International Journal on Textile Engineering and Processes
Vol. 3, Issue 1
January 2017

Studies on Inter fibre cohesion Properties of Sisal Fibre reinforced Polypropylene Composite

*R.N. Turukmane, #A.L.Bhongade, #S.P.Borkar, *A.M. Daberao
* Centre for textile Functions-MPSTME, NMIMS, Shirpur, Dhule, and Maharashtra.
# Veermata Jijabai technological Institute, Matunga, Mumbai, Maharashtra.

Abstract

Now a day natural fibre composites are majorly concern with eco-friendly aspect and human safety. Natural fibres such as sisal, jute, banana and sun hemp fibres shows best properties not less than glass fibre, and carbon fibre. The present work expounds the development of composites from polypropylene matrix and sisal fibre as reinforcement without surface modifications of sisal fibres. These composites were prepared at different fibre volume fraction varying from 0.15 to 0.25. The studies were done on inter fibre cohesion properties at different volume fraction of fibres were investigated. The profound work to be applicable in various areas such as automobile industry, civil & construction, sport textile and packaging industry.
Keywords – Sisal. Volume fractions, composites, polypropylene.

I. Introduction

The sustainable textile composites can be manufactured with cost effectiveness is need of today's world. These can be possible by manufacturing biodegradable composites [1]. The potential advantages of natural fibres for the reinforcement in composites have been paid attention in the past few decades. This is due to the fact that natural fibres are lightweight, low in cost and eco-friendly. Natural fibre composites with thermoplastic and thermoset matrices are now utilized for door panels, seatbacks, headliners, dashboards and other interior parts by European car manufacturers [2]. These fibres are easily obtained in India and are a major concern to be recycled as reinforcement material to substitute synthetic fibres. The tensile test, flexural test and Impact strength test were done and comparison were made on the formed composite [3]. The results may be used to further investigate the relevant chemical treatment or manufacturing processes to optimize the mechanical properties of sisal fibre as a replacement material for synthetic fibre

II. Literature Survey

As a result of the increasing demand for environment friendly materials to reduce the cost of traditional fibres (i.e., carbon, glass and aramid) reinforced petroleum-based composites, new bio-based composites have been developed. Researchers have begun to focus attention on natural fibre composites (i.e. bio composites), which are composed of natural or synthetic resins, reinforced with natural fibres [4]. A composite is mainly composed of two phases which are uniformly bounded together by interfacial bonding. The reinforced fibres can be (glass, Kevlar, jute, sisal, cotton) or fillers embedded in a matrix (Thermoset or Thermoplastic) [5]. The matrix holds the composite in its shape whereas the reinforcement imparts and improves the overall properties of the composite. Composites are formed by combining of two or more materials to give a set of properties that cannot be achieved either by the matrix or reinforced material [6]. The matrix not only holds the fibres together but also protects them from damage by sharing any stress among them. The matrix is soft enough to be shaped with tools, and can be softened by suitable solvents to allow repairs to be made [7]. Any deformation of a sheet of fiberglass necessarily stretches some of the glass fibres, and they are able to resist this, so even a thin sheet is very strong. It is also quite light, which is the advantage in many applications.

III. Materials and methods

The major materials in this research are Sisal fibre and polypropylene pellets. The fibres are procured from local sources and polypropylene chips from the man-made fibre production industry [8]. The raw fibres are cut into lengths of 25 mm, opened and form a nonwoven web on Rando feeder machine and needle punched to get compact nonwoven web for uni direction material as a reinforcement in polypropylene composite. Sisal webs were taken for composite fabrication as per the fibre matrix volume fraction calculated by using volume fraction calculator. The fibre and matrix volume fraction ratios were considered for preparation of composites as follows 0.15, 0.20 and 0.25. These composites were fabricated separately by using thermoplastic method of composite manufacturing. The mixture of sisal fibre were taken in to the mould of size (LxBxH) 200 mm x 200 x 5mm [9, 10]. The Polypropylene chips were initially laid in to base of the mould followed by uniform laying of sisal fibre web. After initial preparation, the mould were kept into the hot press compression moulding machine at a temperature of 175^0C for 30 minute, after cooling the composites retained and cut to specified as per ASTM standards [11].

