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Studies on Ipomea batata fiber reinforced compatibilzsed PP composite

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ABSTRACT

Natural fiber reinforced thermoplastic polymer composite have received remarkable attention because of their eco-friendly nature, acceptable mechanical properties and value added applications contributing to the cost effective benefits of the farmer. Ipomea batata fiber is a natural fiber that is available in India in huge quantity. Till today, a very little work has been documented in the literature using Ipomea batata fiber as a reinforcing fiber for polymer composite. The present investigation deals with the aim to evaluate the possibility of Ipomoea Batata fiber as a reinforcing agent for polypropylene have been prepared with the use of 4% modified Polypropylene (MAPP) as compatibilizer. Composites of compatablized polypropylene reinforced with 5%, 10%, and 15% IBF (Size 2 to 5mm) containing 4% maleic (MAPP) have been processed by singal screw extruder. The composites are analyzed for mechnical properties and thermal properties. .The morphological studies have been carried out by SEM . The results reveal that upon reinforcement with short IBF, the flexural modulus of in comprasion with uncompatiblized PP composite than those of the compatibilised PP composites increases with increasing amount of reinforcing fiberin coparsion with uncompatibilized pp composites. These results confirm the reinforcing effect of the short IBF in reinforced compatibilized composites.
Key Words: Polypropylene, Ipomoea batata fibre, TGA, SEM, Mechnical properties.

Introduction

Composite materials are known to mankind in the old stone age. In recent years polymer based composite materials have found potential applications in automotive ,sporting goods, electrical, marine,household applications etc(1). Polymer composite materials posses excellent high strength and stiffenss, light weight and high corrosion resistance.

In the past decade extensive research work has been conducted on the natural fiber reinforced composite materials in several applications, Natural fiber are available in

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abundance in nature and can be used to reinforced polymer to obtain light and strong material. Natural fibers from plants are beginning to find their way into commercial applications.

Natural Fiber composite have some disadvantages which lie in their high level of moisture absorption, poor wettability and insufficient adhesion between untreated fiber and the polymer matrix which lead to debonding with time (2- 4). A better way to measure the adhesion between natural fibers and thermoplastic bonding strength interaction between the anhydride group of maleated coupling agents and the hydroxyl group of natural fiber can overcome the incompatibility problem to increase the tensile and flexural strength of natural fiber thermoplastic composites (5- 8).

Composites using natural fiber as reinforcement have received remarkable attention in recent years in order to achieve a good dispersion of the reinforcement in their polymer matrix.Natural fibre such as flex,hemp,jute,henquen and many other have been used as fibre reinforcement component for composites in recent years, Advantages of natural fibre over man made fibre might be because of their low density ,low cost,biodegradibility and recyclability, .This is the reason that natural fibres have replaced glass fibres in composite materials.Physico-mechanical properties of natural fibres especially flax, hemp, sisal,jute are ,excellent and might competete with glass fibre in strength and Young's modulus. Natural fibre reinforcement composites can have applications in plastics, automobile and packaging industry to reduce material cost.Chemical modification of natural fibres is performed to enhance the adhesion with polymer matrix..The art of making composite is restricted mainly to synthetic polymer and synthetic reinforcing fibres like glass ,carbon, and nylon, Potentially a natural fiber based composites using cellulose ,wood, jute, kanaf,hemp,sesal,pineapple,coir,etc as reinforcing fibre in a thermosetting resin matrix has received considerable attention among scientist all over the world for their specific properties (9-13).The present paper deals with the development of Ipomea batata short fiber reinforced polypropylene composite matrix using related coupling agent and to see its effect in the performance of composites in relation to mechanical properties and thermal behavior.Not even a single paper is documented in the open literature pertaining to Ipomea batata reinforcement in any polymer matrix.

