Institute for Sustainability; University of Bath

Project Title:	Innovative polymerisation strategies for the development of novel polymers and hybrid biomaterials from sugars
Lead Supervisor and co-supervisors:	**Dr Antoine Buchard (Department of Chemistry) – Lead supervisor** Dr Hannah Leese (Department of Chemical Engineering) – Co-supervisor
Industrial Partner:	-

Project Summary

PhD in Synthetic Polymer Chemistry and Materials Science

Applications are invited for a 3.5 year PhD studentship in the Buchard group (www.buchardgroup.org) in the Department of Chemistry at the University of Bath (UK), on the development of sugar-derived polymers and hybrid biomaterials.

The project:

In this project you will develop innovative polymerisation methodologies to produce novel materials from renewable feedstocks with unique properties. You will in particular target the synthesis of polymer materials that combine synthetic polymers derived from sugars with biomacromolecules such as structural proteins (e.g., silk), natural polysaccharides (e.g., cellulose) or enzymes. A variety of polymer architectures and polymerisation strategies will be investigated, including metal and organocatalysis, controlled radical techniques, as well as state of the art bioconjugation techniques. The analysis of the materials produced will be performed to establish their structure/properties relationship, assess their (bio)degradability and recyclability, study their bioactivity and progress towards the development of useful renewable biomaterials.
This project will contribute towards creating original hybrid materials with excellent physical properties (e.g., ductile and tough), and enhanced (bio)degradability and functionality thanks to the sugar moiety. In particular, you will target renewable and degradable materials of relevance to the health and energy sectors.

This project is a collaboration with the Materials for Health Lab led by Dr Hannah Leese. in the Department of Chemical Engineering at Bath

Training:

The student undertaking this project will receive training in a wide variety of experimental techniques at the molecular and macromolecular level, and will gain expertise across chemistry, materials science and biology. Synthesis of organic compounds (monomers) and polymers (via catalysis and controlled living methodologies) will be required during the project. Multinuclear NMR, mass spectrometry (MALDI), Size-Exclusion Chromatography (SEC) and X-ray scattering will be important techniques. Polymer materials will also be analysed routinely using Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), electron microscopy, and mechanical testing. The PhD candidate will also have the opportunity to complement these experimental skills with some training in computational chemistry (Density Functional Theory, Molecular Mechanics) for mechanistic and structural studies, including polymer modelling.
As bioconjugation and the applications of the novel hydrid biomaterials are being explored, the student will also be trained in techniques such as electrophoresis and various biological assays, for example to determine how the activity and selectivity of proteins are influenced by their coupling with a sugar-based polymer.
The student will finally have opportunities to present their work at group meetings, departmental seminars and suitable national and/or international conferences, as well as to be involved in the University of Bath teaching activities.

Secondment abroad:

To enhance the training experience of the PhD student, a fully funded 3-month secondment in a laboratory abroad is included in the project.

Contact us:

Informal enquiries are encouraged and should be addressed to Dr Antoine Buchard (a.buchard@bath.ac.uk).

Sustainability issues addressed

Today, the problems associated with the intensive use of non-degradable polymers derived from fossil fuels are well known.

Research in the Buchard group (www.buchargroup.org) addresses all aspects of the development of sustainable polymers. We develop new reactions for the synthesis of novel monomers from renewable feedstocks, design new polymerisation catalysts and processes, and produce innovative polymers for new technologies, including packaging, battery solid electrolytes and health materials. Our group have for example recently discovered a method that replaces phosgene with for the synthesis of cyclic carbonate monomers. We have also successfully applied this protocol to various sugar derivatives (mannose, xylose. thymidine…) and developed promising polymers, with desirable attributes including renewability, high performance, tuneability, recyclability and degradability.

Group website: www.buchardgroup.org

List of publications: www.buchardgroup.org/publications

For recent representative publications, see below:

[1] T. M. McGuire, J. Bowles, E. Deane, E. Farrar, M. Grayson, A Buchard, "Control of Crystallinity and Stereocomplexation of Synthetic Carbohydrate Polymers from D- and L-Xylose" *Angewandte Chemie International Edition* **2021**, *60*, 4524-4528.

[2] T. M. McGuire, E. F. Clark, A Buchard, "Polymers from Sugars and Cyclic Anhydrides: Ring Opening Copolymerization of a D-Xylose Anhydrosugar Oxetane" *Macromolecules* **2021**, *54*, 5094-5105.

[3] M. Piccini, J. Lightfoot, D. Castro Dominguez, A. Buchard, "Xylose-Based Polyethers and Polyesters Via ADMET Polymerization toward Polyethylene-Like Materials" *ACS Applied Polymer Materials* **2021**, *3*, 5870-5881.

[4] M. Oshinowo, J. R. Runge, M. Piccini, F. Marken, A. Buchard, "Crosslinked xylose-based polyester as a bio-derived and degradable solid polymer electrolyte for Li+-ion conduction" *Journal of Material Chemistry A* **2022**, *10*, 6796-6808.

[5] C. Hardy, G. Kociok-Köhn, A. Buchard, "UV degradation of poly(lactic acid) materials through copolymerisation with a sugar-derived cyclic xanthate" *Chemical Communications* **2022**, 58, 5463-54660.

Research in the Leese group (www.materialsforhealthlab.org) focuses on developing advanced materials for transformative sustainable healthcare, specifically, materials that can detect and diagnose the presence of disease at point-of-care.

Leese group website and list of publications: www.materialsforhealthlab.org/publications/

Eligibility criteria and selection process

Application:

Formal applications should be made via the University of Bath's online application form for a PhD in Chemistry. Please ensure that you state the full project title and lead supervisor name on the application form.

http://www.bath.ac.uk/guides/how-to-apply-for-doctoral-study/

Funding Eligibility:

This studentship is for 3.5 years' duration and includes Home tuition fees, a stipend (£17,668 per annum, 2022/23 rate) and a budget for research expenses and training.

Information may be found on our fee status guidance webpage, on the GOV.UK website and on the UKCISA website.