IV. Experimental details

In this research, the prepared samples were tested in VJTI physics lab Mumbai, tensile strength test, flexural modulus test and impact strength test were conducted on composites samples. The tensile test is conducted by using TINIOUS OLSEN (test machine of cross head of 2mm/min. Tensile test specimens were prepared according to ASTM designation: D 638–03 these specimens are of dog-bone shape. The gauge sample length is 115mm, width 19mm and thickness 4mm. The flexural test is conducted using the same test machine. The specimen dimensions were cut as per the ASTM D 790 – 07 such as length 120 mm width 12.75 mm and thickness 4.2 mm. The impact test were done as per ASTM D 256 - 06a and the where the specimens having dimensions, length 63.5 mm, width 12.7 mm and thickness 4mm, with a 'V' notch depth of 2.54 mm and notch angle of 45^0.

V. Result and Discussion

1. Results

1.1Tensile test strength

S. No	Volume fraction	Breaking load (Kg)	Tensile strength (Mega Pascal)	EAB%
1	0.15	29.8	12.168	3.846
2	0.2	49.4	20.17	3.583
3	0.25	34.55	14.11	3.385

EAB- elongation at break

1.2 Flexural test strength

S. No	Volume fraction	Length mm	Width mm	Thickness mm	Flexural strength(Mega Pascal)	Flexural modulus(Mega Pascal)
1	0.15	120	12	4	23.34	1336
2	0.2	120	12.1	4.1	42.94	2386
3	0.25	120	12	4.2	39.47	2154

1.3 Impact test strength

S. No	Volume fraction	Length mm	Width mm	Thickness mm	Energy (Joule)	Impact strength(KJ/M^2)
1	0.15	63.5	12	4.1	0.5	9.84
2	0.2	63.5	12	4	0.7	21.653
3	0.25	63.5	12	4.2	1.1	13.77

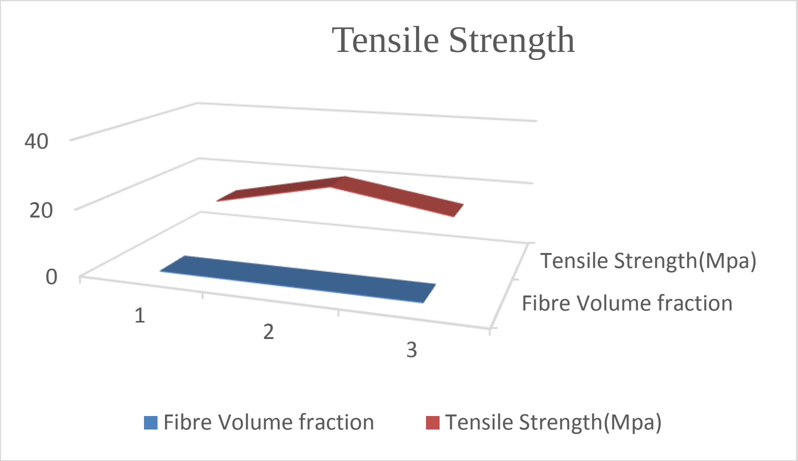
2. Graphs and Discussion

Inter cohesion properties

Inter cohesion properties of Sisal-Polypropylene made composites were studied thoroughly so that it could be useful for many applications.

