Chemical treatment has an influence on the strengthening of recycle wood pp composite (r-WoPPC) filament

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ABSTRACT – The strength of printing filament is an essential consideration in commercial FDM filament production. In the context of filament made from Recycle Wood PP Composite (r-WoPPC). The purpose of this study is to compare silane-treated and untreated wood that is being used in the manufacture of r-WoPPC filament using a twin-screw extruder, and then to measure the strength of the filament using a wire pull test. The silane treatment for wood in the manufacturing of r-WoPPC demonstrated great potential, as the use of silane increased the maximum force on fibre loading by more than 10% compared to untreated wood with the same fibre loading.

1. INTRODUCTION

Wood fibres may be recycled and are renewable. They have low specific gravity and high strength. It originates from enterprises like furniture and pulp and paper. Affordability and health are major considerations in today's world as previous study O. L. Rominiyi et al. [1]. It can accumulate and burn, polluting the air and soil [2]. To employ 3D printing, it is necessary to create bio-composites from waste polymers and natural fibres such as recovered polypropylene (PP) and wood dust. In this case, the heated feedstock filament is modelled. Its thermal and rheological properties are crucial. It is best to use materials and polymers with high viscosity yet low glass transition temperatures. Natural fibres are commonly treated with NaOH since it is simple and affordable. It significantly improves filler-matrix adhesion [3]. Using a chemical treatment known as silanes, which are widely employed in composites and adhesive formulations as effective coupling agents, this study was conducted as previous study M.Asim et al. [4]. Their use in inorganic filler reinforced polymer composites like glass fibre reinforced polymer composites and mineral-filled polymer composites has been very good. There are also adhesion promoters in many adhesives, or they are used as substrate primers, which makes them stick better [5,6]. Silanes have also been used to make natural fibre/polymer composites because of their two-in-one structure. According to Steven J Goodman [7], the wire pull out test is used to determine the following: A pull test is used to measure the strength of wires, connectors, and crimp joints. The cable assembly will be pulled at a predetermined rate and load. The wires are commonly connected to a mechanical pull tester, which pulls on them. FDM filament is usually made of a thermoplastic polymer that can be heated up again to make new parts. People push the liquid filament through a heated nozzle to make it harder when it comes to the printing platform. Fillers are used to improving the material properties of the printed component [8]. A previous study found that there is a lack of mechanical properties on research using recycled PP polymer with wood dust stability data and characteristics to develop FDM filament using an twin screw extruder. In this paper, the authors studied the mechanical properties of recycle wood PP composite (r-WoPPC) filament after treating the fibre with silane as a coupling agent and untreated composite filament as reported in this paper.

2. METHODOLOGY

2.1 Preparation of wood dust

Starting the preparation of wood dust fibre, raw wood dust is sieved with a screen of 125micron to eliminate debris and other contamination. Then, sieved wood dust is cleaned with distilled water for both wood dust for the untreated process and the chemical treatment process. In the chemical treatment process, the silane solution was prepared by dissolving complex APS (aminopropyltriethoxy silane) by 2% in a mixture of 70% methanol and 30% water, respectively. The solution was then stirred for another 30 minutes [5,9]. The wood dust fibres were then immersed in a silane solution for three hours and dried in a 60°C oven for 72 hours to eliminate all moisture from the fibres.

2.2 r-WoPPC filament fabrications

For r-WoPPC, untreated and treated wood dust and polymer r-PP are separated into three fibre loadings of 1,3, and 5% for wood dust and sized between 1.5 to 1.75mm r-WoPPC to using LABTECH twin screw extruder generate composites that are covalently bound fibre with polymers in filament form appropriate for FDM commercial application. Table 1 shows list of composite preparation according to A. Haryati et al. [9] using around 500-600gram for total composite.

Table 1 List of composite preparation.

Treatment	wt%	Wood (g)	Recycled PP (g)	Total
Silane	1	5	495	500
	3	15	485	500
	5	25	475	500
Untreated	1	5	495	500
	3	15	485	500
	5	25	475	500

2.3 Wire Pull test on r-WoPPC filament

The most important for this research is the tensile test or wire pull test to find out the level of strength of the sample that has been produced. this method uses the ISO standard according to iso 3341 which uses a jig following Figure 1. according to I. Ferreira et al. [10]. All the samples were subjected to a 10kN load at 200mm/mm for both the untreated and silane-treated samples described above.

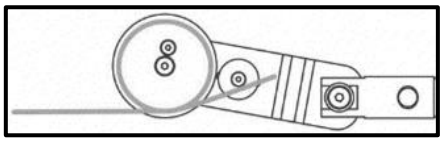

Figure 1 Filament testing jig clamping.

3. RESULTS AND DISCUSSION

The beginning of the preparation of untreated and treated wood dust samples should be done carefully because there is less loss when the wood dust washing gesture is performed. As per observations, dry wood dust should be properly dried in an oven with a temperature of 60°C as well as 72hour.

Next, for producing r-WoPPC with a twin extruder, it's important to find the temperature range for producing filaments of uniform size and smooth surface. Otherwise, to get the starting temperature, referring the MSDS or performed a Differential scanning calorimetry (DSC) made on PP recycling to get the right temperature.

For the wire pull test, the study found that the results were as Table 2.

Table 2 List of results of wire pull test.

Treatment	wt% of Fibre Loading	Max stress (MPa)
Silane	1	28.61
	3	29.52
	5	24.05
Untreated	1	26.81
	3	24.93
	5	23.68

The reading on the filament silane sample was greater than the untreated treatment for all fibre loadings, i.e., 29.5MPa at a differential mark of 18.41%, compared to the uncoated result reading of 3%. This is because the filaments in the r-WoPPC silane sample went through a process that resulted in a successful bonding between the fibres and the polymers. This process began with the application of a silane bonding agent, which produces a significantly stronger filament binding in comparison to the filaments that were left untreated.

4. CONCLUSION

To summaries, chemical expression treatment is critical since it demonstrates the function agent's ability to construct stronger filaments, which can be seen in comparison to the sample filament that did not get any treatment. Additionally, proves that the fibre loading mixture is formulated that as more fibre is mixed, the r-WoPPC resistance decreases, however in the FDM context, the product is easily broken and destroyed; it is also conceivable that the printed product's surface is not smooth and facing any problem during the printing process.

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