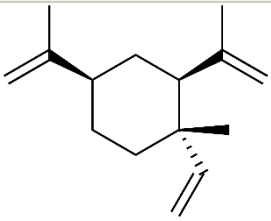
Bath Monash Global PhD Programme in Sustainable & Circular Technologies

Project Title:	β-elemene as facile building block in sustainable polymer synthesis
Supervisors at Bath: Supervisors at Monash:	Prof. Matthew Davidson Prof. Tanja Junkers (lead)
Home Institution:	Monash University
Indicative period at Host Institution:	2 years at Monash; 1.5 years at Bath with exact dates to be confirmed

Project Summary



A switch from oil-based to bio-based monomers for polymer synthesis is a necessity to reach more sustainable solutions in materials development. Within this realm, especially esters and amides have found large interest due to their comparatively simple mode of polymerizations, and due to the abundance of the required functional groups in biological feedstocks. Compounds that feature unsaturations are, however, also of high interest, since they open avenues towards radical (polymerization) reactions. A basis for research can here be found in *β*-elemene (see structure), which features three vinyl groups with distinct chemical reactivity. While not directly polymerizable *β*-elemene can be used in a variety of ways. On one hand it can serve as a crosslinker in thiol-ene reactions, and hence has the potential to replace pentaerithritol-based compounds that are classically used for this purpose. In the Monash research group, the reactivity of *β*-elemene with multifunctional polymer thiols will be evaluated for their use in polymer microbead synthesis. This pathway is highly attractive as it does not require any chemical modification of the natural compound before crosslinking. Also, the distinct difference between the two different vinyl groups can potentially be used to employ *β*-elemene as an asymmetric core for miktoarm-star polymer synthesis.

Further, the group in Bath has demonstrated that the vinyl groups can be selectively epoxidized. This opens further pathways towards functional polymers. Here, the epoxides will be ring-opened to increase the functionality of the monomer. The resulting (multi)ols can then be converted into (meth)acrylates via continuous flow processes used at Monash. (Co)Polymerization of the resulting monomers will allow to form either complex crosslinked materials, i.e. hydrogels and hyperbranched polymers, or linear polymers with pendant vinyl groups that can be used for on-demand post-polymerization modification.

The above described variety of polymer materials will be targeted, and materials made thereof be thoroughly investigated towards their thermal and mechanical properties. The most promising materials will be scaled in continuous flow reactors to cover as well sustainable resources, as well as green processing strategies. The PhD student will develop skills in monomer and polymers synthesis and characterisation, in flow chemistry and materials characterisation. Initial work to develop polymerization routes for *β*-elemene will be carried out at Monash (Year 1). Materials will then be further tested and new monomers prepared in Bath (Year 2). Further design, synthesis, characterisation and testing of appropriate materials (Year 3) will be carried out in Monash with input from and trips to Bath 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:
  - 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.