Faculty of Mechanical and Manufacturing Engineering Technology

FABRICATION OF NEW FILAMENT WIRE FROM OIL PALM REINFORCED THERMOPLASTIC COMPOSITES AS FEED STOCK FOR FUSED DEPOSITIONING MODELING (FDM) USING EXTRUSION PROCESS

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NUR AINA MARKDYIAH BINTI HASHIM

A thesis submitted in fulfilment of the requirements for Bachelor's Degree in Manufacturing Engineering Technology (Product Design) with Honours

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UTeM as a partial fulfilment of the requirement for Bachelor's Degree in Manufacturing Engineering Technology (Product Design) with honours. The member of the supervisor is as follow:

Signature	:	…….
Supervisor Name	:	MOHD NAZRI BIN AHMAD
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DEDICATION

This report is dedicated to my beloved parent, Mr. Hashim Bin Yusoff, and Madam Eshah binti Yajid those always highly support me, and understanding to make it all possible throughout my Bachelor Degree program. I would like to dedicate this thesis to my supervisor En. Mohd Nazri bin Ahmad for his guidance on providing me so much useful knowledge and provide guidance or supports for me along the way of my final year project. Furthermore, I would like to dedicate this project to technicians En.Basri bin Bidin and En. Mohd Farihan bin Mohd Sabtu who provide me a great assist and guidance on fabricating my project's.

ABSTRACT

Additive Manufacturing is one of imperative strides to produce the product even though not all materials are suitable for 3D printing. The main objective of this project is to study the possibility for 3D printing the polymer composite materials using the natural fiber as the binder. The filament material selection is important to develop a decent product. However, the polymers that created by FDM tend to lose their properties and becomes a stiffness material. In order to solve this problem, the natural fiber was added to the original polymer materials. The mixed filament from all composition ratios obtained from extrusion process shows the possibility of making the new filaments. Furthermore, the specimens of virgin ABS and 5% oil palm mix ABS produce from 3D printer shows the possibility of making new products. The results of the tensile test show the value of ultimate tensile strength for Oil Palm Reinforced Polymer was greater than virgin ABS by 5%. The end results did not deviate away from the normal expectation and its show successful results which show a good possibility that oil palm fiber composite can be mixed with thermoplastics as the binder.

ABSTRAK

Pembuatan menggunakan bahan tambahan adalah salah satu langkah penting untuk menghasilkan produk akan tetapi tidak semua bahan sesuai untuk pencetakan 3D. Objektif utama projek ini adalah untuk mengkaji kemungkinan pencetakan 3D bahan komposit polimer menggunakan serat semulajadi sebagai pengikat. Pemilihan bahan filamen adalah penting untuk membangunkan produk yang baik. Walau bagaimanapun, polimer yang dihasilkan oleh FDM cenderung kepada kehilangan sifatnya dan menjadikan bahan kaku. Untuk menyelesaikan masalah ini, serat semula jadi telah ditambah kepada bahan polimer asal. Filamen campuran dari semua nisbah komposisi yang diperoleh daripada proses penyemperitan menunjukkan kemungkinan membuat filamen baru. Tambahan lagi, spesimen ABS dara dan campuran kelapa sawit 5% dari pencetak 3D menunjukkan kemungkinan membuat produk baru. Hasil Ujian Tegangan menunjukkan nilai kekuatan tegangan akhir untuk kelapa sawit memperkukuh polimer adalah lebih besar daripada ABS dara sebanyak 5%. Keputusan akhir tidak menyimpang dari jangkaan asal dan menunjukkan hasil kejayaan yang menunjukkan kemungkinan yang baik bahawa komposit serat kelapa sawit boleh dicampur dengan termoplastik sebagai pengikat.

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In preparing this report, I was in contact with many people. They have contributed to my understanding and thought. In particular, I wish to express my deepest gratitude to my supervisor, En. Mohd Nazri bin Ahmad for guiding me in this project. The success of this Final Year Project (FYP) is highly influenced by his information, suggestions, and ideas. His willingness to assist me through his guidance, encouragement, advice and continued support has been a great motivation for me to succeed in my project. I would also like to thank all the lecturers and technical staff for sharing their opinion with me in their area of expertise which leads to the success of this project.

