Faculty of Manufacturing Engineering Technology

INVESTIGATION ON RHEOLOGY PROPERTIES OF NATURAL FIBRE COMPOSITE FOR FUSED DEPOSITION MODELING APPLICATION

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INVESTIGATION ON RHEOLOGY PROPERTIES OF NATURAL FIBRE COMPOSITE FOR FUSED DEPOSITION MODELING APPLICATION

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(Ts. Dr. Syahibudil Ikhwan Bin Abdul Kudus)

DEDICATION

This report is dedicated to Ts. Dr. Syahibudil Ikhwan Bin Abdul Kudus for without his early inspiration, coaching and enthusiasm, none of this would have happened. This dedication is especially dedicated to my parents. To my mother, Zawiyah Binti Md Luwi for his ongoing love and support, he also taught me to trust in Allah and believe in hard work and to my mother who could not see this final report completed. I also dedicate this report to my family who always support me with their unconditional love that motivates me to set a higher target in completing this final year project. This dedication is also dedicated to my beloved friends that have provided me with a strong love shield and always surround me and never lets any sadness enter inside.

Thank you.

ABSTRAK

Inovasi pengilangan tambahan (AM) telah disambungkan secara berkesan dalam aplikasi yang berbeza. Pemodelan deposisi bercampur (FDM), yang menonjol di antara sistem AM yang paling menonjol, adalah strategi yang paling banyak digunakan untuk pembuatan bahagian-bahagian termoplastik yang sebahagiannya digunakan sebagai model cepat untuk ujian praktikal dengan titik minat kemudahan, pembaziran yang tidak ketara, dan kesederhanaan perubahan material. Oleh kerana sifat mekanik termoplastik tulen, salah satu cara yang mungkin adalah dengan menambah bahan bertetulang komposit serat semula jadi ke dalam bahan plastik untuk membentuk filamen pencetak 3D. Dalam kajian ini, kami mencadangkan penilaian kitar semula mekanikal ABS, bahan yang digunakan secara meluas dalam konteks pencetakan 3D sumber terbuka, untuk menubuhkan daya maju bahan NFC ini untuk digunakan dalam pencetak 3D sumber terbuka. Makalah ini akan menilai ciri-ciri bahan degradasi dan juga akan membolehkan kita memahami keperluan teknikal dan cabaran untuk pembangunan.

ABSTRACT

Additive manufacturing (AM) technology have been effectively connected in different applications. Fused deposition modeling (FDM), is the most broadly utilized strategy for manufacturing thermoplastic parts those are for the most part utilized as fast models for practical testing with points of interest of ease, insignificant wastage, and simplicity of material change. Due to the limited mechanical properties of pure thermoplastics, one possible way is by adding reinforced materials such as natural fibre composite (NFC) into plastic materials to form a filament of 3D printer. In this study, propose an evaluation of the mechanical recyclability of ABS, material widely used in the open-source 3D printing context, in order to establish the viability of this NFC material to be used in the open-source 3D printers. This evaluate the degradation material properties and thus allow us to understand the technical requirements and challenges for development of 3D printer filament.

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LIST OF ABRIVATIONS

NFC - Natural Fibres Composite

AM - Additive Manufacturing

PLA - Polyactid

PP - Polypropylene

ABS - Acrylonitrile Butadiene Styrene

FRC - Fibres Reinforced Composite

3D - Three Dimensional

σt - Tensile Strength

CHAPTER 1

INTRODUCTION

This chapter provides the project background including the Natural Fibre composite, additive manufacturing and filament of the 3D printer in Fused Deposition Machine (FDM). The problem statement, objectives and the scopes of this project on the development of natural fibre composite as filament in additive manufacturing also will be introduced.

