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DEVELOPMENT AND CHARACTERIZATION OF NATURAL FIBER REINFORCED COMPOSITES

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Abstract: During the last few years, natural fibers have received much more attention than ever before from the research community all over the world. These natural fibers offer a number of advantages over traditional synthetic fibers such as low environmental impact and low cost. In the present paper, a study on the synthesis and mechanical properties of natural fiber reinforced composites has been reported. The materials considered for this study are Polypropylene based natural fiber reinforced composites made by compression molding. The natural fibers used as reinforcement in this study are Grewia-Optiva, Nettle and their hybrid consisting of both Grewia-Optiva and Nettle. The results indicate that, the mechanical properties of hybrid type of composite are superior when compared to other two types of composites.

Keywords: Natural Fiber, Polymer Composites, Grewia-Optiva, Nettle, Hybrid Composites

1. INTRODUCTION

Since the past few decades, research and engineering interest has been shifting from traditional polymeric materials to ûbre-reinforced polymer-based materials due to their unique advantages of high strength to weight ratio, non-corrosive property and high fracture toughness [1]. These composite materials consist of high strength ûbers such as carbon, glass and aramid, and low strength polymeric matrix. Glass fiber and carbon fiber reinforced plastics have been developed and are being commercially used in various applications ranging from household goods, sports goods, aerospace and automobile industries, etc.

The use of these synthetic fiber reinforced plastics have now imposed severe environmental concerns due to non-renewable and non-biodegradable nature of the petroleum derived plastics, as well as synthetic fibers [2].

An alternative to overcome this problem is being explored worldwide by replacing synthetic fibers with natural fibers as a reinforcement in plastics. A comparison of various parameters between natural fibers and glass fibers is shown in Table 1.

Table 1
Comparison Between Natural Fibers and Glass Fibers [3-5].

Attribute	*Natural fibers*	*Glass fibers*
Specific weight	Low	High
Specific strength	High	Low
Bending stiffness	High	Low
Impact strength	Low	High
Density	Low	High
Wear of tooling	Low	High
Fire resistance	Poor	Good
Cost	Low	High
Recyclability	Possible	Not possible
Disposal	Possible	Not possible

The classification of natural fibers based on their origin is shown in Fig. 1.

Most of the investigations reveal that, the mechanical properties of natural fiber reinforced polymer matrix composites are controlled mainly, by the volume fraction of the fibers, fiber-matrix adhesion, fiber-aspect ratio and fiber orientation [7].

A number of investigations have been made on various natural fibers such as kenaf, hemp,

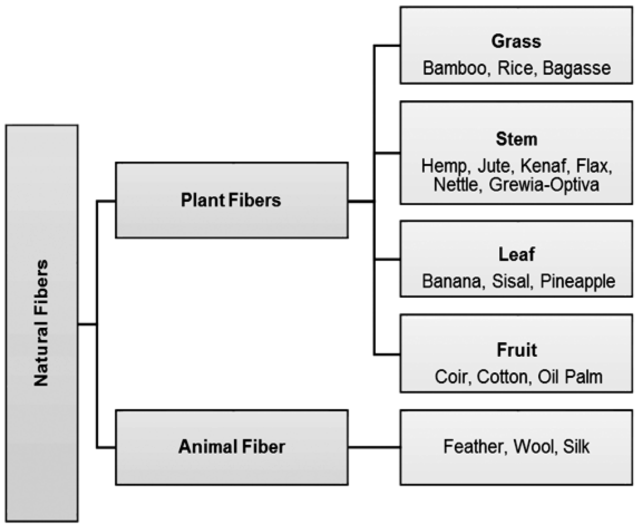

Figure 1: Classification of natural fibers, based on origin [6]

flax and jute, to study the effect of these fibers on mechanical behaviour of composite materials [8-10].

In the present study, natural fiber reinforced polypropylene composites have been developed using compression molding. The mechanical properties in terms of tensile and flexural strength of grewia-optiva, nettle, and hybrid (grewia-optiva + nettle) fiber reinforced polypropylene based composites have been compared.

2. MATERIALS AND METHODS

Nettle (N) and grewia-optiva (GO) fibers, in mat form were supplied by Uttrakhand Bamboo and Fiber Development Board, Dehradun, India. Polypropylene (PP) was obtained from Indian Oil Corporation Limited (IOCL).

Before composite processing, natural fibers, PP pellets were dried in oven at 70°C for 4 hours to ensure that all absorbed moisture was removed. PP pellets were converted into PP films of 1 mm thickness by compression at a temperature of 170°C on compression molding machine for a contact time of 8 minutes followed by cooling under pressure and finally PP film was removed at 80°C. Composite laminates were prepared by placing the alternate layer of PP film and fiber mat. Two layers of fiber mat and three layers of PP were used. At top and bottom, Teflon sheets were used to avoid sticking of PP films to the aluminum plates. High pressure and temperature was applied on stacked layers of PP films and fiber mat for 10 minutes and cooling was performed under pressure. Composite laminates were removed from the mold when temperature was 80°C.

Three different compositions consisting of N+PP, GO+PP and GO+N+PP (hybrid) were fabricated.

2.1. Mechanical Testing

2.1.1. Tensile Testing

Samples for tensile testing were cut from the developed composite laminates and tests were performed using universal testing machine (UTM) (Instron: 5900 series) in accordance with ASTM 3039. The crosshead speed was kept as 1.5 mm/min. five samples were tested for each type of composite and mean value is taken for comparison.

2.1.2. Flexural Testing

Flexural tests were performed in accordance with ASTM D790 on UTM using 3 point bending fixture. The span length and thickness of the specimens was 64 mm and 4mm respectively. The tests were performed at a crosshead speed of 2mm/min.

3. RESULTS AND DISCUSSION

3.1. Tensile Properties

The effect of reinforcing polypropylene with different fibers grewia-optiva, nettle and hybrid (grewia-optiva and nettle) on tensile strength is graphically represented in Fig. 2. The hybrid composites having 2 alternate layers, each of grewia-optiva and nettle fiber mats (PP/GO/N) has resulted in 143.2% and 22.6 % increase in tensile strength as compared to PP/GO and PP/N respectively. This may be attributed to the better interfacial bonding between matrix and hybrid reinforcement.

3.2. Flexural Properties

The flexural strength of the developed composites has been represented in Fig. 3. The flexural strength of the developed composites is compared. It was observed that the hybrid composites (PP/GO/N) exhibit higher flexural strength compared to PP/GO and PP/N. The flexural strength of hybrid composites is increased by 121.7% and 47.26% with

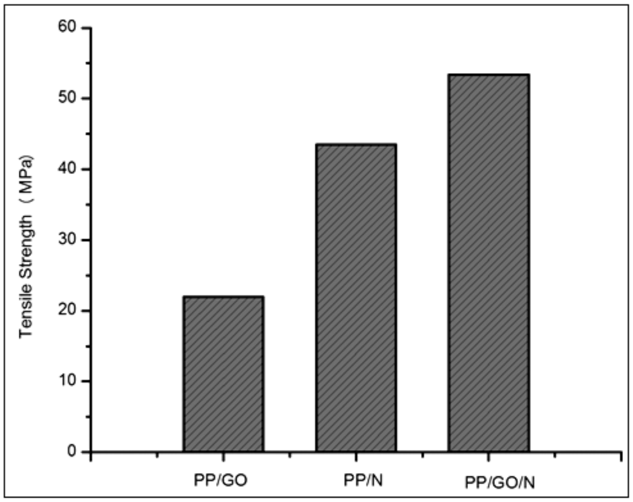

Figure 2: Tensile strength of PP/GO, PP/N and hybrid (PP/GO/N)

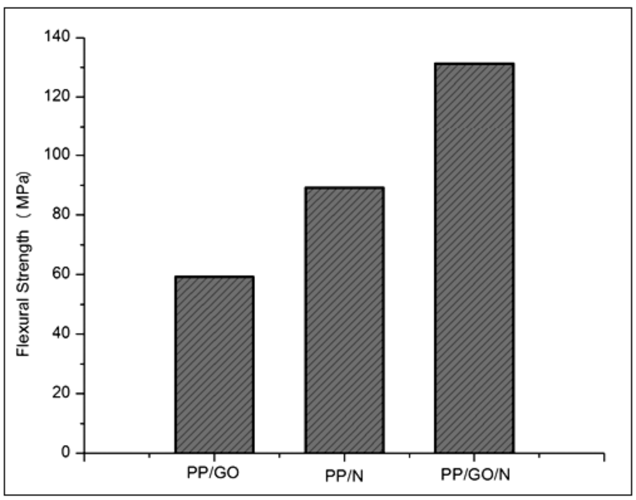

Figure 3: Flexural strength of PP/GO, PP/N and hybrid (PP/GO/N)

respect to PP/GO and PP/N. This may be attributed to the higher stiffness of hybrid reinforcement.

4. CONCLUSIONS

In the present paper, polypropylene based natural fiber reinforced composites, consisting of grewia-optiva, nettle and hybrid of both grewia-optiva and nettle were successfully developed using compression molding. The mechanical properties in terms of tensile and flexural strength of developed composites were investigated and compared.

The tensile strength of the hybrid composite was found to be 143.2 % and 22.6% higher than PP/GO and PP/N, respectively. The flexural strength of the hybrid composite was found to be 121.7% and 47.26% higher than PP/GO and PP/N, respectively.

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