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CHARACTERIZATION OF ABS COMPOSITES REINFORCED SHORT GLASS FIBER

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ABSTRACT

Acrylonitrile Butadiene Styrene (ABS) has several mechanical applications such as gears, bearings, washers etc. In these applications, wear is the primary cause of failure. In this study ABS from e-waste was reinforced with short glass fibers (SGFs). The effects of SGF concentration, on the mechanical properties of the composites were examined. Increasing the SGF concentration at a weight ratio of 5 and, 30% resulted in improved tensile strength, tensile modulus, but drastically lowered the strain-at-break. Extrusion process was used for reinforcement and bonding between ABS and SGF which are supported by scanning electron micrographs of the ABS/ SGF composites, which exhibited an improved adhesion between the SGFs and ABS matrix.

KEYWORDS: ABS, Short Glass Fiber, Reinforcement, Composites, Polymer

INTRODUCTION

Glass fiber-reinforced polymeric materials are widely used as structural materials in many engineering applications. Because they offer several advantages, such as ease of processing, the possibility of obtaining complex shapes, higher strength/density ratio, and recycling, short glass fiber (SGF)-reinforced thermoplastics are of great commercial and scientific interest [1]. It is known that some properties of plastics are improved by the incorporation of SGF with economical processing methods such as extrusion and injection molding [1, 6]. The properties of SGF-reinforced thermoplastics depend not only on the properties of the matrix and fiber, but also on the glass fiber content, orientation and aspect ratio of the fibers, distribution, and fiber/matrix adhesion [7-9].

The high toughness values, dimensional stability, and good surface texture of acrylonitrile-butadiene-styrene (ABS) terpolymer make it an important material for industrial applications [4, 5]. Previous studies showed that incorporating SGFs into recycled ABS to balance the toughness and stiffness resulted in an improvement of tensile strength and modulus values, but a decrease in toughness. Few studies also showed that the adhesion between ABS and glass fibers was scurry [2, 3, and 10].

In this study we aimed to produce SGF reinforced ABS materials by extrusion to observe the effects of the SGF loading level on the mechanical and morphological properties of composites as well to observe the effects of interfacial adhesion between the fibers and the polymer matrix.

MATERIALS AND EXPERIMENTAL PROCEDURES

Materials

Both ABS and glass fibers were taken from waste. Source of ABS was electronic waste and for glass fiber FRP industrial waste was converted into short glass fiber.

Composite Production

Before processing, ABS and short glass fibers granules were dried in a vacuum oven for 2 hr at 60°C. Composites containing 5, 10, 20, and 30 wt% SGF were prepared by melt-mixing in a single screw plastic extruder. The ABS granules and glass fibers were fed from the main feeders. The molten composite obtained from the die of the extruder was water-cooled and pelletized. The process condition from feed to die was kept as shown in Table 1 respectively. Thus we obtained granules of processed ABS (PABS) and SGF composite. The specimens for the mechanical characterization were moulded using a hydraulic press machine at 220°C and sheets were formed. The hydraulic press machine used in this study was a hot press hydraulic press. The principle of the operation is that the preweighed (about 26 g) raw material is loaded into the die of 100x100x2mm size placed between two support plates. Then the plastic granules are allowed to melt between hot plate presses machines for 15 min, once the material is melted supply of water is done to allow its cooling.

Table 1: ABS was First Extruded at the Given Conditions then Compounded with SGFS at the Same PROCESSING Conditions in the Second Extrusion Step

Sample	ABS	SGF Wt %	Barrel Temp °C)	Screw Speed
PABS	100	0	150 190 200	20
PABS5GF	95	5	155 195 210	15
PABS10GF	90	10	155 195 210	15
PABS20GF	80	20	155 195 210	15
PABS30GF	70	30	155 195 210	15

Mechanical Testing

Tensile tests were performed according to ASTM D 638 by using a Tinius Olsen 25K universal testing machine on dumbbell samples (2 mm x 10 mm cross-section; gauge length 40 mm). A crosshead speed of 2 mm/min was used.

