ABSTRACT

The reinforcing effects of resorcinol-formaldehyde latex (RFL) coated short Aramid fiber (Technora) on two different thermoplastic elastomers (TPEs) have been investigated based on mechanical, rheological and morphological characteristics as a function of fiber length and loading. Ethylene-octene copolymer (EOC) and ester based thermoplastic polyurethane (TPU) have been explored as the TPE matrices. Both the low strain modulus and the Young's modulus increased as a function of fiber loading and length. However, due to poor interfacial interaction between the fiber and the matrix and the formation of fiber aggregation especially with 6 mm fiber at high loading, the elongation and toughness of the composite were found to decrease drastically. In order to solve these problems, a low molecular weight maleic anhydride grafted polybutadiene (MA-g-PB) was treated with the Aramid fiber prior to mixing it with the polymer matrix. FTIR analyses of the MA-g-PB treated Aramid fiber reveals that it is chemically attached over the fiber surface via ester linkages. The improvement in tensile strength, elongation at break, toughness to stiffness balance and a good quality of fiber dispersion even for fibers with high aspect ratio could be achieved in EOC-Aramid fiber composite with the use of 3phr of MA-g-PB. The detailed morphological investigation on the tensile fractured surfaces of the MA-g-PB treated Aramid fiber/EOC composite was in line with the improved mechanical properties. The fibrillation of the Aramid fiber during melt mixing was identified as a major cause for the severe fiber dispersion problem in Aramid fiber reinforced TPU composite, which has been well confirmed from the SEM analyses of the tensile fracture surface morphologies. The MA-g-PB used in this study is also found to be a good choice for controlling the fibrillation and thereby increase the quality of fiber dispersion in the TPU matrix. An extensive dynamic rheological studies of the fiber filled TPE composite have been carried out using a Rubber Process Analyser (RPA 2000) under both strain and frequency sweep experiments. From the analyses of the variation of dynamic shear storage modulus under strain sweep as a function of fiber loading a remarkable indication of strain induced fiber orientation has been observed beyond a dynamic strain of 100%. The shear storage modulus of the neat matrix and the composite were same irrespective of the fiber loading beyond this strain region. A new testing methodology has been devised using RPA particularly to understand how the in process strain induced fiber orientation affects the melt rheological properties. Finally, a comparative study has been made with 6 mm Technora and Twaron Aramid fiber reinforced TPU composite. It has been observed that Twaron fiber undergoes a severe processing induced fiber breakage whereas Technora Aramid fiber shows good length retention property. The mechanical and dynamic mechanical properties of the Twaron Aramid fiber reinforced composites were inferior than that of Technora Aramid fiber reinforced composites due to the severe processing induced fiber breakage of Twaron fibers. The failure mechanism of Twaron Aramid fiber reinforced TPU has been examined by SEM analyses to understand the inferior mechanical properties of Twaron-TPU composite and proper solution has been given with MA-g-PB to enhance the mechanical properties.

Key words: Ethylene octene copolymer, Thermoplastic polyurethane, Aramid short fiber, Coupling agent, Melt rheology and Morphology