

Blending of Polystyrene And Low Density Polythene To Enhance The Physical Properties By Using Compatibilizer-Styrene Ethylene/Butylene Styrene

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Abstract- Polymers are materials made of long, repeating chains of molecules. These polymers are blended to improve the properties. Blending is the process of combination of two or more polymers which produce a new polymer with improved properties. In this study blending is used to enhance the physical properties of Polystyrene/low density polythene (PS/LDPE) by using compatibilizer like styrene ethylene/butylene styrene. With this blending, the variation of thermal, mechanical and morphological properties of PS and LDPE with SEBS as compatibilizer is studied. Blends with different compositions of PS/LDPE in 100/0, 80/20, 60/40, 40/60, 20/80 and 0/100 wt% were prepared through melt blending in a twin screw extruder at a temperature of 200 °C and a screw speed of 60 rpm. The compatibilizer (SEBS) with 5% concentration of total weight of the blends was used. Various tests were conducted for the mechanical properties. Morphological behaviors was observed. It showed different variations in properties like tensile, flexural decreased and compressive properties increased with increase in LDPE content used in the blend. However the elongation at break of the blends tended to increase with increasing LDPE. Impact strength of the blends increase slowly with LDPE up to 40 wt%, after that it increases sharply with increasing LDPE. The impact energy of the LDPE –rich blends exceeded with that of pure LDPE. The optimum properties like elongation at break and impact strength of PS and LDPE blends are observed at 60 wt% of LDPE content in polystyrene and low density polyethylene blend.

Keywords- Polymers, polystyrene, low density polythene, blending, compatibilizer, extrusion.

I. INTRODUCTION

Blending is an efficient way to produce new polymers with improved properties. This study is focused on the blending of polystyrene (PS) and low density polyethylene (LDPE). It also improve some deficient properties of polymers. Despite the high performance, the cost of block and graft copolymers, the PS/LDPE blend system is considered

immiscible and incompatible due to benzene rings in the PS and straight carbon chains of aliphatic kind in the LDPE. So compatibilizer is used for miscibility purpose. One of the compatibilizer is styrene-ethylene/butylene-styrene, which is effective due to PS and EB blocks of SEBS are miscible with PS and LDPE blends respectively. By adding this SEBS observed improvements in properties through an affinity and polarity concept. In this study the effects of this compatibilizer on mechanical and thermal properties of PS/LDPE are reported. Compatibilizers are used to promote interfacial adhesion between pair of polymers which are otherwise immiscible.

1.1 Extrusion:



Fig 1.1 Twin screw extruder

1.2 Injection Moulding:



Fig 1.2 Injection Moulding

1.3 Universal Testing Machine



Fig 1.3 Universal Testing Machine

1.4 Tensile Strength



Fig 1.4 Tensile Strength

1.5 Flexural Strength



Fig 1.5 Flexural Strength

1.6 Compressive Strength



Fig 1.6 Compressive Strength

1.7 Impact Strength

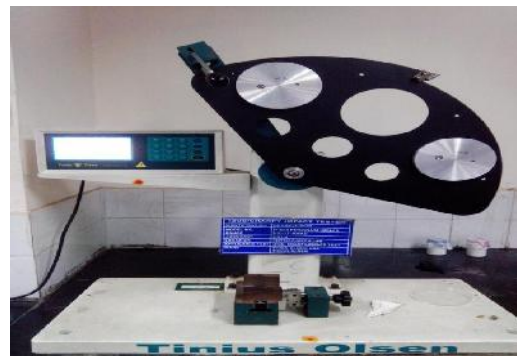


Fig 1.7 Impact Strength

1.8 Heat Deflection Temperature



Fig 1.8 Heat Deflection Temperature

1.9 Melt Flow Index



Fig 1.9 Melt Flow Index

1.10 Scanning Electron Microscope



Fig 1.10 Scanning Electron Microscope

II. MATERIALS AND METHODS

2.1 Materials Used:

Polystyrene, Low density polyethylene and styrene ethylene / butylene styrene (SEBS).

