

Bath Monash Global PhD Programme in Sustainable Chemical Technologies

Project Title:	Catalyst Reincarnation: Post-polymerization Functionality of Ring-opening Polymerisation Catalysts as Bioactive Additives in Biomedical Materials
Supervisors at Bath:	Professor Matthew Davidson (lead) and Professor Janet Scott
Supervisors at Monash:	Professor Phil Andrews and Professor Laurence Meagher
Home Institution:	University of Bath
Indicative period at Host Institution:	From January 2021 to December 2021

Project Summary

Poly(lactide acid) (PLA) and poly(lactic-co-glycolic acid) (PLGA) are biocompatible and resorbable polymers widely used in biomedical and therapeutic applications. They are prepared via ring-opening polymerisation (ROP) of lactide (LA) and glycolide (GA) monomers using metal-based catalysts that must subsequently be removed prior to use. We propose to design bismuth-based catalyst systems for the controlled ROP of LA and GA and, rather than removing the catalyst from the final polymer, we will investigate the bismuth-mediated bioactivity (e.g., antimicrobial) of these materials. In effect, a Bi-based catalyst system will be reincarnated as Bi-based functional additives for the material in use. Having established the principle of bismuth catalyst reincarnation, and evaluated the bioactivity in use, we will target specific applications (e.g., biocompatible antimicrobial coatings) through control of polymer architecture and composition. For example, tuning material hydrophilicity, porosity and swelling could be achieved through 'growing' PL(G)A from oxidised cellulose surfaces.

The target bismuth catalysts will be defined from preliminary studies on complexes which have been shown to exhibit antibacterial activity (alpha-hydroxy carboxylates, hydroxamates, sulfonates and phosphinates) towards critical multi-drug resistant bacteria and which are also labile enough to initiate polymerisation. These complexes are also able to be introduced as additives if higher Bi loadings are required to achieve sufficient bacteriostatic activity. Bio-assays will involve toxicity of the catalysts towards a range of pathogenic bacteria as well as mammalian cells (COS-7 and human fibroblast cells) while the polymer films will be studied for their ability to inhibit biofilms and their surface bacteriostatic activity. Bismuth content and elution rates will be studied with ICP-MS, polymer profiles will be examined by SEM/TEM and EDX.

The project will develop skills in synthesis and characterisation of bismuth compounds, bio-based polymer synthesis and biological testing of materials. Initial work to develop selective and active bismuth catalysts for (co)polymerisations will be carried out in Bath (Year 1). Materials will then be tested and further developed in Monash (Year 2). Further design, synthesis, characterisation and testing of appropriate materials targeted for specific applications (Year 3) will be carried out in Bath and Monash as appropriate.

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:
 - The scholarships/studentships include:
 - *a full tuition fee sponsorship* provided by Bath (home or EU students only) or Monash for the course duration (up to a maximum 42 months)
 - *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.

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How to apply

Please express interest for up to three projects in order of preference. Please submit your application at the Home institution of your preferred project. 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 Sunday 12 May.

Monash University

Expressions of interest (Eoi) can be lodged through <https://forms.gle/XkC1TKpqVQh4B4N1A>. The Eoi should provide the following information:

CV including details of citizenship, full transcripts of academic records, evidence of English language level (IELTS or TOEFL), nominate your host institution (ie Bath or Monash), two referees and contact details, indication of which projects are of interest.

University of Bath

Please submit an application through the following link:

https://samis.bath.ac.uk/urd/sits.urd/run/siw_ipp_lgn.login?process=siw_ipp_app&code1=RDUCH-MO01&code2=0001

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 up to three projects you are interested in and rank them in order of preference. Please also include the names of the Bath lead supervisors.