Materials

The polypropyle grade Repol 110 supplied by Reliance Polymer was used as matrix. The maleic anhydride polypropylene (MAPP) supplied by PLUS Polymer, Faridabad was used as compatibilizer. The Ipomea batata fiber (2 - 5 mm) was provided by Cotton department, CSA University, Kanpur.

Expermental

Preparation of polymer composite

The polymer composite was prepared with the help of Ipomea batata fiber of 2 to 5 mm size as reinforcement in polypropylene matrix using MAPP as compatibilizer by Hakke Rhoecord Single screw extruder in

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the temperature profile between 160^0C to 180^0C.

Specimen preparation

To carryout the mechanical and thermal properties as per ASTM standard the specimens were prepared by Texiaer Injection moulding machine.

Testing and characterization

Mechanical property

Tensile strength and flexural strength of composites have been carried out using Universal Testing Machine as per ASTM D 638 & ASTM D 790 respectively. The Izod & Charpy Impact of the composites were determined with help of Izod & Charpy Impact Tester.

Characterization

The thermogravimetric analysis (TGA) was carried out under nitrogen environment using a TGA (Perkin Elmer). The experiment perfomed in the temperature range of 0 to 450^0C at heating rate of 10^oC/min in nitrogen atmosphere.

Morphology

The morphology of the composites were carried out with the help of scanning electron microscope (Model JSM S 5800 JEOL). Prior to SEM analysis specimens were gold coated with the help of gold sputtering unit in order to avoid charging effect and to enhance emission of the Secondary electrion.

Results and discussion

Mechanical properties

Tensile strength of Ipomea batata fiber compatibilized polypropylene composite with the concentration of IB fiber .is shown in Figure -1.It has been observed that with the increase of % of fiber tensile strength increases.This is absorbed to better interfacial bonding between fiber and matrix .SEM analysis also confirms this finding.figure also shows that with the increase of %of fiber concentration ,the value of elongation at break decreases as expected.This might be attributed to decrease in fraction of thermoplastic and enhancement in interfacial area which resulted in an increase of brittleness.

The flexural strength is carried out by specimen of three point bending method has been used as per ASTM **D790.**

Figure-2 shows the variation of flexural strength of composite with concentration of Ipomea batata fibre in MAPP composites .It is evident fromfigure to tjat with increase of loading of fiber increase in flexural modulus may be attributed to excellent interfacial adhesion between IB Fiber and MAPP matrix .Another reason may be ascribed to increase in the cellulose content present in IB fiber MAPP composites .

variation of flexural modulus with the concentration of Ipomea batata fiber in MAPP composites is depicted in Figure-3.

Flexural modulus increases with increase of IB fiber loading in IB fiber MAPP composites.This may be due to increased in the cellulose content presence in IB fibre MAPP composites and another reason may be attributed to the increased bonding between IB fiber and MAPP matrix.

Variation notch izod impact strength of the

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composites is shown in Figure-The notch impact strength of IB fibre MAPP composite increases with increase in the IB fibre concentration.Exellant interfacial bonding between the IB fibre and MAPP matrix may be the reason for the enhancement of the impact strength of the composite.

Variation of charpy impact strength of the composites under investigation is depicted in Figure-3.It has been observed that with the increase of loading fibre content charpy impact strength increase.This may be due to the absence of microspaces between the IB fibre and MAPP matrix.

Characterization

The results obtained from TGAThermogram are depicted in Table and Figure-4 The TGA result for Ipomea batata fiber compatibilized Polypropylene composite shows the existence of a two step degradation mechanism for,The first step carresponds to the degradation of PP and the second corresponds to the degradation of IBF & MAPP.It is well established that pure PP degrades approximately to 210^{0C} .It is clear that MAPP helps in increasing the thermal stability of the Ipomoea batata fiber compatibilized polypropylene composite .

