaches offer a potential solution, but one of the main limitations is a lack of experimental data linking thickness, channelling and collected signal for a known specimen and well characterised instrument.

Results will be presented of a systematic study between thickness and EDX signal for known crystal structures and compositions. These will be matched with image simulation taking into account elastic and thermal scattering. The results presentenced will be carried out using a dual aberration corrected FEI Titan[3], with well-defined probe illumination conditions, fitted with a standard 30mm^2 ultra-thin window Si(Li) detector (0.13 sr) and a new 60mm^2 windowless SSD detector (0.3 sr). Thickness will measured by position averaged convergent beam electron diffraction (PACBED), with EDX spectra acquired scanning over the same specimen area. Results will be presented from several specimens including Strontium titanate, GaAs/InGaAs radial nanowire heterostructures and Al-Cu alloys. By recording data from multiple areas with different thicknesses, trends between thickness, X-ray signal and channelling condition and its implications for quantitative high resolution EDX will be explored.

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2. P. G. Kotula, D. O. Klenov and H. S. von Harrach, M&M 18(4), 2012
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Acknowledgement: The Australian research council is acknowledged for financial support through grants DP130102538 and LE0454166 (FEI Titan[3]).