Bath Monash Global PhD Programme in Sustainable & Circular Technologies

Project Title:	Magnetic Ionic Liquids for Electrodeposition of Materials for Sustainable Energy Applications
Supervisors at Bath: Supervisors at Monash:	Dr Sara Dale, Dr David Liptrot Dr Jie Zhang, Em Prof Alan Bond
Home Institution (Bath):	
Indicative period at Host Institution (Monash):	12 months

Project Summary (to include a brief description of the relevance to sustainable & circular technologies)

Graphene, one of the first 2-dimensional materials, was first synthesised using sticky tape in a completely inefficient manner. This method, however, did allow exploration of 2D materials and heralded an explosion in interesting chemistry developed because of the unique nature of these systems. Since then, scientists have developed a swathe of new techniques to make 2D materials without having to open the stationery drawer, one of which is electrochemical deposition. This project will use a bottom-up method to make 2D materials and, using soft templating through the interaction of magnetic fields with magnetic ionic liquids, allow exquisite control over their morphologies and formation of binder-free 2D materials on a conductive substrate.

Ionic liquids are molten salts which are liquid at room temperature consisting of purely anions and cations and were originally developed as green solvents/electrolytes. Magnetic ionic liquids contain a paramagnetic ion meaning the properties of that ion are influenced by the application of a magnetic field. This project brings together synthetic chemistry and electrochemistry to offer new insights into magnetic ionic liquids. Currently, there are very few magnetic ionic liquids commercially available, and the first part of this project will be to synthesise a range of magnetic ionic liquids which have varying degrees of susceptibility to a magnetic field. These ionic liquids will then have their electrochemical properties characterised through both standard (incl. cyclic voltammetry, electrochemical impedance spectroscopy etc.) and more sophisticated (such as Fourier transformed ac voltammetry available at Monash University) electrochemical techniques as well as atomic force microscopy (AFM) of the electrochemical double layer ions. Imaging the double layer with AFM will, for the first time, characterise the fundamental electrochemical properties of these liquids under a magnetic field.

Once the basic properties of the ionic liquids have been characterised, they will be used as solvents for the electrodeposition of 2D materials. 2D materials have a wide variety of properties and have been shown to be good catalysts for hydrogen evolution and CO_2 conversion. Here the magnetic ionic liquid under an applied magnetic field, will act to control the morphology and exposed crystal facets of the 2D material electrodeposits and research will be carried out to optimise the structure of deposits for hydrogen evolution and CO_2 conversion.

Features of the programme

- PhD researchers will be registered at both institutions and will be awarded a joint PhD degree.
- PhD researchers will be jointly supervised by academics from both Monash and Bath Universities.
- All PhD researchers in the joint programme will also undertake a bespoke advanced training plan covering a range of topics focusing on sustainability.
- Applicants can apply to either Monash University or the University of Bath as their nominated home institution.
- PhD researchers will undertake a period of no less than 12 months at the partner institution.
- Up to four scholarships/studentships will be offered. Additional and suitably qualified applicants who can access a scholarship/studentship from other sources will be also considered. Evidence of funding must be provided.
- The scholarships/studentships include:
  - a full tuition fee sponsorship provided by Monash or Bath for the course duration (up to a maximum 42 months). Note, however, that studentships for Bath-based projects will provide cover for UK/EU tuition fees ONLY.
  - a living allowance (stipend) provided by Monash or Bath Universities.

Note: Overseas Student Health Cover (OSHC) must be paid by the student, unless covered by the university.

How to apply

You MUST express interest for three projects in order of preference. Please submit your application at the Home institution of your preferred project ('Home' institution details can be found in the project summary). However, please note that you are applying for a joint PhD programme and applications will be processed as such.

The deadline to submit applications is 30th January 2023

Monash University

Expressions of interest (EoI) can be lodged through https://www.monash.edu/science/bath-monash-program. The EoI should provide the following information:

CV including details of citizenship, your Official Academic Transcripts, key to grades/grading scale of your transcripts, evidence of English language proficiency (IELTS or TOEFL, for full requirements see: https://www.monash.edu/graduate-research/faqs-and-resources/content/chapter-two/2-2), and two referees and contact details (optional). You must provide a link to these documents in Section 8 using Google Drive (Instructions in Section 8).

University of Bath

Please submit your application through the following link: https://www.csct.ac.uk/bath-monash-global-phd-programme/

Please make sure to mention in the "finance" section of your application that you are applying for funding through the joint Bath/Monash PhD programme for your specified projects.

In the "research interests" section of your application, please name the three projects you are interested in and rank them in order of preference. Please also include the names of the Bath lead supervisors.