Coherent X-ray Diffraction Imaging (CXDI) for the Study of Nano-scale Materials and Devices

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Currently, there is a vibrant research effort for utilising the unique properties of low-dimensional self-assembled nano-scale structures to form high performance materials and devices. Nanocrystals of metals and both III-V & II-VI compound semiconductors are readily synthesised using techniques ranging from chemical vapour transport to molecular beam epitaxy. Materials such as C, Au, Ag, InSnO, GaN, ZnS, ZnO, CdS, CdSe, and CdTe have been used to grow nanowires, nanorods, nanoribbons, and nanoscale branched structures. These building blocks are likely to form the basis of many novel materials and devices of the future. Nano-materials have found use in applications ranging from thin film transistors, photovoltaic devices and light emitting devices to drug delivery systems.

Nano-scale structures can be highly strained because of confinement effects and the strong influence of their external boundaries. This often results in dramatically different electronic, magnetic and optical material properties of considerable utility. Coherent X-ray Diffraction Imaging (CXDI) has emerged as a non-destructive tool for three-dimensional imaging of strain and defects in nano-scale crystals. In this method, the phase and morphological structure is reconstructed using iterative computational techniques. This is achieved by inverting Coherent X-ray Diffraction measurements to obtain real-space images of the nano-scale crystals. To date, support-based methods have worked well, but are less successful for *highly strained* structures, defined as those which contain (real-space) phase information outside the range of $\pm\pi/2$.

Dr. Newton is at the forefront of research into nano-scale materials and devices based on II-VI compound semiconductors. In this seminar, he will present recent theoretical and experimental research into the use of Coherent X-ray Imaging for the study of novel nano-scale materials. This will begin with a review of his recent work on in-situ plasma assisted synthesis of nanoscale materials followed by his work on CXDI for studying strain in nano-crystals. Finally he will review the new approaches to the phase retrieval problem (encountered in CXDI) that he has developed which have allowed for phase reconstruction of *highly strained* structures for the first time.

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