Centre for **Sustainable** Chemical Technologies

MONASH University

UNIVERSITY OF BATH

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: Supervisors at Monash:	Professor Matthew Davidson (lead) and Professor Janet Scott 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.