Table 2.1 The Materials and specifications

Material	Grade	Supplied by
Polystyrene(PS)	HPPS HH-30	H.P Polymers, Fathenagar, Hyderabad
Low density polyethylene(LDPE)	16MA400	H.P Polymers, Fathenagar, Hyderabad
Styrene-ethylene/butylene-styrene(SEBS)	99.5%CAS	Kinetic polymers, Jeedimetla, Hyderabad

2.2 Experimental procedure:

Preparation of blends:

Polystyrene (PS) and Low density polyethylene (LDPE) blends were prepared with different compositions of 100/0, 80/20, 60/40, 40/60, 20/80 and 0/100 by weight of 3 kgs and mixed. 150 grams of SEBS is added to every batch as compatibilizer. Then it is extruded in a twin screw extruder at 200°C and 60 rpm speed to get a uniform mixture. The product obtained is like a thin thread, is cut into pieces of 2 cm length and sent to injection molding. The polymer is melted and injected into the mold which can be fixed according to the

desired shape and size for testing. Then the polymer is cooled to make it solidify and is taken out for testing different physical, chemical and thermal properties. The specimen is tested mechanical properties like tensile, flexural, compressive and impact strength by using Universal Testing Machine. Thermal properties are tested by Heat Deflection Temperature, Melt flow index apparatus.

III. RESULTS AND DISCUSSIONS

3.1 tensile strength:

According to ASTM-D -790, tensile test was done at the cross head speed 5 mm/min with compatibilizer and without compatibilizer.

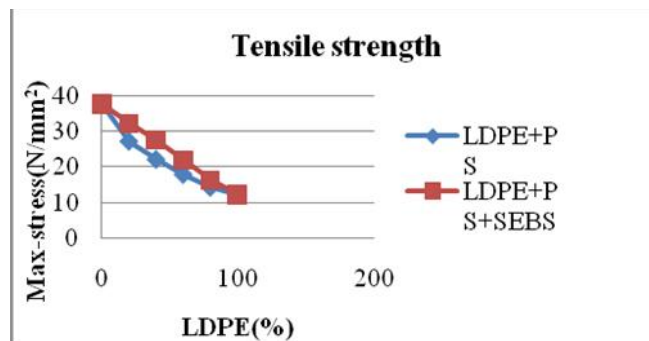


Fig 3.1: Effect of LDPE on Tensile strength of PS/LDPE blends with and without compatibilizer

From fig 3.1 observed that increase in wt% of LDPE decreases the tensile strength with compatibilizer slightly higher than without compatibilizer. This is due to pure PS exhibits a brittle fracture at low elongation.

3.2 Elongation at Break

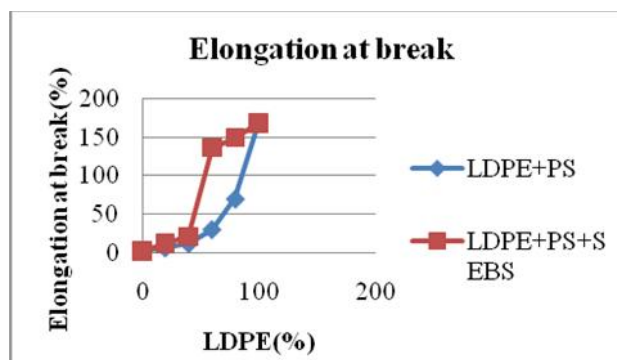


Fig 3.2 Effect of LDPE on elongation at break with and without compatibilizer

From fig 3.2 observed that the elongation at break increase gradually with increasing LDPE upto 40 wt%, and

then a sharp increase. It is noted that addition of 5 wt% SEBS resulted in overall improvement. So, SEBS is effective compatibilizer.

3.3 Flexible Strength

According to ASTM-D-790, flexural test was done at 100mm support span and 3mm/min rate of cross head speed with and without compatibilizer

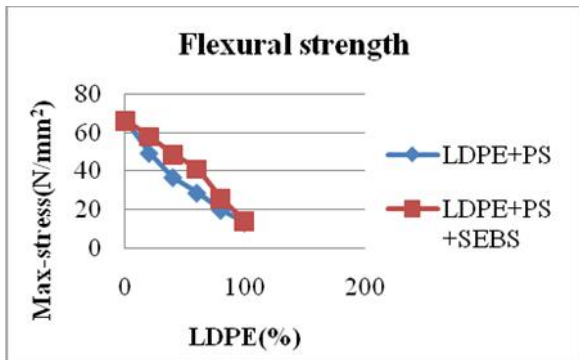


Fig 3.3 Effect of LDPE on flexural strength of PS/LDPE with and without compatibilizer

From fig 3.3 observed that flexural strength decreases with increase in LDPE. The flexural strength is higher for compatibilizer when comparing without compatibilizer.