Morphology

Figure -5 shows the SEM images of 10/90 IBF reinforced PP without a compatibilizer. The image indicates sufficient interfacial bonding between IBF and PP. Freeze fracture surface shows that IBF are pulled out hence, holes are visible in the SEM Picture.This might be attributed to pulling out of fibers from the matrix. Figure -6 shows the morphology of the IBF reinforced PP composite with 4%MAPP compatibilizer.It is evident from the SEM that compatibilizer promotes interfacial bonding between IBF and PP to appreciable extent.SEM image of freeze fracture suface depicts that IBFare intact due the strong interfacial adhesion with pp matrix.This might be an indication of the fact that fiber are embeded in the matrix .It can be concluded from the SEM images that particle size has been reduced and particles are seen to be intact in the matrix. From this observation .it is clear that maleic anhydride acts as a compatibilizer for this composite system.

Conclusions

From the above discussion it can be concluded that

(a) there is an enhancement in the mechanical property with the increase of loading % of IB batata fibre in MAPP matrix.

(B) the morphology of the composites as analysed by SEM also confirms this finding.

(C) the thermal stability of the compatibilized IB fibre MAPP composites is more pronounced as compared to uncompatibilized composites.

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Table : Composition of Ipomea batata Fiber / Polypropylene Composites

S.No.	Weight of Poplypropylene MAPP in gm	Weight of Ipomea Batata Fiber in gm	Total Weight in gm
1	1000	0	1000
2	950	50	1000
3	900	100	1000
4	850	150	1000

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Table -1 Percentage Improvement in Impact Strength / Charpy Impact Strength with Increasing Amount of Reinforcing *Ipomea batata* Fiber.

% Fiber	% Compatibilised Polypropylene	Impact Strength In J/M	Charpy Strength In J/M
0	100	15.38	35.89
5	95	18.46	38.46
10	90	21.53	46.15
15	85	24.61	53.8

Table 2: Percentage Change in the Flexural Modulus/ Fluxeral moduls Values of *Ipomea batata* Short Fiber Reinforced Compatibilized Polypropylene Composites with Increasing Amount of Reinforcing *Ipomea batata* Fiber.

% Fiber	% Compati-bilised Polypropylene	Flexural Modulus In GPA	Flexural Strength In MPA
0	100	0.77	30.6
5	95	0.84	32.2
10	90	1.07	39.7
15	85	1.27	48.6

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Table 3: Percentage Change in the **Tensil Modulus/ Tensil Strength /Elongation break** Values of *Ipomea batata* Short Fiber Reinforced Compatibilized Polypropylene Composites with Increasing Amount of Reinforcing *Ipomea Batata* Fiber

% Fibre	% compati-bilised pp	Modulus In GPA	Tensile strength In MPA	Elongation at break
0	100	0.48	24.6	12.2
5	95	0.56	26	11.6
10	90	0.67	26.8	9.1
15	85	0.71	28.5	5.5

Table -4 The details of TGA experiment, and Temperature of Initiation of Degradation, maximum Degradation and Final Degradation for Compatibilized Polypropylene Matrix.

Sample Name and Amount	Initial Tempe-rature ^oC	Final Tempe-rature ^oC	Rate of Heating ^oC/min	Temperature of Initiation of Degradation	Temperature of Max Degradation	Temperature of Final Degradation
Compatibilized Polypropylene 15 mg	0^oC	450^oC	10^oC/ min	$227\,^oC$	375^oC	418^oC

