Whorrod Research Fellow

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Making polymers from sugars and CO$_2$

His main research interest deals with the development of novel renewable polymers and their applications as sustainable materials.

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Abstract

In this talk, I will present how our group at the University of Bath in the UK have been using sugars and CO$_2$ as renewable feedstocks for the creation of novel polymers. We have, in our group, developed a procedure for the synthesis of cyclic carbonates from diols and CO$_2$ under mild conditions (room temperature, low CO$_2$ pressure), which presents an alternative to the traditional use of phosgene derivatives for monomer synthesis.[1] I will describe how we have applied this synthetic route to the various sugar derivatives (e.g. from mannose,[2] thymidine[3] and 2-deoxyribose[4]), to produce several novel cyclic carbonate monomers, which are sometimes not accessible via traditional phosgene methods. In particular, I will show how we have used DFT calculations to guide our synthetic targets. Subsequent controlled Ring-Opening Polymerisation (ROP) of these new monomers is possible using organocatalysts or metal precursors, in solution or in the melt, which yields aliphatic poly-carbonates featuring a carbohydrate backbone. The key properties of these polymers, including preliminary degradability studies, will be presented. I will also demonstrate that copolymerisation, as well as pre and post-polymerisation functionalisation is possible and can be used to further tune the polymer properties. Finally, I will give a brief overview of other research areas we are involved in (coordination chemistry for ROP catalyst development, DFT mechanistic investigations, and other sustainable monomer synthesis methods, in particular H$_2$O$_2$-mediated Baeyer-Villiger oxidation).

References: