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Impact In Mechanical Behaviour Of Pla By Addition Of Natural Fiber Reinforcement Fillers

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Abstract

The bio compatible organic polymers are nowadays become a number one contender for the plastic manifolds. Owing to its excellent load accepting and withstanding nature, capability to less retardation to temperatures and good strength: weight ratio made them the first choice to go for selection along with its eco-friendly nature. Even though possessing several impacts the boundaries have been fixed which have less strength and high cost. The proceeding work will investigate the pre and post nature of the bio composites when binded with a natural filler as an additive. With keeping the ASTM standards in mind, the mechanical properties have been analyzed and the impact is noted. The study suggests that the mechanical property on adding the natural fibre slightly increased initially but reduces on further addition.

Keywords: Biodegradable, Polylactic Acid, Sansevieria.

I. INTRODUCTION

3D Printing Technology

3D printing an exact contrast of subtractive manufacturing process which develops the desired objects by adding the materials one over the other which reduces the scrap generation. Thus, creates a new opening for the dreamers and innovators to develop their own world in 3-dimensional modeling.

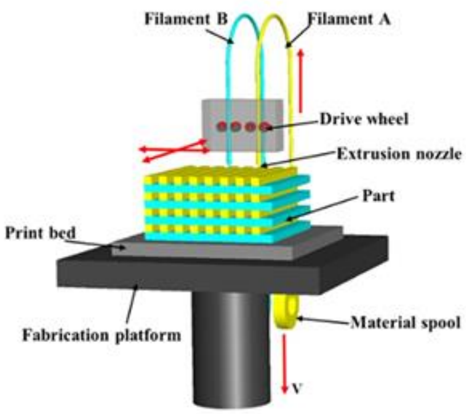

Fig 1. 3D printer

To make this dream come true in the manufacturing stream it is a need of an hour to find a suitable material which satisfies all the overwhelming requirements of the manufactures. Some proven Thermoplastic materials like acrylonitrile buta- diene styrene (ABS), polylactic acid (PLA), poly- amide (PA) and polycarbonate (PC) as well as thermosetting polymer materials like epoxy resins are

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well suited materials for 3D printing. The perfect suitability of material will open gates for the 3D printing technology to find its applications in various streams. The love towards these materials is due to its very light weight and accessibility to make very intricate shapes. This property made this material to make its foot print in aero applications, Constructional sectors, Art craft industries, Tissue Engineering and Organ implantations etc.

Even though possessing various attractions the 3D printing technology is tied within certain boundaries due to its weak strength and lack of load bearing nature. That makes this technology to sit in the dugout as a prototype model.The above-mentioned problems will be addressed by binding the low strength 3D printing materials with suitable binders which enhances the geometrical and load bearing nature whose performance will not be matched by any individual component. Encapsulation of small materials, fibers or Nano fillers along with the polymers will give birth to PMC's which have a greater mechanical and functional behavior. The impact created by 3D printing over the past have grabbed attention of various researchers. Mostly all the researcher has their concentration on 3d printing fabrication methods and pure polymer materials. Here the focus is on the combined study of both the composites and 3D printing technology which is growing up like a demand of situation in recent years.

II. LITERATURE ANALYSIS

The fighting nature of Sansevieria roxburghiana against bacteria and other pathogens with exhibit zero negative effects which in turn make way for the development of a new medicines. This responsive nature of this plant ensures the fighting capability against the microbes which enhances the material life against the microorganisms. It is identified that the fibre possess good mechanical behaviour when it is exposed with NaOH solution for high temperature for a stipulated time period of 120 minutes. On comparing the mechanical behaviour of untreated fibre the tensile behaviour is improved by 42% and degradation temperature is increased by 6.6%. As the situation demands to produce harmless and eco-friendly materials, we are ignoring the traditional chemical based components. Based on the various properties and nature of applications suitable materials have selected. The center of attraction of these eco composites are lighter, flexibility, acoustic insulation and degradability which makes these them as first choice. But the area of concern is the cost of the biopolymers.The mechanical behaviour of PLA with reinforcement is identified to be highly impressive. When compared with the 100% pure PLA the 70:30 combination of PLA and fibre exhibits greater mechanical properties and thermo mechanical properties. Two combinations have been taken one is PLA-Jute and other is PLA-ramie. It is analyses that the PLA-ramie possess higher mechanical strength than PLA-jute combination. The reason behind that is ramie have greater strength than jute. On improvising the fibre composition, the softening temperature goes up and degradation temperature drops down. The morphology of Sansevieria fibre in SEM analysis is observed to be 165µm. The density of the fibre indicates the lean nature which possess very less weight. Gage length does not have any direct correlation with tensile strength. The probability of material to get degrade drops to a greater extend when the length of gage varies. The chemically treated coir fibre with bio polymer possess greater mechanical and biodegradable properties when compared with non-treated coir fibre. The tensile and flexural behaviour of treated coir is always better than the untreated coir. The two situations to overcome are weak bonding nature of fibre at less weight percentage and accumulation of fibre at higher weight percentage. The transparent nature of PLA and limonene films is always in a commendable manner.

