

STUDIES ON PROPERTIES OF POLYPROPYLENE FILLED SEBS/MICA/SILICA BLENDS (FOAMED/UNFOAMED) FOR AUTOMOTIVE APPLICATION

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ABSTRACT

The purpose of this work is to compare the effects of different types of filler (silica, mica) loadings and elastomeric content on interfacial properties, morphology and mechanical properties of polypropylene blends modified by 5, 10, 15, and 20 Vol % of poly (styrene-b-ethylene-co-butylene-b-styrene) SEBS added to the total blend volume. We considered the effect of foamed and informed blends properties to understand how the changes occur between adhesion, the filler and the matrix. The blends samples were homogenized in a twin screw extruder. The compatibility of PP and fillers focused on this study and further the foaming nature. The morphology of ternary polymer blends revealed by light and scanning electron microscope was compared with morphology predicted models based on interfacial properties. The results indicated that the general morphology of blends systems was determined primarily by interfacial properties, whereas the spherulitic morphology of the polypropylene matrix was a result of two competing effects: nucleation effect of filler and solidification effect of elastomer. Tensile and impact strength properties were mainly influenced by combining competitive effects of stiff filler and tough SEBS elastomer. Spherulitic morphology of the polypropylene matrix might have affected some mechanical properties additionally.

KEYWORDS: Polypropylene, filler, SEBS, Foam

INTRODUCTION

Today, polypropylene is among the outstanding concerned material due to its attractive price/performance ratio and high stiffness. Polypropylene (PP) is used to produce a variety of products, such as molded parts, films and textile fibers, and so forth. It is the only commodity resin that has a heat-distortion temperature above 100°C. Over the last decades, the development of new polymeric materials has been oriented toward blends and composites because they are more attractive systems with great significance for research and industrial applications. The main reason these compounds are being developed is, to obtain materials with specific properties at low manufacturing costs. There has been a lot of ways to improve the mechanical properties of PP for different applications, among which the most common one is going for incorporation of elastomers, fillers, or the combination of both. The specific reason for the incorporation of elastomers is that it acts as impact modifiers for PP, and reduces its stiffness. However, fillers usually improve the stiffness, strength, hardness, and abrasion resistance of PP, but they reduce its impact strength. Most of polymer blends are incompatible, resulting in materials with weak interfacial adhesion and thus poor mechanical performances; therefore, the greatest challenge in the field of the multiphase polymer blend research is the manipulation of the phase structure via a judicious control of the interfacial interactions between the components. One of the classical methods to ensure adhesion between the phases (reduce the interfacial tension) is the use of the third component, a compatibilizer, which results in a finer and

more stable morphology, better adhesion between the phases and consequently better mechanical properties of the final product. Thus, studies have revealed the concept of compatibilization by using rigid silica nano-particles in a wide range of size and with a variety of surface treatments. The considerable specific surface area of these nano-particles (50-400 m²/g), the type of silica nano-particles and the concentration of silica in the blend play a major role in their rheological behaviour and their dispersions in the blend. Thus, we have studied how the properties change with the incorporation of these fillers along with elastomers.

EXPERIMENTAL

Materials

Polypropylene (PP: 3030MG, IOCL) of melt flow index MFI=11g/10min whose molecular weights are: Mn=68,800g/Mol and MW =201000 g/Mol were taken into study. Poly (styrene-b-ethylene-co-butylenes-b-styrene) SEBS supplied by the CVS Polymer corporation, Delhi was used of MFI of is 4.7 (g/10 min at 2400C) and the weight ratio of styrene / ethylene butylenes is 20/80 wt%. Silica (SiO₂) an inorganic filler having density 980kg/m³ which was supplied by R.K. Industries, Delhi. Mica was collected from Mahavir Chemicals, Delhi in powder form.

Blending and Sample Preparation

PP, SEBS, SiO₂ and Mica were compounded in a DSM twin screw mini extruder. The screw speed was between 130-150 RPM. The extruder was filled with 15gm material. We use three blending procedures.

