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Novel living ring-opening polymerisation method to synthesise a novel class of multifunctional, sequence-controlled, degradable and biocompatible polymers

Problems addressed

- Commonly used synthetic polymers are mainly statistical or random copolymers, in which the monomer sequence distribution is generally statistical and poorly controlled, leading to indisciplinable and unpredictable structural, physicochemical and biological properties.
- Living radical polymerisation methods are commonly used to synthesise polymers, which can potentially be used in many industrial applications. However, existing living radical polymerisation methods synthesise polymers with carbon-carbon backbones that are non-degradable.
- Polyethers have attracted interest from synthetic chemists, materials scientists and biologists due to their exceptional biocompatibility. Of these, discrete/uniform poly(ethylene glycols) (PEGs) with defined chain lengths and excellent biocompatibility have received the most attention from synthetic chemist 1. However, PEG molecules synthesised by existing methods are commonly mono- or bi-functional homopolymers. The physical and biological advantages of PEGs have never been combined with the structural and information-bearing complexity of sequence-defined multifunctional heteropolymers. With the exception of facile α,ω-chain terminal modification, polyethers have not been amenable to site-selective structural modification, optimization of inherent properties or later incorporation of functional elements at specific sites.

Technology overview

- This invention relates to a novel quantitative, one-pot iterative living ring-opening polymerisation (QOIL-ROP) method for scalable synthesis of a class of novel polyethers, including various PEGs, and polyesters that are not only sequence-controlled but also multi-functional with integrated degradability and biocompatibility.
- The QOIL-ROP method has been shown to precisely control the chain composition, monomer sequence and degree of polymerisation, to determine polymer physiochemical and biological properties and degradation behaviour. By precisely controlling the chain length and distribution of functional groups, multifunctional polyethers and polyesters can be generated. The generated polymers are tuneable to balance their stability and degradability.
- In addition, the scalable QOIL-ROP method does not require any intermediate purification procedures between successive chain extension steps, unlike the other reported iterative polymer synthesis methods. In each chain extension step, real-time monitoring of polymerisation can be carried out by nuclear magnetic resonance (NMR) spectroscopy and size exclusion chromatography (SEC) to achieve quantitative monomer conversion.

Proposed Use

The degradable and biocompatible copolymers with controlled structural versatility and functional diversity have many industrial applications especially in the production of polymer films, packaging, fibres and separation membranes, as well as nanotechnology and information storage.

Benefits

- Simple, scalable, and cost-effective polymerisation method
- Catalysts used are non-toxic, commercially available, and U.S. FDA-approved
- Generates a library of novel multifunctional, sequence-controlled polyethers and polyesters with biocompatible and degradable backbones that existing polymerisation methods could not achieve
- Manufactured polyethers and polyesters have precisely controllable monomer types, sequences and chain lengths that allows for tuneable functionalities and site-selective post-polymerisation modification as needed
- Generated polyethers and polyesters have various applications including the production of plastic films, packaging, fibres and separate membranes, as well as nanotechnology and information storage.

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Reference

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