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Last but not least, I would like to say a word thanks to my family members, especially my parents for their constant support and encouragement throughout the years.

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LIST OF ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
FDM	-	Fusion Deposition Modeling
CAD	-	Computed Aided Design
ABS	-	Acrylonitrile Butadiene Styrene
RP	-	Rapid Prototyping
PLA	-	Polylactic Acid
OPRP	-	Oil Palm Reinforced Polymer

CHAPTER 1

INTRODUCTION

1.1 Background

Over two decades ago, growing interest in make observations of Natural fiber made from different part or materials has increased from much scale. The reasons for increasing to the condition of having general approval for bio composites or natural fiber composite (NFC) are its more than enough able to use, in competition quality and their conditions of friendliness (Saheb and Jog, 2015). In addition, the possible state of producing of new natural fiber products extrusion has made clear the way become forthcoming material.

Current observations including improvements have made the clear importance of natural fiber too important to worldwide. The high-tech manufacturing had made clear importance of natural fiber like flax, hemp, Jute, coconut and sisal to producing brand-new item (Salit, 2014). Natural fiber that attracted is possibly taking place in addition to produce by synthetic fiber for the made of different part or materials technology. Something amazingly, natural fiber is inexpensive and has excellent rigidity in concept of heaviness made a comparison between produce by synthetic fiber. Those fiber products are illuminated and eco-friendly. Their mechanical nature constrains the fiber is used them in high-technology applications.

Common global market had existed to compel to increasing construction dwelling and automobile-related industries. The requests for natural fiber made of different part or materials had existed become large from landed property, creation foundation and automobile-related manufacturing. The application of natural fiber has to act very quickly increase in automobile-related and done by machine manufacturing. Plant fibers are appealing to mechanical maker as they are bright and mechanical strong. Plant fiber composites can be used rather than produce by synthetic fiber as guiding resin materials. The moulding or forming, outlining method of plant fibers need smaller of power for moulding artificial fiber. It not only reduces cost but also care for nature. In addition, mechanical built with oil palm of natural fibers are more convenient against using the made from of unnatural material foam. As an outcome of that , users are agreeable to the environment advantage and pleasant profit offered by natural fiber composites (Saheb and Jog, 2015).

1.2 Problem statement

The 3D printer now is developing rapidly and advancement on it is still on research to recover it feature of the 3d printer output. 3D printer operated by using filament as ink to print 3d product. The filament material selection is important to deliver a decent product. However, 3d printer models have problem with their mechanical properties and printed part of the most part cannot fulfill mechanical properties for practical application. As an outcome, this issue has offered another idea of 3d printing strategy view by adding polymeric material's grid. An industry is realized that the polymers created by FDM loss of their properties and tend to be stiffness materials. For these reasons, by adding natural fiber will be the one of the solution original materials. The common filament that mixed composite is more affordable and has better firmness regarding weight contrasted with manufactured fiber (Pandey, 2015). Natural

fiber consists of lignin and cellulose is the greatest plentiful polymer in nature. Lignin and cellulose are available in the cell give fundamental support, firmness against microbial attack and oxidative stress. Moreover, natural fiber is the compound position that was matching with multifunction of the technologies these days (Marwah *et al.*, 2016).

1.3 Objective

The project focuses on production of 3D printer filament from natural fiber composites mixed thermoplastic by extrusion process. The main objectives for this project:

(i) To fabricates a new 3D printer filament wire from Oil Palm Reinforced Polymer (OPRP) using extrusion process.

(ii) To perform tensile test on Oil Palm Reinforced Polymer (OPRP) printed parts.

