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NOVEL ECO-FRIENDLY MULTIBLOCK COPOLYMERS POLY(BUTYLENE/TRIETHYLENE SUCCINATE): EFFECT OF BLOCK LENGTH ON MECHANICAL PROPERTIES AND BIODEGRADABILITY

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Abstract

In the past few decades biodegradable aliphatic polyesters have attracted increasing interest owing to the huge environmental concerns about traditional non degradable plastics. Aliphatic polyesters are known to be biodegradable, being easily decomposed by the cleavage of ester bond linkage. Poly(butylene succinate) (PBS) can be considered one of the most promising one, due to its relatively high melting point and excellent processability. However, its high cost, relatively poor mechanical properties and slow biodegradation rate restrain its extensive use. There is also a great interest on polyesters based on alkylene ether glycols: the presence of ether linkages in the chain indeed increases the hydrophilic character of the polymer, favouring its dissolution under environmental conditions. It is well known that thermal and mechanical properties and biodegradability of polymers strongly depend on molecular weight, hydrophilicity, flexibility of chains, and morphology, such as crystallinity degree (*Xc*), size, form and number of crystallites. In this work we propose reactive blending as a simple and versatile solvent-free synthetic approach to produce new copolyether-esters, obtained by melt mixing PBS and poly(triethylene succinate) (PTES) (PBS:PTES=50:50 mol%, Ti(OBu)4 as catalyst) for different reaction times, with block length decreasing with the increase of mixing time. Their mechanical properties and biodegradation profiles were related with block length. Biodegradation test was carried out by using *Candida cylindracea* ([E]= 50 U/mL) at 30°C, pH=7.0. Copolymers degrade to a much higher extent than PBS. Moreover, copolymer biodegradation rate regularly increased as the block length decreased, probably due to a lowering of Xc, with exception of sample characterized by the longest sequences. ATRIR and DSC analyses confirmed that the amorphous phase is the region attacked first by enzyme. NMR analysis, indicated that enzyme hydrolysis involved preferentially ester groups of TES sequences, probably because of their higher hydrophilicity. Lastly, copolymer mechanical properties appeared to be strictly related to Xc. The random copolymer, characterized by the lowest Xc, exhibited an elastomeric behavior, having the lowest elastic modulus and the highest deformation at break (around 700%). It was demonstrated that copolymerization is an efficacious way to increase PBS biodegradability and that mechanical properties and biodegradation rate can be modulated changing block length, which affects both crystallinity degree and hydrophilic/hydrophobic ratio.