- First PP and SEBS were blended in the twin screw extruder at 200⁰ C for 5 minutes.
- The three different components (PP, SEBS, SiO₂) and (PP, SEBS, Mica) were blended, at 200⁰ C for 5 minutes separately in the mixing chamber.
- The four components (PP, SEBS, SiO₂, and Mica) were loaded to the mixing chamber simultaneously and compounded at 2000 C for 5 minutes.
- The blend ratio between PP and SEBS were 80/20 Vol% of the PP / SEBS blend while the blend ratio of (PP/SEBS/SiO₂), (PP/SEBS/Mica), (PP/SEBS/SiO₂/Mica) were 80/15/5, 80/15/5 and 80/10/5/5 Vol% respectively.
- Specimens for different mechanical testing were prepared using a laboratory press, compression molding machine at 200⁰ C for 4 minutes.

RESULT AND DISCUSSIONS

Mechanical Analysis

Tensile properties Young's modulus (E) and yield stress were measured with a UTM Shimadzu apparatus at 23 °C and strain rate of 2 mm/min (ISO 527). The values of E of the blends were similar and slightly decreased with the elastomer content (Fig. 1). The incorporation of mica into pure PP gradually increased E. The values of E increased because of the incorporation of a filler with a significantly higher stiffness (170 GPA) as compared with the stiffness of PP (1.7 GPA). A gradual change of the spherulitic morphology of the PP matrix by the introduction of mica as well as plane-parallel orientation of mica crystals may affect E, additionally.

The addition of SEBS to PP/mica blend decreased E more significantly than the addition of silica because of the greater extent of the core-shell morphology in PP/SBES/Mica than in PP/SEBS/Silica blends with interlayer thickness as the determining factor.

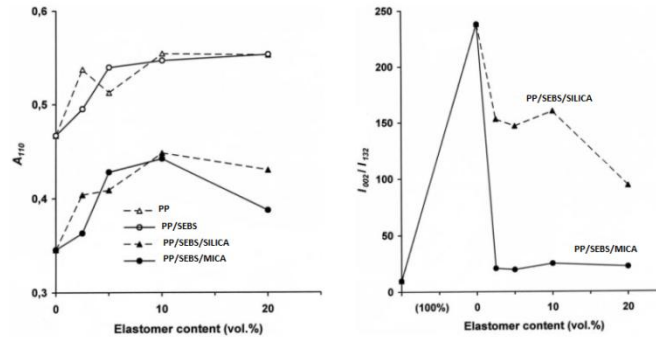


Figure 1: Dependence of Intensity and Orientation Ratio of PP Blends on Elastomer & Fillers

Morphological observation

PP/SEBS blends are actually immiscible two phase systems because of negligibly or small entropy of mixing. The fracture of the blends occurs mostly at the PP-SEBS phase boundary as in the case of PP blends. Unreformed, dispersed SEBS particles torn from the PP matrix can be clearly seen from the SEM micrographs of the fractured sample surfaces; Figure 2 illustrates the selected PP/SEBS blends. SEM micrographs of fractured sample surfaces in portraying the morphology in more detail.

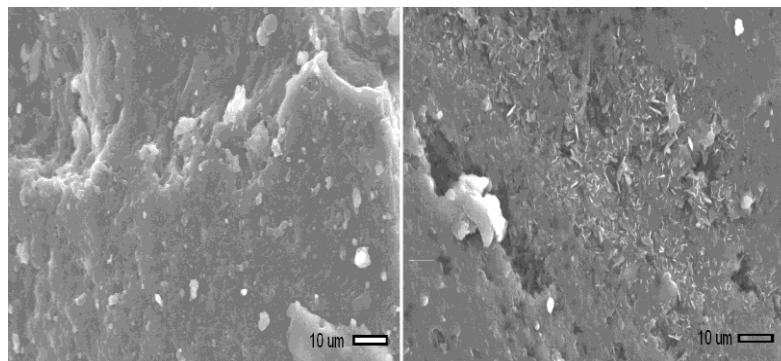


Figure 2: PP/SEBS blends mica filled fractured sample

CONCLUSIONS

SEBS encapsulated silica, crystals at a higher extent than the SEBS mica, thus causing the core-shell morphology and disorientation of plane-parallel mica crystals nucleated in the phase PP phase. The coalescence of the dispersed SEBS particles led to irregular elongated particles, whereas the dispersed phase of the silica in PP and SBES particles remained spherically shaped even at higher SBES contents. Thus, it can be concluded that mechanical properties are increased by the incorporation of elastomer however; evidence more about this may require higher studies for analytical and theoretical explanations.

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