MONASH University

# MONASH CENTRE FOR ELECTRON MICROSCOPY

## Warwick Monash Alliance: Dual Seminar

**Date:** Tuesday, 10th December 2024
**Time:** 11:00 – 12:00PM
**Venue:** Theatre S10,
16 Rainforest Walk, Monash Clayton Campus

**Craig I. Hiley,**

*Department of Chemistry, University of Warwick, Coventry, CV4 7AL, United Kingdom*

### Topic 1: Hydrothermal and Solvothermal Synthesis of Functional Materials

### Abstract

Solvothermal (or hydrothermal, when water is used as a solvent) synthesis is a preparation method that utilises a solvent heated close to or above its boiling point in a sealed vessel, resulting in a large autogenous pressure. This extremely adaptable method allows for the synthesis of a wide range of materials, thanks to the low temperatures employed (relative to traditional solid-state synthesis) and the high degree of chemical control.[1] I will demonstrate how the technique can be used to prepare novel oxides and fluoride materials, as well as recent work in making a wide range of halide perovskite materials for filling into single walled carbon nanotubes, and tin sulfide with a novel topology.

[1]Hiley, C. I.; Walton, R. I. *CrystEngComm* 2016, **18**, 7656-7670.

### Biography

Craig Hiley completed his MChem degree at the University of Warwick in 2010, with a final year research project on hydrothermal synthesis of ruthenium oxides in the Walton Group. He remained in the Walton group to undertake a PhD on synthesis and characterisation of a range of oxide materials with catalytic applications, in collaboration with Johnson Matthey.
After completion of his PhD, in 2015 Craig moved to the group of Professor Matthew Rosseinsky FRS, at the University of Liverpool, where he worked on the synthesis and structural analysis of alkali-metal intercalation in polycyclic aromatic hydrocarbon superconducting materialss. Between 2018 and 2022 Craig worked at the University of Leicester on non-invasive energy-dispersive X-ray diffraction of cultural heritage objects. In October 2022, Craig returned to the University of Warwick to work on the solution synthesis and characterisation of fluoride perovskite and perovskite-related materials.

**Convener**: Professor Laure Bourgeois
Email: mcem@monash.edu Tel: 9905 5563

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## Warwick Monash Alliance: Dual Seminar

**Jeremy Sloan,**

*Department of Physics, University of Warwick, Coventry, CV4 7AL, United Kingdom*

### Topic 2: Picoscale magnetic halide double perovskites inside SWCNTs: high crystallinity and dominant microstructure observed

### Abstract

Modern applications of perovskites often require them to be made on a quantum scale with colloidal, 2D, quantum dot, and, in thin films, molecular-scale preparations being developed, fine tuning optical band gaps and other properties. In Warwick[2] and, in complementary research in Berkeley in the US,[3] we have made unit-cell and sub-unit cell halide perovskites by growing them inside carbon nanotubes. This has enabled the growth of single-unit (and sub-unit cell) cell wide $CsPbX_3$ (X = Br, I) and $CsSnI_3$. Even on this small scale, these materials reproduce many of the same structural characteristics that we commonly associate with the bulk materials but also with some eye-catching differences. In my talk, I will describe the application of high-performance electron microscopy to the imaging of these fascinating new materials in Warwick, SuperSTEM and Berkeley but will also introduce their extended chemistry to include double halide perovskites and magnetic halide perovskite derivatives.[4]

[2]Kashtiban, R. J.; Patrick, C. E.; Ramasse, Q.; Walton, R. I.; Sloan, J. *Adv. Mater.* 2023, **35**, 2208575.

[3] Gao, M.; Park, Y.; Jin, J.; Chen, P-C.; Devyldere, H.; Yang, Y.; Song, C.; Lin, Z.; Zhao, Q.; Siron, M.; Scott, M. C.; Limmer, D. T.; Yang, P. *J. Am. Chem. Soc.* 2023, **145**, 4800.

[4]Hiley, C.; Mangat, J.; Bal, K.; Walton, R. I.; Sloan, J. (et al), to be submitted.

### Biography

Jeremy completed his PhD in Materials in 1995 in the School of Engineering at the University of Wales, Cardiff under Prof. Richard J. D. Tilley FRSC. He then joined the Inorganic Chemistry Laboratory at the University of Oxford in 1995 as a PDRA, initially working with Prof. Malcolm L. H. Green FRS, and during this time discovered integral 2 x 2 and 3 x 3 atomic layer KI ‘Feynman Crystals’, aka 'Extreme Nanowires', and 1D polyhedral chains of lanthanide, barium, cobalt and other halides grown in single walled nanotubes. In 2000 he was awarded a Royal Society University Research Fellowship and in 2004 received the FEI European Microscopy Award at the ICEM in Antwerp. After a Senior Lectureship at the University of Surrey and a Readership at QMUL, Jeremy moved to the University of Warwick where he is now Reader in Electron Microscopy. Subsequently in 2018 he was awarded an EPSRC Established Career Fellowship to further research the crystallography and functional evolution of atomically thin confined nanowires formed in carbon nanotubes. In 2023, he authored an article in Advanced Materials describing the formation of single unit cell wide halide perovskites inside carbon nanotubes for the first time, published almost simultaneously with an article by Peidong Yang’s group in Berkeley which appeared in JACS describing similar crystal growth.