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ORIGINAL PAPER

Thermal, rheological and mechanical properties of poly(propylene carbonate)/methyl methacrylate–butadiene–styrene blends

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Abstract Different amounts of core–shell methyl methacrylate–butadiene–styrene (MBS) impact modifiers were incorporated into biodegradable poly(propylene carbonate) (PPC) in a batch mixer, aiming at improving the mechanical properties and raising the glass transition temperature (T_g) of PPC. A series of properties, such as thermal behavior, miscibility, rheological and mechanical properties, and the morphological analysis of PPC/MBS blends were investigated in detail. PPC was partially miscible with MBS according to the results of dynamic mechanical analysis tests which showed a little shift in the peaks associated with the glass transition temperatures. The differential scanning calorimetry results showed that the T_g of PPC increased gradually as MBS content increased. Additionally, the thermal stability properties of the blends were improved dramatically. The rheological properties obtained by the melt flow index tests indicated that the melting viscosities of PPC/MBS blends increased with the addition of MBS, and all melting viscosities of the polymer blends were higher than those of pure PPC. The mechanical properties of PPC/MBS blends implied that the elongation at break increased from 5.3 % of pure PPC to 52 % after incorporation of 20 % MBS into the blends. Accordingly, the impact test results indicated that MBS could toughen the PPC matrix effectively, about 3.7 times higher compared to pure PPC. The scanning electron microscopy studies on PPC/MBS blends showed that MBS particles were dispersed well in the PPC matrix when MBS content was below 10 %, whereas the aggregation could be clearly seen when the content of MBS was over 15 %.

Keywords Methyl methacrylate–butadiene–styrene · Poly(propylene carbonate) · Blends · Miscibility

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Introduction

Energy shortage and environmental pollution are tough issues that have been disturbing us for a long time. Researchers have made great efforts to discover eco-friendly materials to replace conventional materials synthesized from petroleum [1–3]. The synthesis of poly(propylene carbonate) (PPC) from CO_2 and propylene oxide (PO), which was first reported in 1969 by Inoue [4, 5], has attracted extensive attention not only for its utilization of CO_2 as an effective way to reduce greenhouse effect, but also for its good biodegradability and biocompatibility [6–8]. At the same time, PPC is a safe polymer and has some important physical and optical properties like tensile strength and high translucency. Possible applications of PPC have been reported such as gas barrier materials [9], scaffolds for tissue engineering [10] and electrolytes. Nevertheless, the flexible carbonate groups present in the backbone chains of PPC cause weak processability, poor mechanical properties and unstable thermal properties [11]. These drawbacks have limited the extensive application of PPC being used as an industrial material, and many attempts have been made to make PPC a more widely used material. End-capping with MAH [12] or cross-linking [13] are usually effective methods to improve the thermal stability of PPC under higher temperatures. What is more, Gao L [14] made an attempt to synthesize pseudo-interpenetrating poly(propylene carbonate)