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By increasing the composition on limonene in the PLA matrix degrades the glass transition temperature. The availability of limonene stimulates mechanical behaviour and plasticization. The Micro Crystalline Cellulose (MCC) chosen as a binder in PLA matrix implicates that MCC accumulates as a filler of micro binders in the cellulose. The SEM analysis state that during the extrusion process the MCC remains the same without debonding. The increase in composition of MCC improves tensile nature which delays the fibre braking due to tensile load. DMTA study suggest that the thermal stability will be drastically improved with enhanced composition of MCC reinforcement. The mechanical behaviour of PLA coil and printed PLA have been examined. The testing is done for various orientation angle. The angle of 45° possess greater tensile strength. At 90° the fatigue resistant fails while endures at 45° which also shows greater endurance limit at this angle. When compared with banana woven epoxy composites the mechanical properties of Sansevieria composites are very attractive. The fiber to reinforcement bonding is very high. But the glass transition temperature level of banana woven at 120 °C is far better than Sansevieria composite at 100 °C .Biodegradable polymers, for example, poly (lactic) corrosive (PLA) have been contemplated for biomaterials applications, for example, characteristic human tendon substitution, anyway these materials could be connected to different parts as aviation, flight, car, sustenance bundling. For some current applications, PLA segments show collected perpetual misshaping coming about because of dynamic mechanical sources of info, coming about on disappointment by laxity of parts. Pointing the improvement of PLA mechanical properties, the joining of carbon nano fillers into PLA framework, explicitly. PLA and nano composites were created by soften mixing pursued by pressure forming in a hot press, with little weight rates of nano fillers. Poly (lactic corrosive) (PLA), is the most investigated bio friendly polymer which is enquires universally up to now. Because of its benefits. The primary reason for this kind of investigation is to interpret the mechanical and physical features that influence its safety, processing capability, debasement. Further we discuss more about the upgradement of PLA such as Segments and adding plasticizers, nucleation specialist expansion, and PLA alterations and nano plans. Under intricate fabrication condition the crystallization capability of PLA is extremely bounded with the boundaries. Development of new structure by adding PLA nano structures enables nucleus stability very hardly along with the improvisation of crystallization. The flexural behaviour of PLA will be increased to a greater extend by bonding the PLA nano fillers in different composition. The binding agents of PLA will be treated with EBS stimulates chain bonding and nucleating capability.

III. PROBLEM IDENTIFICATION

Two of the factors that limit the expansion of 3D printers are the price and the ecological effects of the materials. In high-performance printers for professional use, the printing material is supplied by the manufacturer of the printer, for example, UV-curing resin materials for laser sintering (mostly with an unrevealed composition and patent restrictions) have a high price, because they are adapted to their machine’s settings. Cheaper 3D printers use less expensive polymers; however, most of the materials are of synthetic origin, which means a potential for introducing harmful materials into the environment. However, with the development of new materials and lower prices for 3D technologies, 3D printing could expand into the area of manufacturing unique end-products or small batches of special products. There are a number of possibilities for lowering the price and the health-associated hazards for printing materials. One of them is the use of natural materials such as nature fiber and resins. Sansevieria is an

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organic material that is widely available in nature. Small pieces of fibre and particles can be milled into smaller fractions to provide a fine particle, which can then be used as a filler material in 3D printing with conventional plastic materials. Sansevieria can also be used for printing in combination with a variety of commercial and natural adhesives. In this way the impact of 3D-printed products on the environment can be dramatically reduced. 3D products printed with organic fibers and adhesive could be used for the prototyping of complex organic shapes. Due to the low density of such products, they can be used as a container for more complex forms, to make moulds for laminated furniture, or as a support for making furniture in combination with veneers and foils. The wood flour gas significant advantages as compared to the thermoplastics is considerably cheaper than thermoplastics (200 USD per ton while 1 ton of PLA is 1200 to 2000 USD), higher modulus, environmentally friendly, non-toxic, and easy supply. As the wood flour incorporated in the thermoplastics the price of material for 3D printers will decrease, which considerably increase the use of 3D printer in near future.