3.4 Compressive Strength:

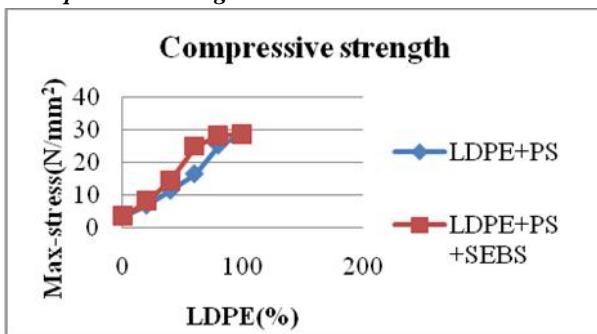


Fig 3.4 Effect of LDPE on compressive strength with and without compatibilizer

From fig 3.4 observed that compressive strength increases with increase in LDPE. The compressive strength is higher for with compatibilizer.

3.5 Impact Strength

According to ASTM-D-256, impact strength was done. The specimen is clamped vertically as a cantilever beam so that the notched end of the specimen is facing the striking edge of the pendulum

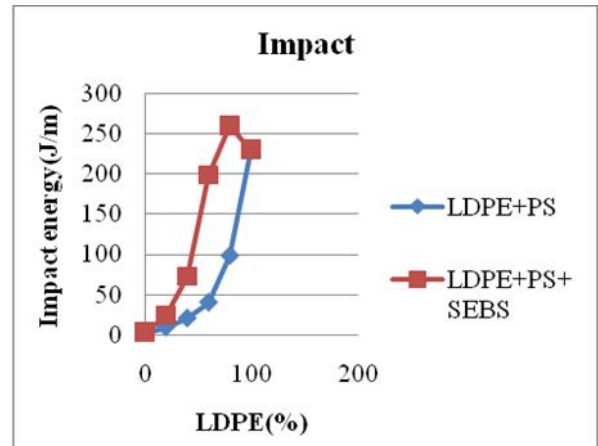


Fig 3.5 Effect of LDPE on impact strength of PS/LDPE with and without compatibilizer

From fig 3.5 observed that impact strength is increased slowly with 40 wt% of LDPE content, and then sharply increased. It is noted that 80 wt% of LDPE content is having more impact strength when comparing without compatibilizer.

3.6 Heat Detection Temperature:

It is the most important factor for finding the efficiency of engineering plastics. It is the temperature at which a polymer deforms. This property can be applied in product design, engineering, and manufacturing of products using thermoplastic components. This test was conducted according to ASTM-D-648. The test specimen is loaded in three point bending in edgewise direction at 18.5kg/cm² outer fiber stress and temperature is increased by 2°C/min until the specimen deflects 0.254mm.

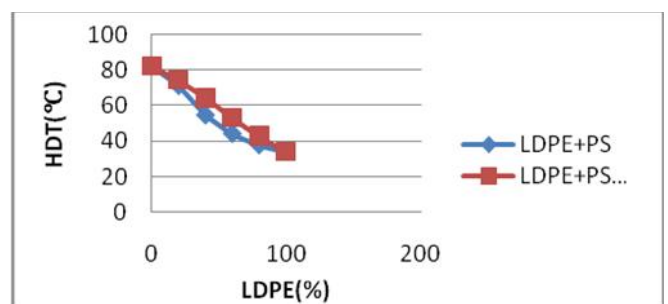


Fig 3.6 Effect of LDPE on HDT with and without compatibilizer

From fig 3.6 observed that the HDT decreases with increasing LDPE.