Scanning Electron Microscopy (SEM)

A low-voltage scanning electron microscope (JEOL JSM-6400) was used to analyze the tensile fracture surfaces of the composites. Fractured surfaces were coated with gold to provide conductive surfaces.

FIBER Length Measurements

As shown in Figure 1 (a), about 150 fibers were randomly selected from the crushed glass fibers. The glass fibers were observed in SEM. The photograph obtained from the scanning electron microscope (JEOL JSM-6400) was analyzed after digital scaling to measure the fiber lengths. The lengths were measured manually from the pictures by utilizing callipers with a precision of 0.05 mm. After the measurement the range of fibers can be seen in Figure 1(b) which shows that most of the FIBERS are between 200-300 microns.

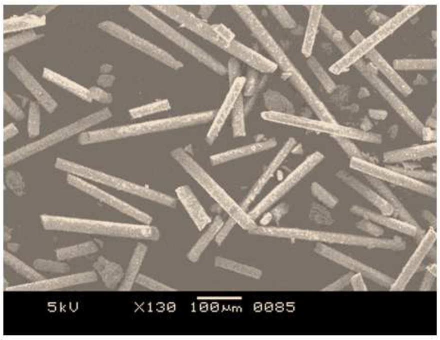

Figure 1: (a) SEM of Short Glass FIBER

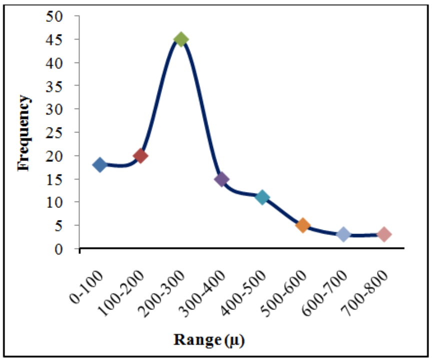

Figure 1: (b) Size Distribution of Glass Fibre

RESULTS AND DISCUSSIONS

Effect of Short Glass FIBER (SGF) Concentration on Tensile Strength

In Figure 2 the tensile strength of PABS was obtained. Further for PABS5GF the tensile strength obtained was found to be maximum. With further increase in content of short glass fiber the tensile strength get lowered for PABS10GF and PABS20GF. But when highest SGF concentration material tested that is PABS30GF the tensile strength improved. The different pointer shows the variation in tensile strength due to SGF .

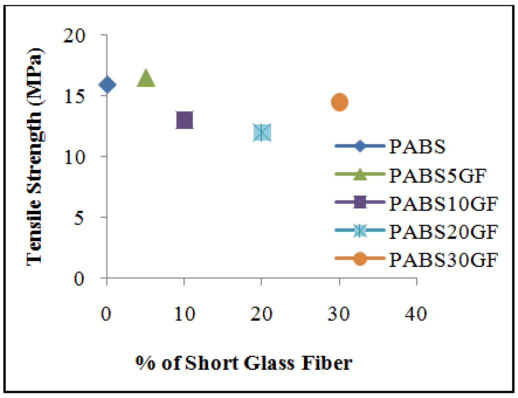

Figure 2: Tensile Strength vs. % of Short Glass Fiber

Hardness Test

Notch hardness can be found using Rockwell hardness test. A constant load of 150N was applied for testing these samples. The hardness values were enhanced as moving to higher percentage of SGF reinforcement in processed ABS.

Table 2: Hardness Value for the PABS and Composite of PABS with SGF

Material	Hardness Value
PABS	103.2
PABS5GF	104.1
PABS10GF	106.5
PABS20GF	109.6
PABS30GF	112.0

Tensile Properties

The relation between extension and applied load (100 N at speed of 2mm/min) for each sample is shown in following figures.