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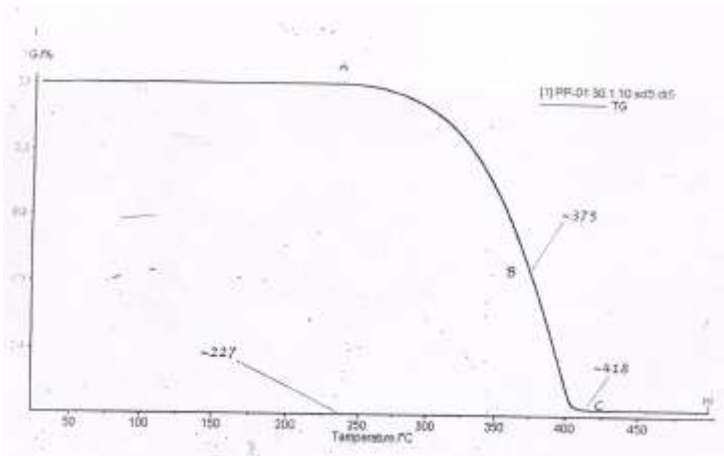
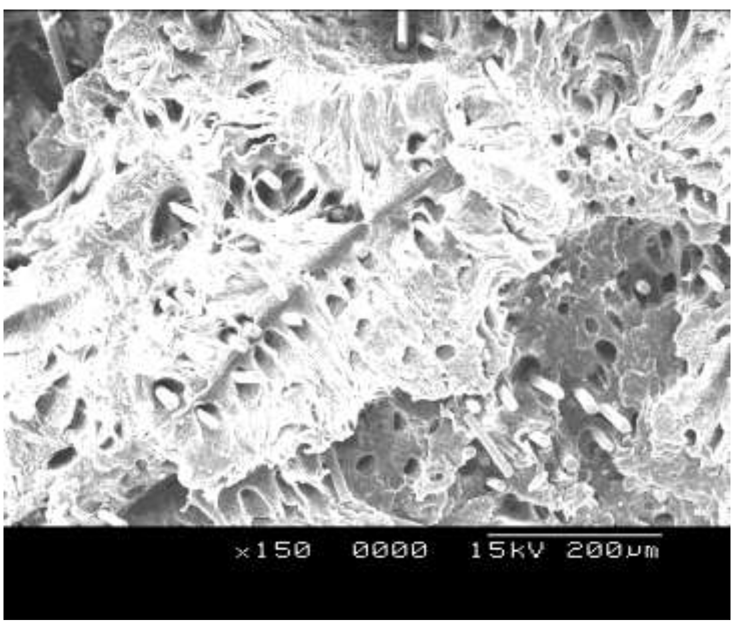
Thermo Gravimetric Analyzer Curve





Morphology of the *Ipomea batata* fiber reinforced polypropylene composite processed without a compatibilizer

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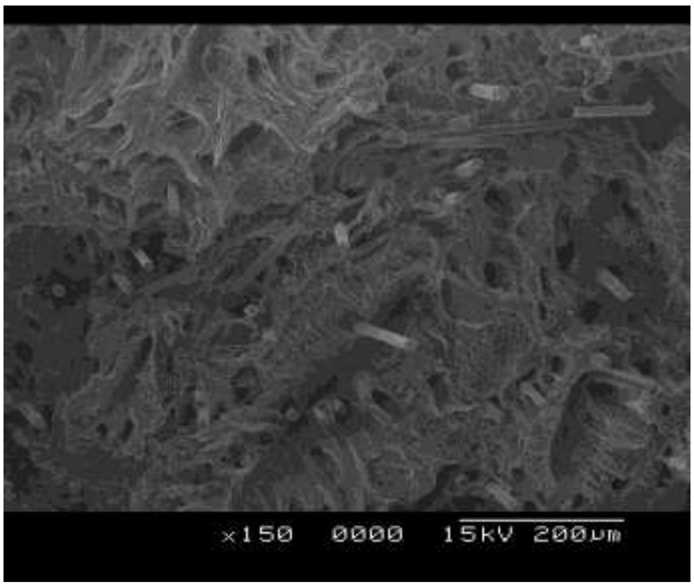
Morphology of the *Ipomea batata* fiber reinforced polypropylene composite processed with 4% maleic anhydride modified polypropylene as uncompatibilizer.



