A SUSTAINABLE APPROACH TO PRODUCE AND UPGRADE POLY(BUTYLENE SUCCINATE)

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ABSTRACT

Green materials, including polymers, are gaining more and more popularity, mainly attributed to the fossil fuel crisis. Green polymers must present green properties such as biological origin and biodegradation and must be produced *via* sustainable methods. Oligomers of a bio-based and biodegradable polymer, poly(butylene succinate) or PBS, are enzymatically synthesized in this work. However, a biocatalysis drawback is the difficulty of forming polyesters of appropriate molecular weight for subsequent processing and use [1]. Consequently, the formed oligomers (prepolymers) are submitted to post-polymerization in the melting point (T_m) vicinity to upgrade their molecular weight and thermal properties [2-4].

Stoichiometric amounts of the monomers (diethyl succinate and 1,4 butanediol) and 10 wt% of Novozym435 were used to produce PBS prepolymers in small lab scale (500 mg). The polymerization was conducted in both solution (toluene, isooctane) and bulk systems for 24 h at 40, 50 and 60 °C. Post-polymerization was then conducted *via* bulk technique, using thermogravimetric analysis (TGA) chamber as a micro-reactor. Reaction temperatures varied from 80 to 90 °C and reaction times from 2 to 26 h, including single- and two-step processes.

PBS structure of the synthesized prepolymers was verified *via* ^{1}HNMR. The prepolymers $\overline{M_n}$, calculated by ^{1}HNMR, was found in the range 1000 – 2800 g/mol and the achieved process yield was 25 – 60%. The most promising PBS prepolymer in terms of good thermal performance and morphology was synthesized in isooctane at 50 °C. Thus, it was scaled up (3.4 g) and submitted to post-polymerization. The reaction temperature was fine-tuned to reach an increased polymerization rate. The most appropriate conditions were defined; the first stage included heating at 80 °C for 2 h and the second at 90°C for 8 h. The final, free of catalyst-residues, truly green PBS grade presented $\overline{M_w}$ of 4500 g/mol and good thermal properties (T_m 104 °C, x_c 70%).

KEYWORDS: bio-based, biodegradable, enzymatic polymerization, PBS, post-polymerization

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