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What can enzyme and supercritical CO2 bring to the synthesis of biodegradable star polymers?

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PURPOSE OF THE ABSTRACT

The development of environment-friendly pathways for the synthesis of polymers is an exciting and challenging topic. Among the different synthetic routes, catalysis and in particular enzymatic catalysis appears to be a very promising method. Furthermore, star-shaped polymers are known to exhibit remarkable properties compared to their linear equivalents. In this study, we investigated the synthesis of star-shaped polymers based on epsilon-caprolactone by ring-opening polymerization according to a core-first approach. To this aim, we have chosen to use a greener pathway combining the utilization of a renewable initiator (D-sorbitol, a natural polyol obtained from glucose), clean solvents (in bulk or in supercritical CO2), and an enzyme as catalyst (Candida antarctica lipase B). For comparison, similar experiments were also carried out in the presence of a conventional metallic-based catalyst (Figure 1). This study presents a sustainable approach towards synthesis of controlled star polymer by using a biocatalyst and scCO2 [1]. The star polymers have been carefully characterized by 1H NMR, 31P NMR (after phosphitylation), SEC-MALS, viscometry, DSC, and MALDI TOF analyses (Figure 2). In addition, amphiphilic star block copolymers were targeted for applications in aqueous media.

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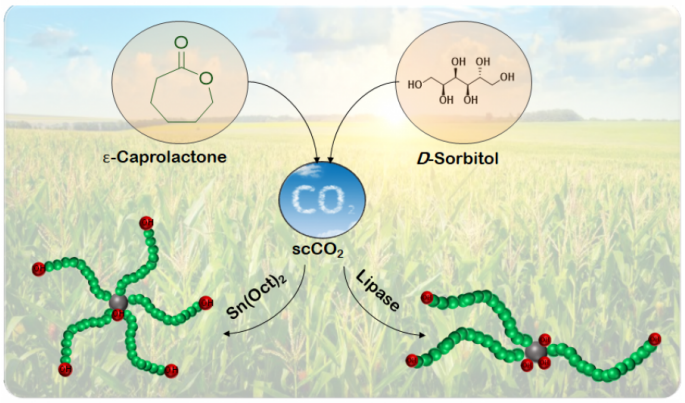
FIGURES



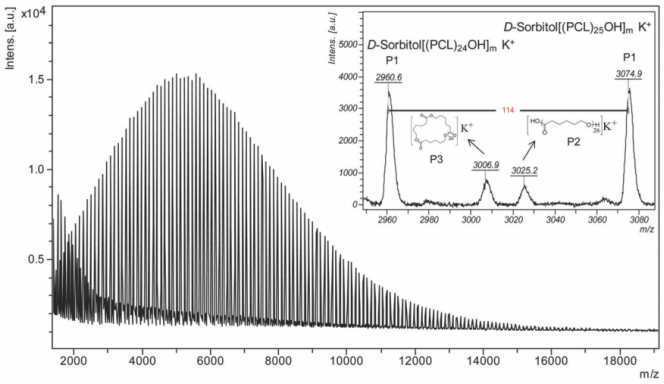


FIGURE 1

Figure 1

Star D-Sorbitol-poly(epsilon-caprolactone) polymers synthesized by metal-catalyzed and enzyme-catalyzed polymerization in supercritical CO2

FIGURE 2

Figure 2

MALDI-TOF mass spectrum of star poly(epsilon-caprolactone) synthesized by enzyme-catalyzed (Novozym 435) polymerization in supercritical CO2. The main population corresponds to star D-sorbitol[(PCL)OH]m,K+

KEYWORDS

polyester | star polymer | enzyme | supercritical CO2

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[1] Baheti P., Gimello O., Bouilhac C., Lacroix-Desmazes P., Howdle S.M., Polymer Chemistry 2018, 9, 5594-5607. http://dx.doi.org/10.1039/c8py01266k