IV. OBJECTIVES

Considering the environmental problems posed by the synthetic polymers, it is decided to develop cost effective and environmental-friendly composites using natural fiber and biodegradable matrix using 3D printing technology. Accordingly, the following are the steps to be planned to predict the functional properties of sustainable particle embedded printed composites:

- To utilize wood flour as reinforcement to enhance the strength of biodegradable Polylactic acid (PLA) matrix.
- Preparation of composite plate.
- To study the fundamental behaviour of all the fabricated composites on the mechanical,
- To select the optimal composites with better functional properties for the structural applications.

Fig. 2 Sansevieria Fibre

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Fig. 2 PLA in pellets form

V. WORKS TO BE DONE

The fabrication and mechanical testing PLA and Sansevieria based composite specimen is done by the methodology given below.

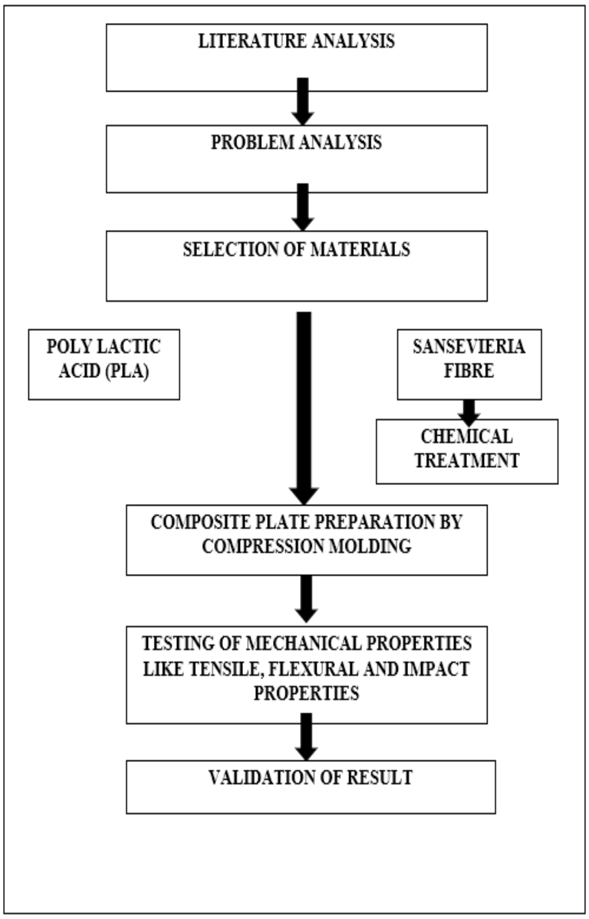

Fig. 4 WORK FLOW

VI. PROCESS OF FABRICATION

Compression Molding

From the literature analysis the pressure to be applied in the compression molding is set to be 5 MPa for 20 weight percentage. Whereas the pressure keeps on changing for different weights. Higher the

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weight percentage of fibre higher the pressure is. The materials to be compressed in molding machine were dried for almost 120 minutes at 105^0 C. To decrease the material processing time the Compression molding have been cold pressed for 25 °C for 3 minutes. Pressure have to be maintained carefully. Too low pressure will have the danger of creating poor composite compaction whereas high pressure will lead to mis-orientation of fibre

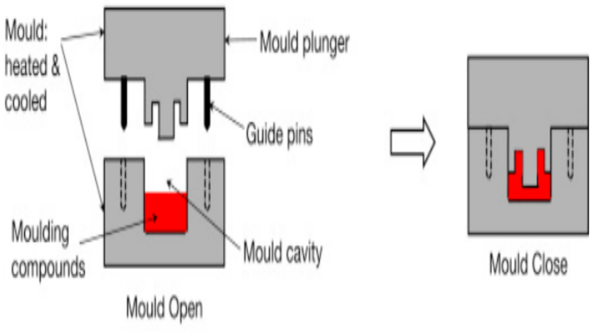

Fig.5 Compression molding machine setup

Specimen Preparation

The elastic behaviour Sansevieria Roxburghiana fiber made it as a first choice for the reinforcement. Along with its microbial fighting nature the fiber stands tall when compared with other fibers. The fiber is set to be chemically treated with alkali solution for around 100 degree Celsius for almost 130 minutes. The fiber is set to be chopped into small pieces to a length of 20mm. The objective is to remove some additives and accumulated strands in the fiber ensuring the pure availability of fiber. The plate is then prepared in a compression molding machine for the below mentioned composition.