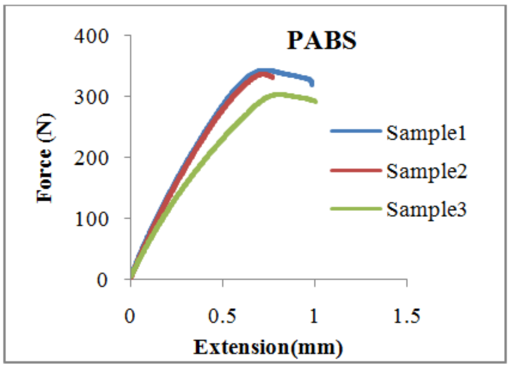

Figure 3(a): It Shows Processed Having Highest Extension on Application of Load Which Shows the Elastic Property in the Material

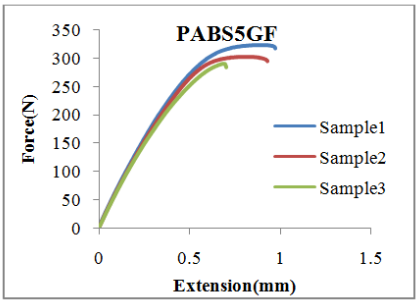

Figure 3(b): At Initial Content of SGF the Elasticity of Composite was Equivalent to Processed ABS for Samples

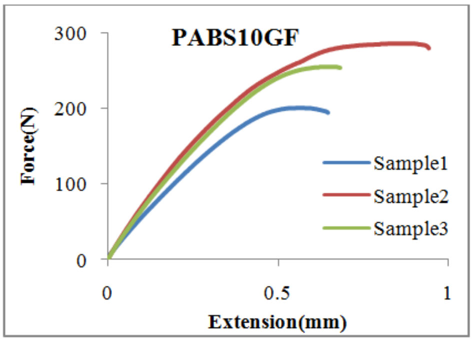

Figure 3(c): For both Samples 1, 3 the Extension Reduced to Half but Sample 2 was Similar to PABS

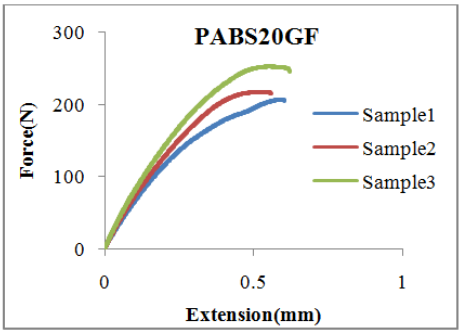

Figure 3(d): All Samples are having Equivalent Extension Value and Load Competence

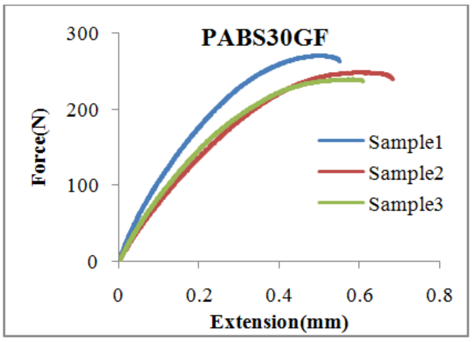

Figure 3(e): At Highest Content of SGF the Extension was Similar to Other Composite But Have Higher Load Variable

SEM Characterization

For SEM characterization observation of fractured surface of tensile specimen was done. From the fracto-graph of PABS and its composite was observed.

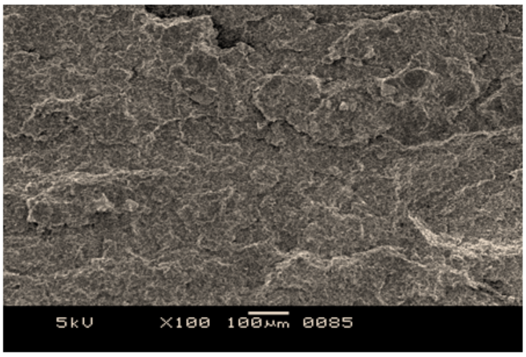

Figure 4: (a) PABS after Extrusion Process there are Various Changes in the Structure of ABS, as There are Small Voids as well as Coarse Grains Size was developed as Shown in Figure 4 (A)