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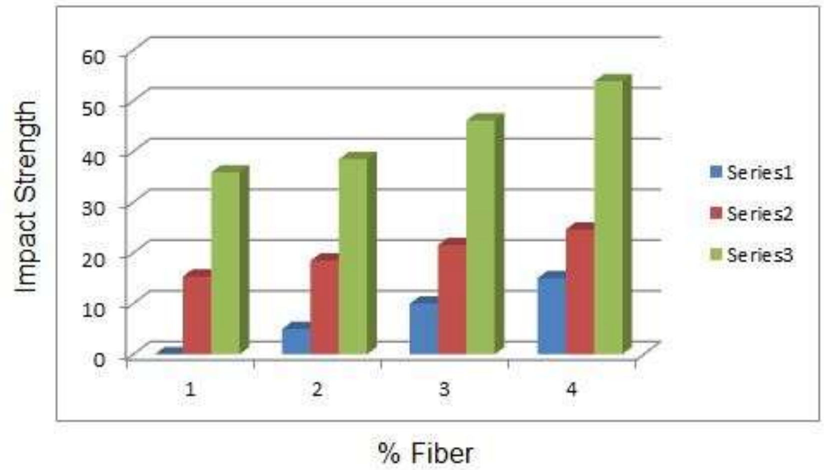
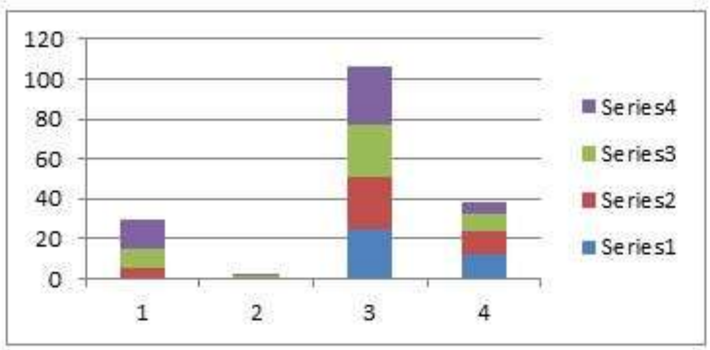
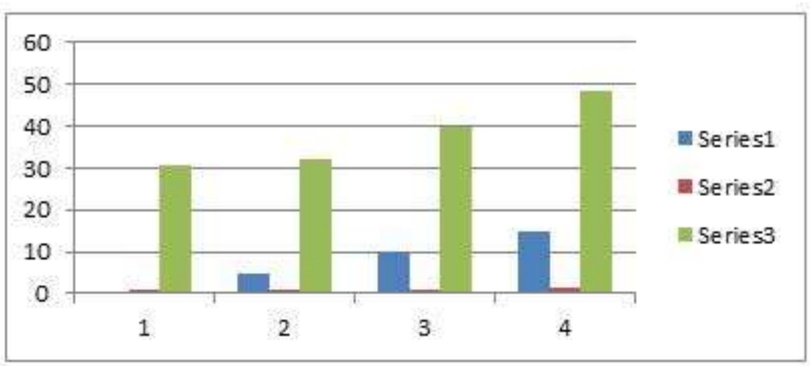
Izod and Charpy impact strength with respect to % of fiber



Tensil strength



Flexural strength



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Figure(1)

Izod Impact Strength of *Ipomea batata* Fiber ReinforcedCompatibilized polypropylene Composites

Figure(2)

Percentage Change in Tensil strength, tensil modulus, Elongation at Break Values of *Ipomea batata* Short Fiber Reinforced Compatibilized Polypropylene Composites with Increasing Amount of Reinforcing *Ipomea batata* Fiber.

Fiure((3))

Percentage Change in the Flexural Strength ,fluxral modulus, Values of *Ipomea batata* Short Fiber Reinforced Compatibilized Polypropylene Composites with Increasing Amount of Reinforcing *Ipomea batata* Fiber.

Figur(4)Thermo Gravimetric Analyzer Curve

Figur(5) Secanning electron microscopy