NUS National University of Singapore

Department of **Materials Science & Engineering** seminar

Presents

Extracting Reliable and Quantitative Information from the STEM

by Dr Lewys Jones

Date: 05 March 2019 (Tuesday)
Time: 10.30am – 11.30am
Venue: E1-06-03

Abstract

As an instrument, the scanning transmission electron microscope is unique in being able to simultaneously explore both local structural and chemical variations in materials at the atomic scale. This is made possible as both types of data are acquired serially, originating simultaneously from sample interactions with a sharply focused electron probe. Quantitative annular dark-field in the scanning transmission electron microscope (ADF STEM), where image intensities are used to provide composition and thickness measurements, has enjoyed a renaissance during the last decade. Now in a post aberration-correction era many aspects of the technique are being revisited. Unfortunately, such scanned data can be distorted by environmental factors, though recently fast-scanned multi-frame imaging approaches have been shown to mitigate these effects. Many microscopic investigations of materials may benefit from the recording of multiple successive images. This can include techniques common to several types of microscopy such as frame averaging to improve signal-to-noise ratios (SNR) or time series to study dynamic processes or more specific applications. In the scanning transmission electron microscope, this might include focal series for optical sectioning or aberration measurement, beam damage studies or camera-length series to study the effects of strain; whilst in the scanning tunnelling microscope, this might include bias-voltage series to probe local electronic structure. Whatever the application, such investigations must begin with the careful alignment of these data stacks, an operation that is not always trivial. In addition, the presence of low-frequency scanning distortions can introduce intra-image shifts to the data.

In this seminar, the recent progress and emerging best-practice for aberration corrected quantitative ADF STEM will be discussed including issues relating to proper acquisition of experimental data and its calibration, approaches for data analysis, the utility of such data, its interpretation and limitations. For multi-frame imaging and spectroscopic data, an improved automated method of performing non-rigid registration customised for the challenges unique to scanned microscope data will be discussed. We will discuss some perspectives on the new potential of multi-frame spectrum-imaging (MFSI) and show how dose-sharing approaches can reduce sample damage, improve crystallographic fidelity, increase data signal-to-noise, or maximize usable field of view.

Speaker

After a first degree in Material Science, Lewys received his PhD from the Department of Materials at the University of Oxford in 2013. This focussed on two themes; scanning stability in the aberration-corrected scanning transmission electron microscope (AC-STEM) and also on applications of focal series of annular dark-field data. After working as a post-doc at the David Cockayne Centre for Electron Microscopy, Lewys moved to Trinity College Dublin to found the Ultramicroscopy Group as the new Ussher Assistant Professor in Ultramicroscopy. Lewys has authored around 100 articles and proceedings with more than 800 combined citations, and has launched two commercial software plug-ins for Digital Micrograph in collaboration with HREM Research. Lewys is a co-director of the SFI-EPSRC Centre for Doctoral Training in Advanced Characterisation, an Associate Editor of the journal Advanced Structural and Chemical Imaging, and has been a Fellow of the Royal Microscopical Society since 2015.

ALL ARE WELCOME!

Host: A/Prof Michel Bosman