Maastricht University

Faculty of Humanities and Sciences

Project title: Synthesis and characterization of polymers containing a biobased alternative to terephthalic acid

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Function: Assistant Professor Biobased Materials

Collaborators: Prof. Stefaan De Wildeman

Proposal (250 words):

Introduction:
Terephtalic acid is a workhorse monomer in polymer chemistry, e.g. for the synthesis of thermoplastic polymers like polyethylene terephthalate (PET), polyaramid (®Kevlar fibers) or thermosets. Terephtalic acid is currently made from fossil based resources, but non-renewable fossils are finite and have undesirable environmental impact (e.g. green-house gas emissions).

Hypothesis and Objectives:
In contrast to the often encountered route of drop-in biobased monomers with an identical structure to the fossil equivalent, in this work structurally slightly different biobased terephthalic acid equivalents (asymmetric ones) will be made from naturally-occurring malic acid. Biobased polymers based on those new monomers can possibly provide additional beneficial properties.

Setting and Methods:
The most efficient synthesis route towards the biobased terephthalic acid derivative will be studied. The biobased monomer will be polymerized via polycondensation into polyesters and polyamides, and the polymers will be characterized via NMR, GPC, MALDI-TOF, TGA, DSC, … Furthermore, the biobased polymers will be processed and the corresponding material properties (e.g. mechanical properties, biodegradation, …) will be compared with the fossil based terephthalic acid polymers.

Impact:
Terephthalic acid has a broad application range going from components for material science (textile, plastic bottles, films, plasticizers, paints and coatings…) and dyes to crucial precursors for the pharmaceutical industry. Several million tonnes are produced annually and the global terephthalic acid market size was valued at USD 57.21 billion in 2016. As such, there is a big market for the development of sustainable polymers from renewable terephthalic acid equivalents.

Requirements candidate: Highly motivated student with good English communication skills and proactive and resolute attitude. Chemistry fields: organic synthesis, polymer synthesis, chemical and physical characterization of monomers/polymers, polymer processing

Keywords: biobased, sustainable polymers, biobased replacement for terephthalic acid, polycondensation

Top 5 selected publications:

1. Wróblewska AA, Bernaerts KV, De Wildeman SMA. Rigid, bio-based polyamides from galactaric acid derivatives with elevated glass transition temperatures and their characterization, Polymer 2017; 124:252-262
2. Delgove MAF, Luchies J, Wauters I, Deroover GGP, De Wildeman SMA and Bernaerts KV. Increasing the solubility range of polyesters by tuning their microstructure with comonomers. Polymer Chemistry 2017; 8:4696-4706
3. Wroblewska AA, Lingier S, Noordijk J, Du Prez FE, De Wildeman SMA, Bernaerts KV. Polyamides based on a partially bio-based spirodiamine
4. Bernaerts K, Mestrom L, De Wildeman S, Biocatalysis toward New Biobased Building Blocks for Polymeric Materials. In Applied Biocatalysis: From Fundamental Science to Industrial Applications, Liese A, Hilterhaus L, Kettling U, Antranikian G, Eds.; Wiley-VCH, 2016; pp 464
5. Bernaerts KV, Du Prez FE. Dual/heterofunctional initiators for the combination of mechanistically distinct polymerization techniques. Prog. Polym. Sci. 2006;31:671-722