FATTY ACID-BASED POLYESTERS AND POLYCARBONATES AND AMPHIPHILIC BLOCK COPOLYMERS THEREOF BY CATALYTIC RING-OPENING POLYMERISATION

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ABSTRACT

Polyethylene is one of the most common and versatile plastic materials in our daily life and accounts for 40% of the total volume of world production of plastic materials - a staggering 80 million tons. However, there are two main challenges for polyethylene; sustainability and feasibility. The polyolefin industry relies heavily on petrochemicals for its raw materials. Moreover, polyethylene is non-degradable, causing major environmental problems in places where waste collection is impossible, for example in the marine environment. While polyethylene has ideal properties for many applications, it is notoriously difficult to modify because of its inert chemical structure and the sensitivity of the catalysts producing the polymer. This creates challenges in areas where (bio)conjugation, blending, adhesion or cross-linking is required.

A new class of polymers with the potential to address these challenges are fatty acid-based polyesters, which can be produced by ring-opening polymerisation of the corresponding macrolactones. As a consequence of the large number of CH_2-groups between the ester functionalities, the properties of these polymers resemble those of polyethylene.[1] The presence of labile ester bonds implies degradability under conditions found in the environment (*e.g.* soil, sea water) and in recycling processes. Moreover, these polymers can be synthesised from renewable fatty acids, e.g. palm kernel oil or castor oil.[2]

It was long claimed that macrolactones such as pentadecalactone could only be efficiently polymerised enzymatically due to the lack of ring strain. Recently, we have developed the first efficient catalysts for the catalytic polymerisation of macrolactones to high molecular weight products.[3] This discovery omits the use of expensive and difficult to remove enzymes and constitutes a significant breakthrough in the development of advanced materials.

The topic of the current contribution is the marriage of PE-like and PE-miscible fatty acid-based polyesters and polycarbonates with other types of polymers, which are fundamentally different in nature. We will demonstrate different novel strategies to produce amphiphilic block copolymers and random copolymers by means of catalytic living and immortal ring-opening polymerisation. These copolymers find application in various fields ranging from compatibilizers, single-use packaging materials, fibres and biomedical devices (drug delivery, implants).

References:

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