TABLE.1 Specimen details

SPECIMEN	**PLA (%)**	**FIBER (%)**	**LENGTH**
1	**100**	0	20 mm
2	**80**	20	20 mm

Fig. 6 Composite Plate

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A. Testing of Composites

TABLE.2 Testing Standards

STANDARD	SPECIFICATION	TEST
ASTM D638	165mm*13mm*3mm	Tensile
ASTM D790-92	127mm*13mm*3mm	Flexural
ASTM D256	60mm*13mm*3mm	Impact

VII. TEST RESULTS

The below table shows the results of the test conducted for different combinations. The first column suggests the mechanical nature of Plain PLA. The second column implicates the change in mechanical behaviour of the plates when an additive is added as reinforcement. In the graph the X axis implicate the sample and Y axis implicates strength in terms of $N/mm^{2.}$ 3 trails have been taken and the average reading is noted as a consolidated in the end. The tensile nature is monitored for several minutes and the readings are plotted using origin software for better understanding.

TABLE.3 Test Results

S.no	Test parameters	PURE PLA				PLA WITH FIBRE REINFORCEMENT			
		T1	T2	T3	Avg	T1	T2	T3	Avg
1	Tensile Strength, N/mm^2	41.54	41.58	41.55	41.5	20.2	18.5	19.5	19.4
2	Flexural Strength,	118.26	119	117.21	118.2	90	88	89.6	89.5

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	N/mm^2								
3	Impact, Joules	5.4	5.3	5.1	5.2	7	6.5	6.2	6.5

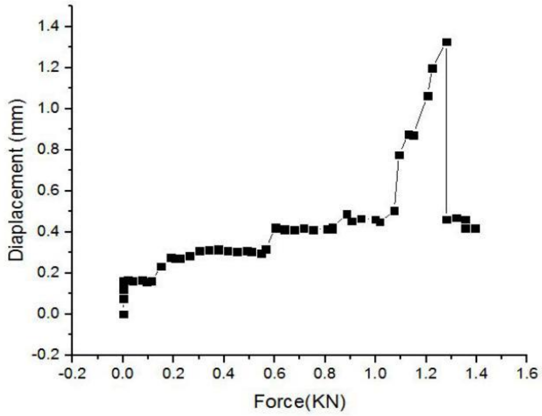

Fig.7 Tensile behavior of pure PLA

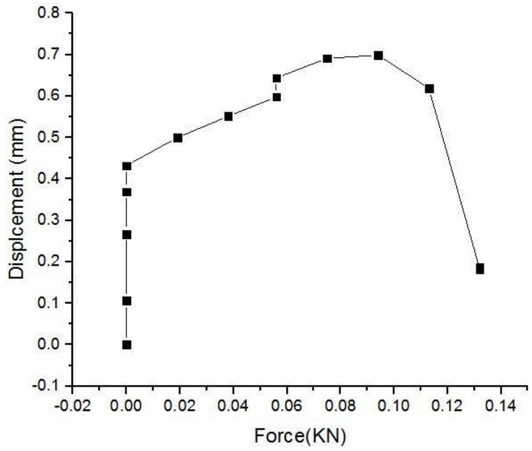

Fig 8. Tensile behaviour of pure PLA

VIII.CONCLUSION

The focus of this study is to understand the change in behaviour of bio compatible plastic when reinforced with natural fillers. The results suggest that the pure PLA without any additives possess high tensile strength of 41.5 N/mm^2 where as the PLA with fiber reinforcement have a tensile strength of 19.4 N/mm$^{2.}$ Thus, we came to understand that on adding a fiber will reduce the tensile nature of fiber to almost 50% this in turn increase the brittle nature of the fiber. Similarly, the flexural nature of

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PLA is about 118 N/mm^2 a common property all the plastics will implicit. On adding the fiber reinforcement, the flexural strength drops down to 90 $N/mm^{2.}$ This indicates that the fiber reinforcement will improves the hardness of the PLA matrix. Finally, the impact nature of Fiber reinforced PLA is better than pure PLA. The impact strength increases from 5.1 joules to 6.5 joules which shows the reinforcement stimulates the impact nature to a certain level. With this fact in mind the work is further extended by checking the same mechanical behaviour by varying the fiber length as well as varying the weight percentage.

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