



Studies on Mechanical Properties of ABS – NYLON 66 POLYBLEND

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ABSTRACT

Polymer blends are capable of providing materials which extend the useful properties beyond the range that can be obtained from single polymer equivalents. Blends of Acrylonitrile-Butadiene-Styrene (ABS) and Nylon 66 were prepared in different ratios in presence of styrene – maleic anhydride copolymer as a compatibilizer by melt blending technique which was carried out using an extruder which was followed by injection moulding process. Nylon 66 at different weight ratios was incorporated into the blends to study the effects of blend ratio on the properties of the blend. This study focused upon tensile, flexural, and impact properties of ABS – Nylon 66 polymer blends.

Key Words: Polymer blends, Nylon 66, ABS, mechanical properties

INTRODUCTION

Blending of two or more polymers has emerged as an established route to design tailor made polymeric materials with desired attributes for various high performance applications [1-4]. It provides a means of producing new materials, which combine the useful properties of all the constituents. However, most of the polymer pairs are inherently immiscible that results in incompatibility with subsequent phase separation in the blend matrix. Different approaches such as use of compatibilising agents, copolymers, grafting agents, reactive extrusion etc., have been the commonly used techniques to modify the interfacial region between the blends and increase the compatibility [5, 6].

Compatibilizers are commonly used to promote blending of immiscible homopolymers. Industrially it is much more common to generate a compatibilizer by an interfacial chemical reaction between reactive polymers. Some homopolymers are inherently reactive, e.g., polyamides have primary amine end groups and polyesters have carboxylic acid or alcohol end groups. In other cases, reactive polymers may be added to otherwise inert phases specifically to promote reactive

compatibilization. The reactive groups then arrive at the interface by diffusion, usually aided by the flow applied by the blending operation, resulting in compatibilizer formation at the interface. The reactive compatibilization is that where an end-functional chain in one phase reacts with a multifunctional chain in the other to form a graft copolymer at the interface. [7-10] Numerous reactively generated compatibilizers are graft copolymers, and for this reason, in some of the literature, "grafting" is virtually synonymous with reactive compatibilization. Graft copolymers can also be formed from reactions such as transesterification involve pendant groups. There are cases in which both reactive species are multifunctional in such cases; the compatibilizer is not expected to be a graft copolymer, but instead a crosslinked network. The distinction between graft architecture and a crosslinked one is not a sharp one. When the functionality of the reactive species only slightly exceeds one reactive group per chain, a highly branched copolymer architecture is expected. With increasing functionality, a true network structure is expected [11-14]. In blends of Nylon-66 with ABS stems from the possibility of combining the desirable characteristics of both of these materials. Blends of Nylon-66 with ABS materials are of significant commercial interest. Nylon-66 provide good strength, stiffness and resistance to non-polar Nylon-66 solvents, whereas ABS materials provide toughness and low cost. Although simple blends of Nylon-66 and ABS exhibit poor mechanical properties, their properties can be greatly improved, often with synergistic effects, through appropriate compatibilization. [15-16] Nylon-66 being a versatile engineering plastic lacks some properties like difficulty in processing, moisture absorption, dimensional instability, sharp melting, lower impact which decreases its area of applications. But it gives superior tensile strength, self lubrication, wear resistance. At this juncture blending with ABS can lead to overcome the limitation and widening the application of Nylon-66. As the chemical resistance of both the polymers is appreciably good they can also be used in biomedical implants, e.g. knee caps; limbs [17-20]. As Nylon-66 and ABS both are leading engineering material used in various applications and up to a certain extent have replaced metals too. Although they have good structural, chemical and mechanical properties, they both tend to have few disadvantages individually. The blending characteristics were increased by addition of compatibilizer as styrene –maleic anhydride copolymer as compatibilizer.

MATERIALS AND METHODS

Materials

Materials and equipment

The materials used in this investigation are as following:

Nylon-66 supplied by Dupont and Acrylonitrile-Butadiene-Styrene (ABS) terpolymer obtained from BASF. Both polymers were dried in vacuum at 90°C (Nylon 66) and 70°C (ABS) for a period of 24 h before processing. Styrene, maleic anhydride and all other chemicals used were of LR grade.

Styrene – Maleic anhydride copolymer (SMA)

Take styrene (85gm), maleic anhydride (15 gm.) and benzoyl peroxide as a initiator (1%). Butanol used as a solvent (100 ml.) in solution polymerization. The temperature of medium is 70-80°C temperature for the 4 hours time period. After reaction time perid the viscosity of the reaction medium is increased and the polymer is precipitated in presence of methanol. The obtained product were dried at 55-60°C temperature. The yield of styrene –maleic anhydride (SMA) copolymer was 60% and it is characterized by its acid value.

Preparation of polyblends of ABS and Nylon 66

Batch Formulation: Total batch size was 300 gm.

Batch No.	Proportion of ABS (%)	Proportion of Nylon 6,6 (%)	SMA (%)
1.	100	0	0
2.	90	10	1
3.	85	15	1
4.	80	20	1
5.	75	25	1
6.	70	30	1

Drying: Prior to melt blending Nylon 66 was dried in an oven with blower for 4-6 h at 90-100°C and ABS were dried in an oven with blower for 4 h at 80°C.

