Centre for **Sustainable & Circular** Technologies

MONASH University

UNIVERSITY OF BATH

Bath Monash Global PhD Programme in Sustainable Chemical Technologies

Project Title:	Novel nanoporous composites for sustainable energy applications
Supervisors at Bath:	Prof Tim Mays (lead), Prof Andy Burrows, Prof Chris Bowen
Supervisor at Monash:	Dr Parama Banerjee
Home Institution:	University of Bath
Indicative Period at Host Institution:	2.5 years at Bath; 12 months at Monash with exact dates to be confirmed

Project Summary

Mays, Burrows and Bowen have collaborated on successful, multi-disciplinary research projects at Bath to develop nanoporous composites comprising polymer matrices (e. g., polymers of intrinsic microporosity) that contain high surface area particulate fillers, such as metal-organic frameworks and activated carbons. The original idea was to develop high-surface area, formable monoliths for hydrogen storage in sustainable energy applications, such as low-carbon fuel cell vehicles, which are easier and safer to handle than powered or granular materials. The work produced robust composite films with high storage capacities.

Recent, proof-of-concept results from an MRes project in the Centre for Doctoral Training in Sustainable Chemical Technologies (supervised by Mays, Burrows and Bowen) used more sophisticated forming methods, including freeze casting and additive manufacturing, to produce new and interesting shapes (such as cylinders ~cm in diameter and a few cm long) which retained high surface areas. We would like to follow up this exciting development in this PhD project by refining and scaling up the forming methods and covering a wider range of matrices and fillers. Via a new collaboration with Banerjee at Monash, we would also like to explore the electrochemical properties of these nanoporous monoliths.

The proposed project, which is an ideal fit to the remit of CSCT, would have the following structure:

Months 1-12: 12 months research at Bath to further develop the composition and forming of the high surface area, nanoporous monoliths. The target application will be hydrogen storage.

Months 13-30: 18 months research at Monash to characterise the electrochemical properties of the monoliths for potential use as electrodes in batteries and supercapacitors for sustainable energy storage. Some early testing will be carried out on samples sent from Bath.

Months 31-42: 12 months research at Bath to study scale-up processing of the monoliths and proof-of concept design for selected sustainable energy applications.

The strong, sustained and relevant publication, dissemination and supervision track records of the research team members bode well for significant project outputs. These will range from fundamental science studies, e. g., analysis of interfaces in the composites, to engineering design. There will also be many skills training opportunities for the PhD student at both institutions. If the project is funded, industrial partners will be approached in the UK and Australia to be involved in the research and advise on future directions.

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 23rd February 2020

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.