3.7 Melt Flow Index

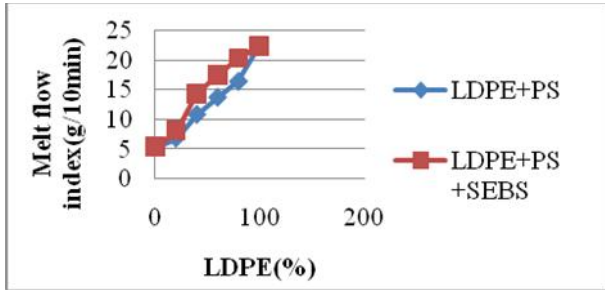


Fig 3.7 Effect of LDPE on melt flow index with and without compatibilizer

From fig 3.7 it is observed that MFI is increased with increasing LDPE content.

3.8 Scanning Electron Microscope (SEM)

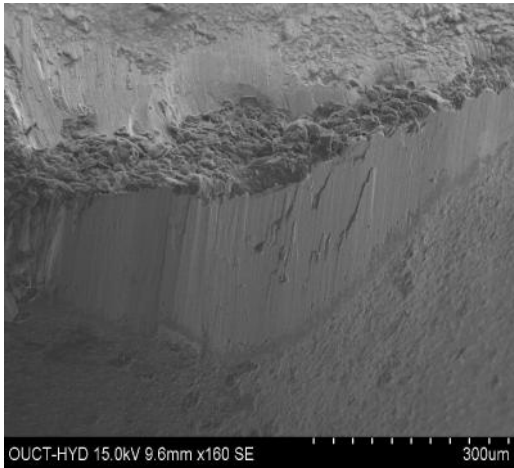


Fig 3.8 100wt% polystyrene

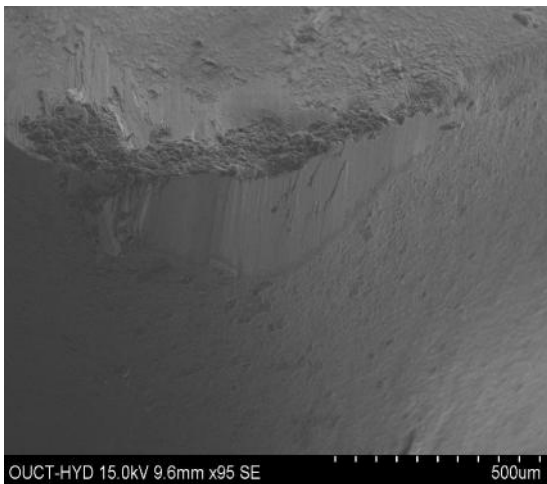


Fig 3.9 100wt% LDPE

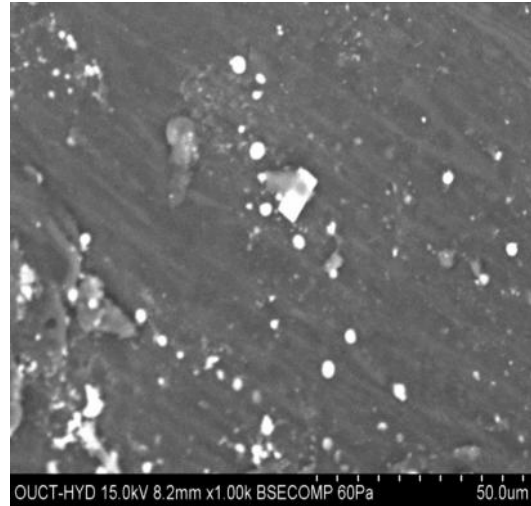


Fig 3.10 40/60 wt% PS/LDPE without SEBS

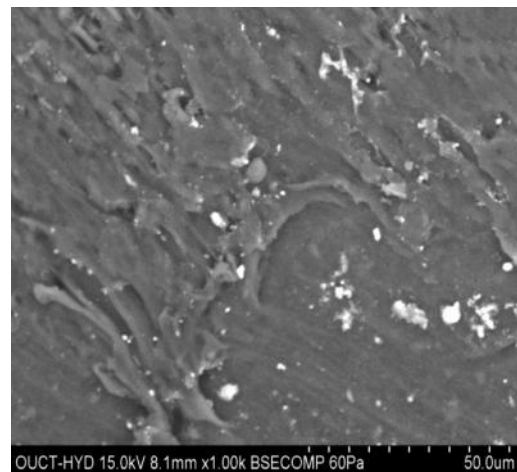


Fig 3.11 20/80 wt% PS/LDPE without SEBS

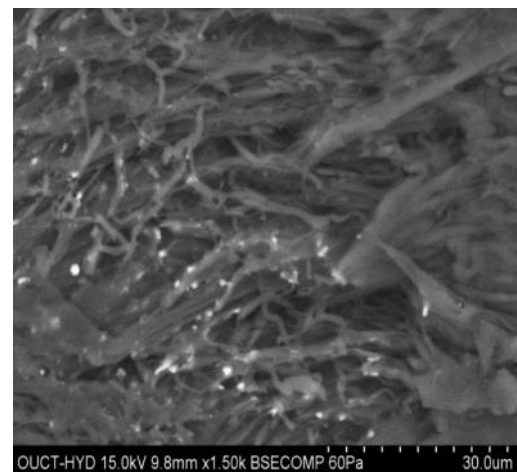


Fig. 3.12 40/60 wt% PS/LDPE with SEBS

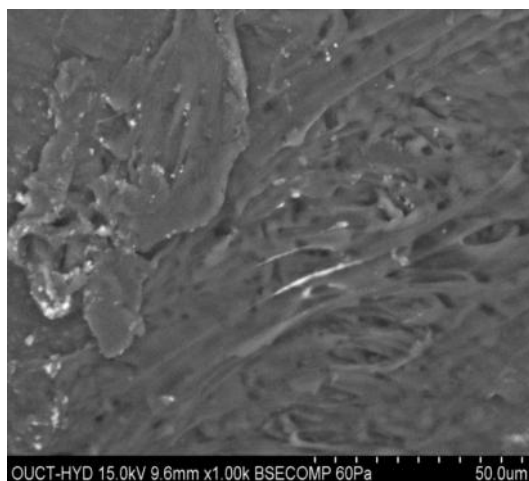


Fig. 3.13 20/80 wt% PS/LDPE with SEBS

The Scanning Electron Microscope photos of PS/LDPE blends and PS/LDPE/SEBS blends are shown in Fig 3.8 to 3.13. These demonstrate a typical matrix droplet structure, which indicates immiscibility between PS and LDPE as shown in fig 3.10 and 3.11. It can be observed that matrix droplets in PS/LDPE blends decreases at SEBS, and size distribution also becomes more uniform in the fig 3.12 and fig 3.13.

It is observed from fig 3.12 and fig 3.14, the average diameter of the dispersed PS phase becomes smaller as the weight fraction of LDPE increases in the PS/LDPE/SEBS blends. Which indicates that SEBS increases the interfacial adhesion between the PS and LDPE blends and miscibility increases as LDPE increases. The optimum miscibility of PS and LDPE blends with SEBS is obtained at 40/60 wt% of PS/LDPE blends.

IV. CONCLUSIONS

In this study a cheaper and flexible, toughened and better commercial grade polymer are produced. It stated that improved properties are observed when compared to individual polymers without compatibilizer which results in reducing production cost for materials which require the use of expensive material. Tensile and flexural properties decreased with increase in LDPE composition due to increase in interfacial adhesion of the polymer blends. The elongation at break of the blends increases with increasing LDPE up to 40 wt% and then increases sharply with increase in LDPE. Compressive properties increased with increase in LDPE in the blends of PS and LDPE. Impact strength of the blends increases slowly with LDPE up to 40% and then it increases with increasing LDPE. The impact energy of the LDPE-rich blends exceeded that of pure LDPE at 80 wt% of the LDPE content. Heat deflection Temperature. Heat deflection

Temperature decreases with increase in weight percentage of LDPE. Melt flow index value increases with increase in LDPE weight percentage. Morphological observation showed that the blends with SEBS as compatibilizer are miscible, increase the interfacial adhesion and decreases the phase dispersion between the components. The optimum miscibility was obtained at 40/60 wt% of PS/LDTE blends.

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