1.4 Scope

This project focused on creating the new fiber by utilizing oil palm fiber and Acrylonitrile Butadiene Styrene (ABS). The filament was fabricated by utilizing the extrude machine and will use it on 3D printer to produce a part. Natural fiber Composite (NFC) is mixing based on thermoplastics and natural fiber, which significantly more nature friendly with enhanced mechanical and tangible properties contrasted with thermoplastic. The project also focuses on fabricating the filament through blending thermoplastic and natural fiber by utilizing the extrusion processes. Subsequently, scope of the project is considering about to fabricate the new NFC filament by mixing natural fiber and thermoplastic. Lastly, use new NFC filament to produce specimen by using 3D printer and analysis the result of the specimen strength by using tensile test method.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

The chapter is determining survey a few written works that have been done by previous analysts from different sources including book, journal, technical report, proceeding paper and article. This data is significant to this study since it can be a guideline on accomplishing last objective. This chapter will focus on fabrication of new filament from oil palm reinforced thermoplastic composites through investigations that have been finished by past researchers. Nevertheless, each relating viewpoints in this investigation, for example, methods, parameters, and results will be account as references before undergoing the experiment process. Later on, it additionally talked about natural fiber and composite material that utilized as a part of fabricate new filament.

2.2 Additive Manufacturing

Prototyping (or Additive manufacturing) is one of the imperative strides to finish the product design. Manual prototyping has been age-old practice. These days Rapid Prototyping is utilized. Rapid Prototyping was introducing in1980's (Dandgaval and Bichkar, 2016). Rapid

Prototyping is group of methods utilized to create fast scale part of physical part of assembly utilizing three-dimensional Computer Aided Design (CAD).

Rapid Prototyping (RP) is a strategy to make models speedier and more cost-effective. It is an innovation which spares time particularly for complicated products. The part or assembly is made by utilizing 3D Printer or Additive Manufacturing Technology. Additive Manufacturing process makes three-dimensional parts straightforwardly from CAD models by including materials layer by layer. Rapid Prototyping is broadly utilized in many industries i.e. from shoe to auto makers.

Rapid Prototyping Technique has two types: added manufacturing and subtractive manufacturing (Dandgaval and Bichkar, 2016). Subtractive type RP is a material expelled strategy from solid piece until the desired design remains. Additive type RP is opposite to subtractive. In this type material is added layer by layer up to wanted design. Additive manufactures has capacity to make any shape and geometry.

There are particular strategies utilized used in RP. for examples Stereolithography (SLA), Fused Deposition Modeling (FDM), 3D Printing (3DP) or Selective Binding, Laminated Object Manufacturing (LOM), Laser Engineering Net Shaping (LENS), Solid Imaging (SI) or Multi-stream Modeling, Selective Laser Sintering(SLS) (Dandgaval and Bichkar, 2016).

2.2.1 Fused Deposition Modeling (FDM)

Fused Deposition Modeling is created by Scott Crump, the founder of Stratasys. Fused Deposition Modeling (FDM) is an additive manufacturing fabricating innovation generally utilized for modeling, prototyping and creation applications. FDM has 3 steps: pre-handling, production, post-processing. In pre-processing, a CAD demonstrated is converted into STL format for FDM process (Dandgaval and Bichkar, 2016). The layers are created until the whole part finish. In post-processing, the part and all backings are taken out by washing or stripping away. Then Part surface is completed and clear up. Figure 2.1 shows technique use in FDM manufacturing.

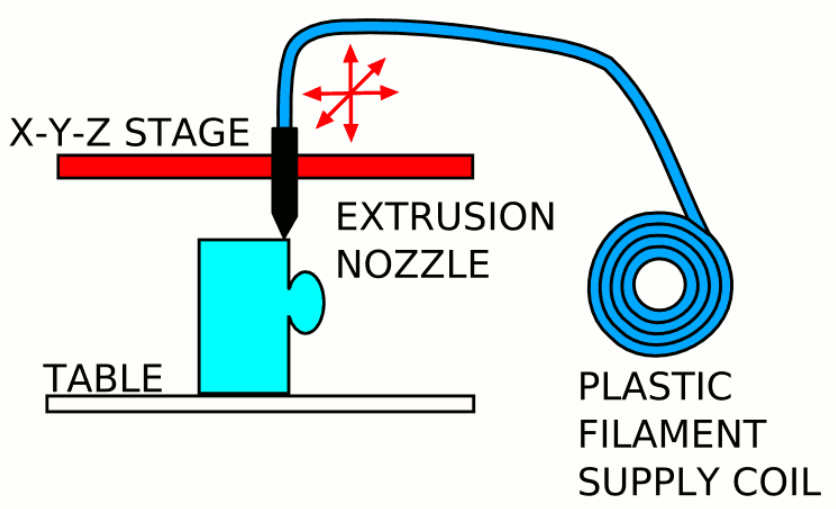

Figure 2.1 FDM manufacturing technique (Feygin, 1989)