2.1Tensile properties

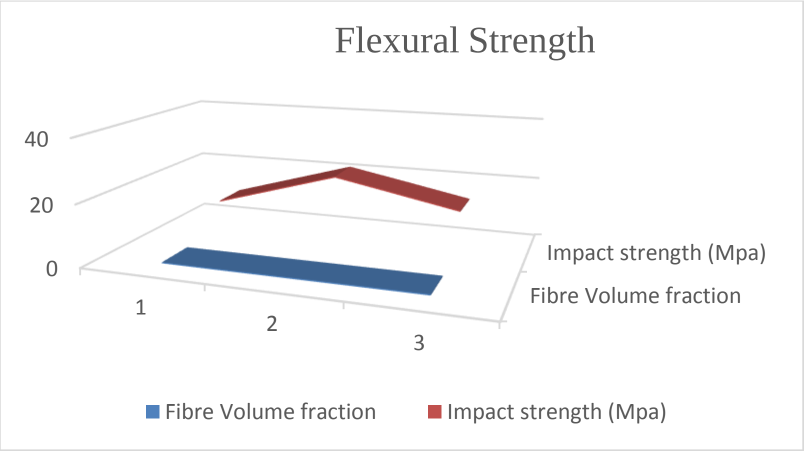
From the Table 1.1 and the graph 1 it is clearly depicted that the tensile strength of the Sisal & Polypropylene composite increased with increased fibre content at 0.20 volume fraction, but it seen that it is decreased after 0.25 volume fraction the adhesion between matrix and reinforced fibre reduces to delaminate and start showing declination in the tensile properties.



Graph 1.Tensile properties

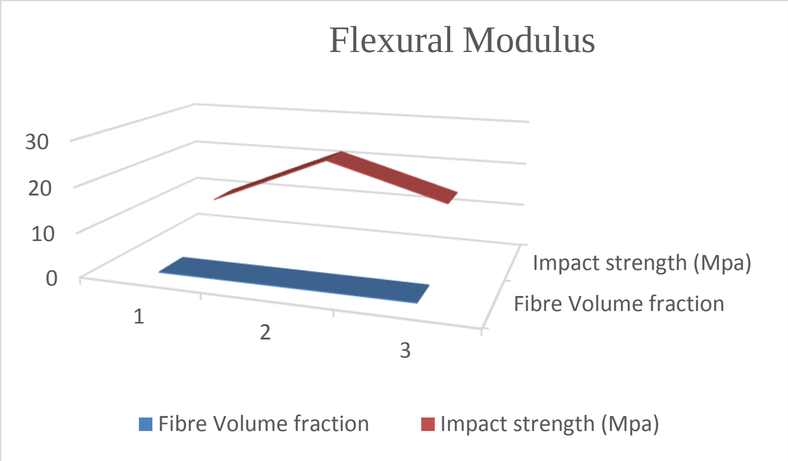
2.2 Flexural properties

Flexural testing was done by three-point bending method. This method depict the study about the ability of the material to withstand the bending forces applied to its longitudinal axis. The effect of the fibre volume fraction on the flexural strength and flexural modulus of the sisal fibre reinforced polypropylene composites can be seen in table 1.2. The testing result shows considerable increase in the strength of both properties up to 0.20 volume fraction and start decline afterword.



Graph 2. Flexural strength

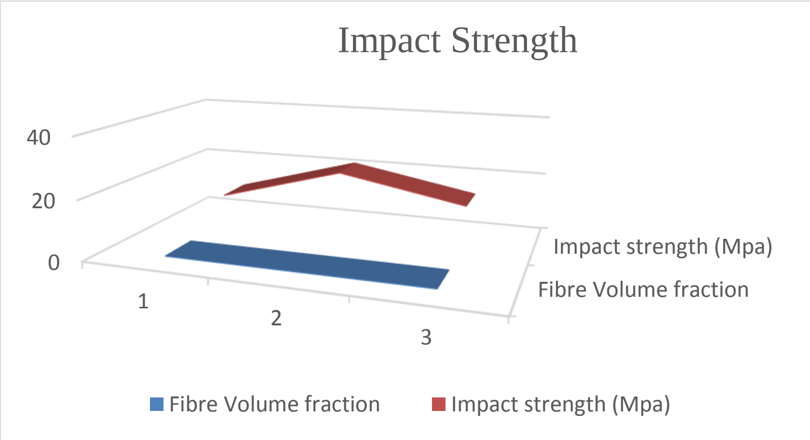
Flexural strength follows a similar pattern as that for flexural modulus. It was observed that the flexural strength increased from 23.34 Mega Pascal to 42.94 Mega Pascal (ref table 1.2) and flexural modulus shows higher value at 0.20 volume fraction i.e 2386 Mega Pascal (ref table 1.2).This results is an increased stress at failure and higher values for flexural strength. This happened because of incorporation of filler material and good interfacial bonding between polypropylene and reinforced sisal fibres.