Mixing: All ingredients were weighed according to formulation and poured into the high speed mixer and mixed at 100 rpm for 3 min.

Melt Blending: The mixer prepared from above was fed into a twin screw extruder and blended at 225-230°C through a die the melt was extruded at into a water bath and then cut into uniform granules.

Sample Injection: Prior to injection moulding, the granules obtained above were dried in an oven with blower for 4-6 h at 105 - 110°C. The dried granules were injected to form the test samples by an injection moulding machine. The injection moulding machine was set in the range of 225-230°C, injection time was 20 second, injection pressure was 75 MPa., the time of pressure retention was 30 second, the cooling time was 30 second and the mould temperature in the range of 60 -90°C.

Test Conducted

Acid value determination of SMA copolymer

Weight accurately 0.5gm of given sample and transfer it into 250 ml conical flask. Add 25 ml of butanone as a solvent and shake vigorously to dissolve the sample. Add 2-3 drops of indicator and titrate against standard alcoholic KOH solution until pink color is observed.

All mechanical properties were measured as per standard ASTM procedure given in literature [21] which is discussed as follows.

Tensile Testing

Samples were cut according to ASTM D 638 specimen dimensions. The machine that was used for the testing of tensile properties is Universal Testing Machine. The test was conducted at velocity 50 mm/min at ambient temperature (28 °C). Three specimens of each formulation were tested and the average values were reported.

Flexural Testing

Flexural Test was also conducted using Universal Testing Machine. According to ASTM 790. For testing, the support span was fixed at 100 mm and the rate of crosshead motion at 3 mm/min. Three specimens of each formulation were tested and the average values were reported.

Impact Testing

The Izod Impact Machine was used for this testing, where 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.

The dimensions of the sample specimens conform to ASTM D256. Three specimens of each formulation were tested and the average values were reported.

RESULTS AND DISCUSSION

The tensile strength, flexural strength and izod impact strength of ABS – Nylon 66 blends in different proportion in presence of 1% SMA is shown in Table 1, 2 & 3. The data shows that tensile strength is increase with increase in percentage of nylon 66. ABS which is having the rubbery main chain of polybutadiene so it is having lower tensile strength but nylon 66 having higher tensile strength than ABS. The increase in property also observed the effects of compatibilizer i.e. SMA. Compatibilizer increase the compatibility of both individual polymers but this will shows upto 25% addition of nylon 66 and then after increasing than Nylon 66 resulting in lower tensile strength of blend than PC. So this was the comparison of PC & blend but in blend tensile strength further increases with increase in treated ABS weight percentage (MAN, styrene treated batch even better than MAN treated batch). Increase in tensile strength using treated ABS may be due to the treatment of ABS which gives better compatibility between ABS and PC, which results in better stress transfer between the filler and matrix. In case of MAN, Styrene treated batch the grafting percentage of MAN has increased resulting in even better compatibility between ABS & PC, hence more tensile strength

Flexural Strength:

The flexural strengths of blends are shown in Table 2 & Figure 2. The data shows that flexural strength decreases with increase in ABS weight percentage. This may be due to ABS, which is having the rubbery main chain of poly-butadiene so it is having lower flexural strength than PC resulting in lower flexural strength of blend than PC. So this was the comparison of PC & blend but in blend flexural strength further increases with increase in treated ABS weight percentage (MAN, styrene treated batch even better than MAN treated batch). Increase in flexural strength using treated ABS may be due to the treatment of ABS which gives better compatibility between ABS and PC, which results in better stress transfer between the filler and matrix. In case of MAN, Styrene treated batch the grafting percentage of MAN has increased resulting in even better compatibility between ABS & PC, hence more flexural strength

Impact Strength:

The Impact strengths of blends are shown in Table 3 & Figure 3. The data shows that izod impact strength decreases with increase in ABS weight percentage. This may be due to ABS, which is having lower izod impact strength than PC resulting in lower impact strength of blend than PC. So this was the comparison of PC & blend but in blend impact strength further increases with increase in treated ABS weight percentage (MAN, Styrene treated batch even better than MAN treated batch). Increase in impact strength using treated ABS may be due to the treatment of ABS which gives better compatibility between ABS and PC, which results in better stress transfer between the filler and matrix. In case of MAN, Styrene treated batch the grafting percentage of MAN has increased resulting in even better compatibility between ABS & PC, hence more flexural strength.

CONCLUSION

In the present work the polymer blends are prepared ABS – Nylon 66 and an effect of SMA has been studied by varying the weight percent of treated Nylon 66 respectively. The results show that physico-mechanical property of blend increase as the weight percent of Nylon 66 increases in the

blend but only flexural strength of polymer blends shows decrease in results due to ABS. 10 to 25 weight percentage of Nylon 66 with 1% SMA appears to be an optimum concentration for achieving better tensile strength properties and above the ratio of 25 weight percentage of Nylon 66 with 1% SMA decreased the tensile & impact strength properties.

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