FDM Technology manufactured pieces layer-by-layer by heating thermoplastic material to a semi-fluid condition and remove it with computer controlled. FDM utilizes two materials: modeling material and support material. Modeling material is the forms a ready piece while supporting material is a platform. Material filament is

encouraging the 3D printers material's flow to a print head .3D print is moved at X and Y axis before downward at the Z axis and to start new coating . (Dandgaval and Bichkar, 2016). Before the 3D print is finished to build, splits the backing material over or dissolved it in cleanser and water.

FDM are clean, easy to utilize office-friendly 3D printing process. FDM technology constructs the most precise part of any additive fabrication system. FDM utilizes real production grade thermoplastics. Thermoplastics can withstand heat, chemicals, sticky either dry situations, mechanical pressure. It used as the supported materials for complex geometries and depressions that would be hard to assemble.

2.2.2 Stereolithography (SLA)

Stereolithography is the greatest generally utilized in rapid prototyping technology. Stereolithography fabricates plastic product or items single coating at any given moment by following a laser beam on the external of a vat of fluid photopolymer, inside that is a portable level to help the product existence manufactured. Figure 2.3 shows the example of standard Stereolithography manufacturing technique. The photopolymer very quickly hardened anywhere the laser beams touches the external of the fluid. During single coating is complete, the level is delivering downward a small split between the vat and second coating is drawn straight above of the first. The sticky possession of the material caused every following coating into binder with the first and entire product . (Feygin, 1989).

Part that hold shades or undermines must continue supporting all along the fabrication procedure by backing form. Those are either manually or automatically designed by a computer program especially created for rapid prototyping. Through of fabrication step, the part is removing from the vat and the support the incision or break.

Stereolithography for the most part is deliberate to give best precision and external finish of all rapid prototyping technology (Feygin, 1989). Throughout the agedness, a through different of materials among properties copying of any designing thermoplastics has been to make. Limited selectively shade changeful materials for biomedical and dissimilar applications are ready for use, and now ceramic materials are created. The technology is also unusual for the a little costly size of part moderate , from piece as big as an auto wheel to as small as a sugar cube , with fine accuracy in consideration to the size of the product .

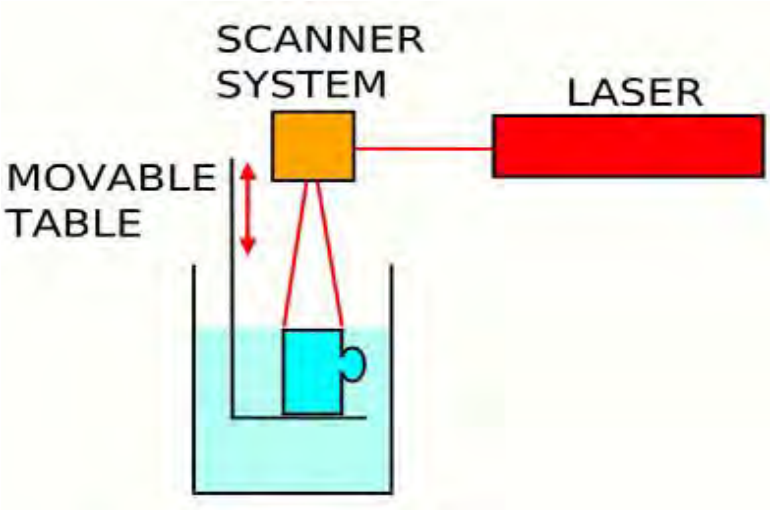

Figure 2.3: Stereolithography manufacturing technique (Feygin, 1989).