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Modification and Characterization of Polypropylene Blending with High Impact Polystyrene by using Compatibilizers

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Abstract - This study proposes blending of polypropylene (PP) and high impact polystyrene (HIPS) that have a similar glass transition temperature to form PP/HIPS polyblend. We know that now a day's various evaluation and modification are going on to use this polymer material for high application performance like aviation and automobile etc. The use of polyblend is rapidly increasing because of low cost, low weight to strength ratio and lower density. The compatibility of the content PP and HIPS is influence by compatibilizers. Compatibilizer improves the mechanical and thermal properties of polyblend. The properties and compatibility of polyblend is examined by using tensile strength, melting temperature, melt flow index and impact strength. The blend containing ethylene vinyl acetate (EVA) showed a positive effect on flexibility of the blend and strength of the blend is also increased.

Key Words: polypropylene, high impact polystyrene, compatibilizers, polyblend and ethylene vinyl acetate, automobile.

1. INTRODUCTION

Polymer blend, defined as the mixture of two or more polymers and copolymers, has recently got much attention as a useful polymeric material for industrial purpose especially when the blend is having modified interface and morphology. Blends are synergistic polymer combinations with real properties derived from a high level of thermodynamic compatibility between components. In terms of processing technique including extrusion, injection molding and manufacturing conditions such as temperature and shear force. [1]

Polypropylene is one of the commodity polymer and has a good mechanical properties, thermal properties, ease of processing, excellent hinge properties and low cost. Its biggest disadvantage is low impact strength which can be improved by modification. Therefore a blending method, a most efficient and easy way has been widely used. For this modification we used high impact polystyrene as a modifier to improve toughening property of polypropylene. HIPS have a nearly same glass transition temperature to PP, which help in ease of processing and improve physical properties PP. polyblend is mostly carried out by melt blending. The properties of polyblend are depended on which technique/method of processing used. The essential factors of blend depend on processing temperature and shear force. However attention to the material degradation caused by high melting temperature is required. [2]

Blends can be divided into two categories, those in which compatibilization leads to a very fine dispersion and those in which some compatibilizing agent is added to facilitate the formation of desired morphology during subsequent processing. Co-crystallization and co-cross linking can often be the suitable morphologies that are resistant to coalescence. Strong base or ion dipole, hydrogen bonding and transition metal complexes have also thermodynamic miscibility of suitable sectionalized blend components and result in improved compatibility in a variety of systems of technical importance. More compatibility is promoted through decreasing surface energy or increasing on attraction with the segment capable of specific interaction and chemicals reaction with the blend components. The copolymers may also be enhanced through the addition of specific low molecular weight compounds, promoting copolymer formation and cross linking. [3]

2. EXPERIMENTAL PROCEDURE

2.1 Materials

Polypropylene granules were purchased from Reliance Industries Limited, Mumbai, Maharashtra. High impact polystyrene granules and ethylene vinyl acetate purchased from local market.

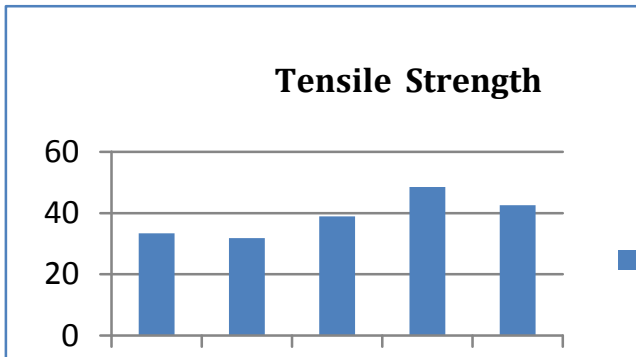
2.2 Procedure

Blend of different composition (HIPS: 20, 25, 30, 45 and 75 wt %) were prepared with fix amount of compatibilizer is added and mixed in high speed mixer, after which they are dried in the humidifier to remove moisture. The materials were first proceeding in extrusion to make small pallets. Then pallets of these materials processed in injection molding machine were suitable melting temperature (200,220,230) was set according to the composition suitability. A homogeneous mixture is form in the barrier and then these melt is injected in to the mold. Mold has a required shape of test specimens. Specimens prepared according to the size required for the testing of mechanical properties. The test specimen tested for different mechanical properties like tensile and impact test etc.

