IMPACT TOUGHENING AND MOLDABILITY CHARACTERISTICS OF POLY(BUTYLENE TEREPHTHALATE) AND POLY(ETHYLENE-OCTENE) BLENDS

by

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CERTIFICATE

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The results contained in this thesis are original and have not been submitted in partial or full, to any other university or institute for the award of any degree or diploma.

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Dedicated

To

My Mother & Sister

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ABSTRACT

The aim of this work is to develop impact toughened PBT based alloys through reactive compatibilisation and study their injection moldability characteristics. Poly(butylene terephthalate) (PBT) being a semi crystalline polymer possesses excellent properties in terms of unnotched impact strength, solvent resistance, rigidity, hardness, abrasion resistance, gloss, electrical insulation etc. and are useful in widespread applications in automotive, construction and electronic industries. PBT's main drawback is notch sensitivity, which is very common to pseudoductile materials. Pseudoductility indicates fairly high resistance to crack initiation but only modest resistance to crack propagation. Notch sensitivity of PBT can generally be eliminated by the incorporation of elastomeric impact modifiers. The advantage of PBT is its high crystallization rates which makes it much suitable for high-speed processing techniques, especially injection molding, resulting in short cycle time and enhanced productivity. Hence, in this work, impact toughening of PBT blends and moldability studies were considered.

In the present study, the extent of room temperature impact toughening of PBT by different grades of elastomers was assessed in terms of the developed morphology in three phases. In the first phase, two different grades of poly (ethylene-co-octene) elastomers having an octene content of 38 wt% (Engage®8200) and 31 wt% (Engage®8401) with differences in flow behavior were melt blended with PBT using a single screw extruder. The PBT/POE blend compositions were maintained at the ratio of 90/10, 80/20 and 70/30 by weight. Out of the two grades of POE, Engage®8200 was found to be superior in impact

toughening of PBT. In the second phase, PBT and POE blends are prepared using two separate single screw extruders having variations in the screw geometry (screw without mixing unit, SSEI and screw with mixing unit, SSEII). The effect of screw geometries on the extent of impact modification of PBT/POE8200 blends was examined. The presence of blister ring (mixing unit) in SSEII is expected to provide better mixing and high homogeneity which is revealed by the morphology of extrudes and injection molding.

Mechanical blending of PBT/POE leads to incompatible blends, resulting in moderate increase in impact toughness, due to the immiscibility. The analysis of tensile properties based on the theoretical models indicated weak interactions between the dispersed phase of POE and PBT matrix and the weakness in the matrix structure upon addition of POE.

Reactive compatibilisation is necessary inorder to attain the enhanced impact modification by addition of suitable compatibiliser. Hence, the third phase involved two-step reactive extrusion of PBT/POE blends. In the first step of reactive extrusion, glycidyl methacrylate (GMA) was grafted onto POE and a grafting level of 0.78% was obtained. The compatibilising efficiency of GMA grafted onto POE is attributable to the reactivity of the epoxy group of GMA with the carboxyl group of PBT. In the second step, reactive compatibilisation of PBT and POE was sought by changing the POE-g-GMA concentration at 2, 5 and 10 wt% in 90/10, 80/20 and 70/30 compositions by weight. Correlation between the developed morphology and the impact toughening of PBT by POE was established using Wu's equation and has revealed a critical interparticle distance

at which brittle to ductile transition occurs. It was found that the impact strength of PBT was increased by almost eleven times that of the neat PBT.

Thermal properties of uncompatibilised and compatibilised PBT/POE blends were studied inorder to examine the effect of POE and POE-g-GMA on the crystallisation behavior of PBT. The melting and crystallization behavior of PBT were unaffected with the addition of POE and compatibiliser. The degree of crystallinity of PBT content in PBT/POE blends decreased moderately with the addition of POE and POE-g-GMA.

Moldability studies of PBT blends were carried out by estimating the as- molded shrinkages (longitudinal, transverse and thickness) at different locations of the specimens and an attempt to correlate volumetric shrinkage with X-ray crystallinity has revealed a direct relation. Anisotropic shrinkage behaviour was dominant in neat PBT than in the blends of PBT/POE with higher transverse shrinkages. Effect of varying injection molding parameters such as holding pressure, injection temperature and injection pressure on the shrinkage of neat and impact toughened PBT/POE blends were studied. Holding pressure was found to be the most influential parameter, which leads to decreased shrinkage in the blends.

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