Graph 3. Flexural modulus

2.3 Impact strength

The prepared composite was tested for impact testing this can be done by using Izod impact strength tester. The factors such as micro scale morphological changes in composites responsible for the impact property of textile composites. A composite having good impact resistance would absorb most of the impact energy and propagate crack very slowly. Following graph gives idea of impact strength test of sisal-polypropylene composite,



Graph 4. Impact strength

The effect of fibre volume fraction on the impact strength is indicated in above graph 4, a moderate increase in impact strength is seen between 10 to 20 % volume fractions and decreases after that, it shows same trend for both composite this leads to better energy absorption when these composite was subject to an impact shock. It has also been reported that higher interfacial adhesion between matrix and filler requires higher energy to sustain high impact.

Conclusion

The mechanical properties sisal fibre reinforced composite were investigated in terms of tensile strengths, flexural strengths and impact strength. The sisal fibre reinforced polypropylene composites exhibits higher tensile and flexural strength and impact strength. From the result it is clear that the tensile strength, flexural strength and impact strength are at the highest value at 0.20 volume fraction It can be concluded that the study conducted on sisal fibre have improved the inter cohesion properties of composites. The Sisal fibre is more compatible with thermoplastic matrix, which induced that it can be used for several industrial applications.

References

1. Yan Li, Yiu-Wing Mai & Lin Ye, Sisal fibre and its composites: a review of recent developments, Composite science and Technology, Vol 60, 2000, 2037-2055.
2. Prof.R.N.Turukmane, Prof.A.M.Daberao, Prof.P.P.Kolte, Dr.V.G.Nadiger, A Review – Nano Technology in Textile composites, International Journal on Textile Engineering and Processes Vol. 2, 2016, 19-22.
3. Chen, R. Y., Huang, Z., Zou, W., Zhang, H. C., & Qu, J. P, Preparation of Polypropylene/Sisal Fiber Composites and Study on the Fiber Orientation. In Advanced Materials Research, Trans Tech Publications, Vol. 989, 2014, 581-586
4. Burgstaller, Christoph. "Comparison of interfacial shear strength from fibre pull out and mechanical testing in polypropylene sisal composites." International Journal of Materials and Product Technology Vol.36, Issue 1, 2009, 11-19.
5. Durowaye, S. I., G. I. Lawal, and O. I. Olagbaju. "Microstructure and mechanical properties of sisal particles reinforced polypropylene composite." International Journal of Composite Materials vol.4, Issue 4, 2014, 190-195.
6. Mohan, T. P., and Krishnan Kanny, Chemical treatment of sisal fiber using alkali and clay method, Composites Part A: Applied Science and Manufacturing, Vol.43, Issue 11, 2012, 1989-1998.
7. Kanny, K, Surface treatment of sisal fiber composites for improved moisture and fatigue properties, Composite Interfaces,Vol.20, Issue 9, 2013, 783-797.
8. Gupta, Arun Kumar, Mechanical and thermal degradation behavior of sisal fiber (SF) reinforced recycled polypropylene (RPP) composites, Fibers and Polymers, Vol.15, Issue 5, 2014, 994-1003.
9. Suppakarn, Nitinat, and Kasama Jarukumjorn, Mechanical properties and flammability of sisal/PP composites: effect of flame retardant type and content, Composites Part B: Engineering Vol.40, Issue 7, 2009, 613-618.
10. Swain, Suchhanda Srabanee, Investigation of fibre orientation using SEM micrograph and prediction of mechanical properties through micromechanical modelling, Bulletin of Materials Science Vol.39, Issue 3, 2016, 837-846.
11. Chegdani, Faissal, Fiber type effect on tribological behavior when cutting natural fiber reinforced plastics, Wear, Vol. 332, 2015, 772-779.