Studies on Reactive Blending and Structure Development of PP Based Blends

By

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DEDICATED TO MY PARENTS

AND

PARENTS-IN-LAW

CERTIFICATE

This is to certify that the thesis entitled "**Studies on Reactive Blending and Structure Development of PP Based Blends**" being submitted by Ms. Purnima Jain to the Indian Institute of Technology, Delhi for the award of degree of Doctor of Philosophy, is a record of bonafide research work carried by her. Ms. Purnima Jain has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to our knowledge has reached the requisite standard. The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

Polymer blends have gained enormous interest in last few decades as they provide the advantages of meeting performance demands, ease of processing and desirable properties in terms of cost performance criteria. However, most of the blends are immiscible leading to the blends with poor physical properties, which are of little commercial importance. Therefore, the development of a suitable compatibiliser is imperative to enhance the compatibility between the blend components. This leads to the development of an alloy in the form of compatibilised blend with stable and reproducible morphology hence controlled rheology and improved physical properties. The present work deals with the studies on polypropylene/polybutylene terephthalate blends and alloys.

Polypropylene and polybutylene terphthalate are two mutually immiscible polymers due to a wide difference in their solubility parameters (10.7 $(cal/cc)^{1/2}$ for PBT and 8.03$(cal/cc)^{1/2}$ for PP) and low entropy of mixing. Both physical and reactive compatibilisation techniques have been employed extensively in the past to develop the compatibilised blends. However, in-situ reactive compatibilisation has attracted a lot of research interest in the recent past with a lot of literature appearing in journals. Therefore, the first aim of the present study was the selection and development of a suitable reactive compatibiliser in the form of a grafted polypropylene and its utilisation for development of PP/PBT alloys. Based on the literature available on the use of grafted polyolefins, GMA was selected as

a suitable monomer for grafting onto the PP backbone. The PP-g-GMA thus developed was used at five different levels in the PP/PBT blends. Blends of PP with PBT and gPP were developed by varying the levels of PBT as 20, 40, 50, 60 and 80 wt.% with gPP level varying as 0, 2, 5, 10 and 20 wt% for each level of PBT. In order to study the effect of viscosity ratio of the blend components, blends were also prepared using three different grades of PBT, namely B1, B2 and B3, that vary in their melt viscosity and carboxyl end group equivalents. For this class of blends, the PBT content was varied as 20 and 80 wt.% and the gPP content was varied as 0, 2, 5, 10 and 20 wt.%. To study the effect of processing conditions on blend performance in terms of mixing, blends were prepared in a twin screw extruder also. Only one grade of PBT namely B2 was used at three levels of PBT i.e. 20, 40 and 50 wt.% with 0, 10 and 20 wt.% gPP levels. This class of blends was then compared for their property performance with those of the single screw extruder.

Various studies have been performed to determine the compatibilising effect of the grafted PP on the PP/PBT blends and alloys. These include the mechanical properties, morphological studies by scanning electron microscopy (SEM), melting and crystallization behaviour studies by differential scanning calorimetry (DSC) and wide angle X-ray diffraction (WAXD) techniques and melt rheology studies by a parallel plate viscometer.

Mechanical properties studies on the PP/PBT/gPP blends and alloys showed a significant improvement in terms of impact strength and tensile strength of the compatibilised blends as compared to the uncompatibilised

Finally, it has been successfully demonstrated that glycidyl methacrylate (GMA) grafted PP can act as an effective compatibiliser for the PP/PBT blends. It has been clearly shown that the compatibilised PP/PBT blends provide an excellent alloy with superior properties. In the end of the thesis, major conclusions have been highlighted and suggestions for future work have been presented.

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