

Abstract

The present work focuses on the structure-property relationships of particulate-filled thermoplastics and thermoplastic elastomer (TPE). In this work two thermoplastics and one TPE were used as polymer matrices, i.e. amorphous bisphenol-A polycarbonate (PC), semi-crystalline isotactic polypropylene (iPP), and a block copolymer poly(butylene terephthalate)-block-poly(tetramethylene glycol) TPE(PBT-PTMG). For PC, a selected type of various Aerosil[®] nano-SiO₂ types was used as filler to improve the thermal and mechanical properties by maintaining the transparency of PC matrix. Different types of SiO₂ and TiO₂ nanoparticles with different surface polarity were used for iPP. The goal was to examine the influence of surface polarity and chemical nature of nanoparticles on the thermal, mechanical and morphological properties of iPP composites. For TPE(PBT-PTMG), three TiO₂ particles were used, i.e. one grade with hydroxyl groups on the particle surface and the other two grades are surface-modified with metal and metal oxides, respectively. The influence of primary size and dispersion quality of TiO₂ particles on the properties of TPE(PBT-PTMG)/TiO₂ composites were determined and discussed.

All polymer composites were produced by direct melt blending in a twin-screw extruder via masterbatch technique. The dispersion of particles was examined by using scanning electron microscopy (SEM) and micro-computerized tomography (μ CT). The thermal and crystalline properties of polymer composites were

characterized by using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). The mechanical and thermomechanical properties were determined by using mechanical tensile testing, compact tension and Charpy impact as well as dynamic-mechanical thermal analysis (DMTA).

The SEM results show that the unpolar-surface modified nanoparticles are better dispersed in polymer matrices as iPP than polar-surface nanoparticles, especially in case of using Aeroxide[®] TiO₂ nanoparticles. The Aeroxide[®] TiO₂ nanoparticles with a polar surface due to Ti-OH groups result in a very high degree of agglomeration in both iPP and TPE matrices because of strong van der Waals interactions among particles (hydrogen bonding). Compared to unmodified Aeroxide[®] TiO₂ nanoparticles, the other grades of surface modified TiO₂ particles are very homogeneously dispersed in used iPP and TPE(PBT-PTMG). The incorporation of SiO₂ nanoparticles into bisphenol-A PC significantly increases the mechanical properties of PC/SiO₂ nanocomposites, particularly the resistance against environmental stress crazing (ESC). However, the transparency of PC/SiO₂ nanocomposites decreases with increasing nanoparticle content and size due to a mismatch of refractive indices of PC and SiO₂ particles. The different surface polarity of nanoparticles in iPP shows evident influence on properties of iPP composites. Among iPP/SiO₂ nanocomposites, the nanocomposite containing SiO₂ nanoparticles with a higher degree of hydrophobicity shows improved fracture and impact toughness compared to the other iPP/SiO₂ composites. The TPE(PBT-PTMG)/TiO₂ composites show much better thermal

and mechanical properties than neat TPE(PBT-PTMG) due to strong chemical interactions between polymer matrix and TiO₂ particles. In addition, better dispersion quality of TiO₂ particles in used TPE(PBT-PTMG) leads to dramatically improved mechanical properties of TPE(PBT-PTMG)/TiO₂ composites.