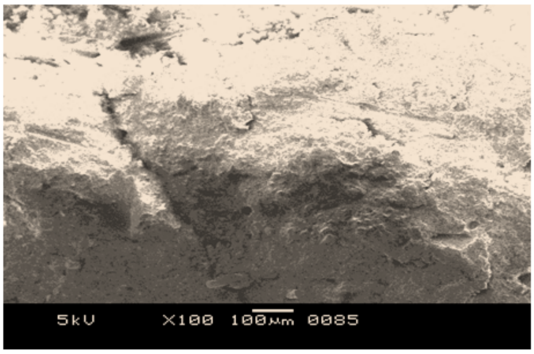

Figure 4(b): PABS5GF

In Figure 4 (b) introduction of Short glass fiber was initial done. The holes which are gnerated on the surface shows the detachment of SGF from the ABS matrix.

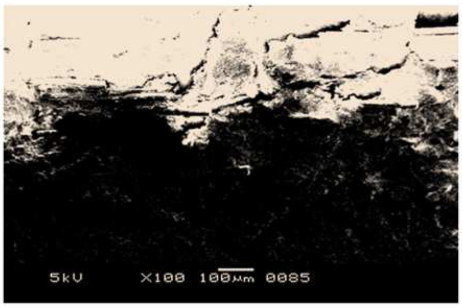

Figure 4(c): PABS10GF

Increase in percentage of SGF to 10% the fractured surface having larger voids and grain size. Irregular surface structure in Figure 4 (c) shows the effect of tensile force.

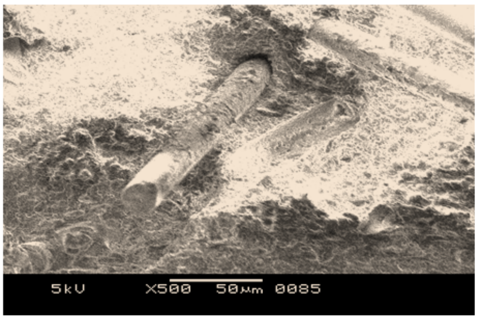

Figure 4 (d): PABS20GF

Further with increased SGF content the bonding of fibers and ABS get more stronger . The fibers attached to matrix in both transverse and longitundal direction shown in Figure 4 (d).

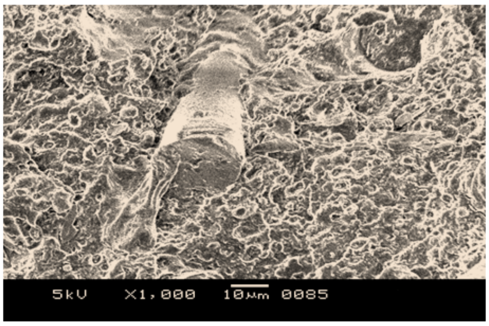

Figure 4(e): PABS30GF

In the final composition SGF is highest and fibers have been observed at higher magnification. Broken fiber surface in Figure 4 (e) shows the strong bond between ABS and SGF.

CONCLUSIONS

When the SGF concentration increased in the processed ABS from 5 ,10, 20, 30 wt%, the tensile strength, tensile modulus, was improved for PABS5GF and PABS30GF but strain value lowered apporximately by 0.30% for all the composite. Increasing the concentration of glass fibers also shows better bond between PABS and SGF. The extrusion temprature for PABS and composite material does not affect the mechanical properties, but the strain at the break was reduced througout the composite testing. The size of Short glass fibres was below 1000 micron(10mm), With increase in SGF concentration the fractured surface of the tensile specimens of PABS5GF, PABS10GF, PABS20GF, PABS30GF material showed the property to withstand break force of 238.2, 242.0 , 245.4, 261.8 N respectively at test speed of 2mm/min. The glass fibers were found broken and detached in PABS5GF and PABS20GF which provides the confirmation about the bonding of SGF with PABS.The scanning electron microscopy images support a well-established interfacial adhesion in the PABS/SGF composites.

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