3. RESULTS AND DISCUSSIONS

3.1 Tensile Strength (ASTMD 638)

Tensile strength is defined as the maximum tensile stress sustained by a test piece during the tension test or ultimate strength of a material subjected to tensile loading. In other words, it is a measurement of the ability of a material to withstand forces that tend to pull it apart and to determine to what extend the material stretches before breaking. It is expressed in N/mm2. Tensile strength of the PP/HIPS polyblend is tested with UTM machine, as specified in ASTMD 638. Samples are prepared according to ASTMD 638 standard. [4]



Graph-1: Tensile Strength at different (PP/HIPS) compositions

The properties of composition illustrated in graph 1 is, the effect of different composition on the tensile strength. As we observe sample 4 have excellent tensile strength as compare others because of suitable composition of HIPS/EVA which improve the stiffness of blend. As compare with other composition have a less or more modification because of variation in composition.

3.2 Melt Flow Index (ASTMD 1238)

Melt flow rate is the rate of extrusion of a thermoplastic material through an orifice of designated dimensions under prescribed temperature and pressure. It is define as the mass of polymer in grams flowing in 10 minutes through a capillary of specific diameter (2.09 mm) and length (8 mm) by a pressure applied using a piston.

Flow Rate = (600/t × weight of extrudate)

Where, t is time of extrudate in sec. [5]

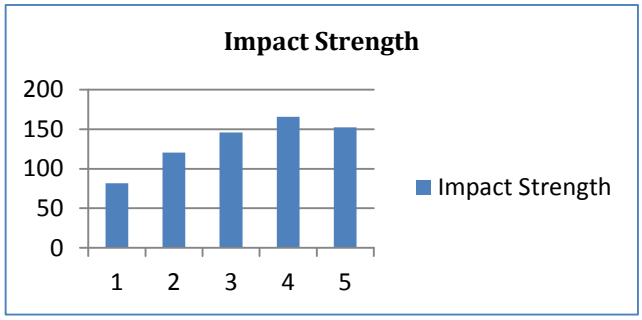
Test Specimens	MFT (g/10min)
Sample 1	10.58
Sample 2	6.27
Sample 3	5.84
Sample 4	4.51
Sample 5	3.25

Table -1: Melt Flow Index on different PP/HIPS composition.

Sample 1 have a high melt flow index as the less HIPS content in the composition. When the HIPS% increases the melt flow rate decreases. Melt flow index is an assessment of average molecular mass and is an inverse measure of the melt viscosity, i.e. high melt flow rate corresponds to low molecular weight. Higher MFI are used in injection molding and lower are used with blow or extrusion process.

3.3 Impact Strength (ASTMD 256)

Impact strength is defined as the ability to resist the fracture under shock loading or ability of material to resist the fracture under stress applied at high speed. It is expressed in J/m. Test specimen size is required as 64.5 × 12.7 × 3.2 mm (2.5 × 0.5 × 0.125 in). [6]



Graph-2: Impact Strength at different (PP/HIPS) compositions

Impact strength of the blend systems investigated was plotted against the blend composition in graph 2. Here the effect of composition observed addition of compatibilizers in the composition help to improve the impact strength. Sample 4 have good impact strength as compare others. Sample one has a less impact strength because of incompatibility of composition. The positive effects of impact strength in all composition occur due to presence of HIPS and EVA. The presence of butyl group in HIPS, yields the effect of toughness.

3.4 Heat Deflection Temperature (ASTMD 648)

Heat deflection temperature (HDT) is a relative measure of a materials ability to perform for a short time at elevated temperatures while supporting load. The test measures the effect of temperature on stiffness. It is define as the temperature at which a standard test bar (12.7 ×12.7×6.4mm) deflects 0.010 inch under a stated load of either 66 or 264 psi when heated at the rate of 2 C/minutes. [7]

Test Specimens	HDT
Sample 1	68
Sample 2	66
Sample 3	70
Sample 4	72
Sample 5	75

Table -2: HDT at different PP/HIPS composition

HDT of the blend was mentioned in fig 4. As the HIPS% increases heat deflection temperature will also increases.

4. CONCLUSION

Tensile strength of polyblend shows good result with addition of 45% HIPS in comparison with all composition. As per study tensile strength and modulus increases and percent elongation decreases with increase of rate of straining. Melt flow rate decreases with increasing percentage of HIPS in composition. Increase the percentage of crystallinity decreases the impact strength and increases the possibility of brittle failure. Pure PP is a crystalline material i.e., it shows a less toughness. Heat deflection temperatures show an improved temperature as increasing high impact polystyrene in composition.

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