Implementing Compressive Sensing, Inpainting and Artificial Intelligence in Scanning Transmission Electron Microscopy

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Images and spectra from aberration corrected STEMs are now used routinely to observe and quantify the atomic scale structure, composition, chemistry, bonding, electron/phonon distribution and optical properties of nanostructures, interfaces and defects in many materials systems. However, obtaining quantitative and reproducible atomic resolution observations for some materials is actually harder with these advanced capabilities, as the increase in beam current with correctors also brings with it the potential for electron beam modification of the specimen during image acquisition. The aim in developing and applying new methods in STEM is therefore now to focus on more efficient use of the dose that is supplied to the sample and to extract the most information from each image (or set of images) – reducing the beam effect and broadening microscopy applications to a wider range of samples and processes. In this presentation, the basic approach behind advanced sampling strategies and their application to beam sensitive materials will be described. Results showing the use of *in-situ* liquid and gas stages to study nanoscale dynamic processes will be presented and the potential insights gained by increasing the image acquisition speed and/or decreasing the electron dose in future will also be discussed.

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Professor Nigel Browning is currently the Chair of Electron Microscopy in the Schools of Engineering and Physical Sciences and is the Director of the Albert Crewe Centre for Electron Microscopy at the University of Liverpool (since 2017). He has over 30 years of experience in the development of new methods in electron microscopy for high spatial, temporal and spectroscopic resolution analysis of engineering and biological structures. He is a Fellow of the American Association for the Advancement of Science (AAAS) and the Microscopy Society of America (MSA). He received the Burton Award from the Microscopy Society of America in 2002 and the Coble Award from the American Ceramic Society in 2003 for the development of atomic resolution methods in scanning transmission electron microscopy (STEM). With his collaborators at LLNL he also received R&D 100 and Nano 50 Awards in 2008, and a Microscopy Today Innovation Award in 2010 for the development of the dynamic transmission electron microscope (DTEM). He has over 400 publications and has given over 300 invited presentations on the development and application of advanced TEM methods.