1.1 Background of Study

Natural fibre is among the primary known cultivated plants and humans have continued to domesticate these crops over time. The worldwide accessibility of natural fibre and other abundantly accessible agro-waste is responsible for this new polymer science and engineering research, and the pursuit for sustainable technology. Natural fibre were presented with the intention of a couple with low budgets compared to present fibre glass and the yielding of lighter composites. They have lower density (1.2–1.6 g/cm3) than that of glass fibre (2.4 g/cm3), which ensures the production of lighter composites. Natural fibre such as hemp, jute, sisal and kenaf are extensively used with conventional petroleum based plastics such as polypropylene and polyethylene. Over the past few decades, there has been an increasing interest in the use of natural fibre in composite applications. There are many advantages that haves been present by this composite compared to synthetic fibre such as low tool wear, low density, cheaper cost, biodegradability and availability. Higher specific strength than glass fibre and a similar specific modulus is one of the reasons for this growing interest. This natural fibre as theoretically offer

desirable specific strengths and modulus at a lower cost. Some of the fibres are obtained by processing industrial, agricultural or consumer waste (Ning, Cong, Qiu, Wei, & Wang, 2015).

Additional manufacturing technologies have the benefit over traditional technology to produce firm, elastic, and dead end products, prototypes, moulds, die or finished products directly from digital information. In addition, they have the advantage of reducing product development time, and most importantly design and unmatched features by other manufacturing methods.

The first AM developed technique is usually compose the pure plastic parts used primarily as a fast prototype. FDM is the utmost broadly used method among all AM techniques for the fabrication of pure malleable parts at low cost, minimum wastage, and ease of material change. At this time only thermoplastic filaments being used as raw materials in FDM, with acrylonitrile butadiene styrene (ABS), polycarbonate (PC), polylactic (PLA), polyamide (PA) and any two kind's mixtures of thermoplastic materials. In line to the pure thermoplastic parts constructed by FDM is a lack of strength as a fully functional component and bearing load. So, the critical problems need to increase the strength of thermoplastic parts made by FDM to overcome limitations. One possible way is to add reinforced materials like NFC into plastic materials (Ning et al., 2015).

1.2 Problem Statement

The 3D printing innovation of the present world is advanced to the point that nearly anything can be effortlessly made by printing process. Nevertheless, there are still some issue

need to improve while using ABS filament because of their low in mechanical properties. Most of the fused deposition modelling, they use ABS plastic as their filament material.

This research study on production of a filament using natural fibre composites. Therefore, the processing parameter such as composition ratio for fibre and matrix, temperature and speed that will undergo extrusion method was investigated.

1.3 Objectives

The objectives of this project are as follows:

i. To characterize Kenaf Reinforced ABS composite for application in Fused Deposited Modelling process.

ii. To determine the appropriate amount of Kenaf particles in ABS composite for project development specification of FDM filament.

1.4 Scope of Study

To achieve the aim of the research, the study was constrained on identifying material and process to fabricate filament in the field of AM systems. This research will focus only on material of natural fibre (kenaf) and ABS plastic. The research will undergo rheological test to produce a filament based on their viscosity.

1.5 Expected Result

The result expectation for the project:

I. Development of NFC filament based on their viscosity.

II. The suitable percentage composition for NFC and virgin ABS will be success.

1.6 Summary

This chapter start with defined the problem statement according to the project that will be carried out. From there on we will go through to the objectives of the study which is the main aim to be achieve on this project. Then, this chapter also explained about the scope of the study generally.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter presents the literature review of previous work related to natural fibre composite (NFC), and Additive Manufacturing (AM), aiming to provide a clear understanding of the concept and its application. Discussion on the definitions related to the topics is also presented.

2.1 Natural Fibres

Natural fibre biodegradable polymer combinations are basically defined as a type of materials that are composed of natural fibre and biodegradable polymer as a matrix. Natural fibre is a renewable Source and a fresh generation of cavalries and supplement for polymer based on materials. Natural fibre can be separated into some different categories, source, deviation of plant, animal and mineral types (Mei po Ho & Lau, 2012). Natural fibres acquired from the leaves of the plant, plant internal crops or seed plants, from animal furs, insecticides and mineral products. Figure 2.1 shows the classification of different natural fibres.

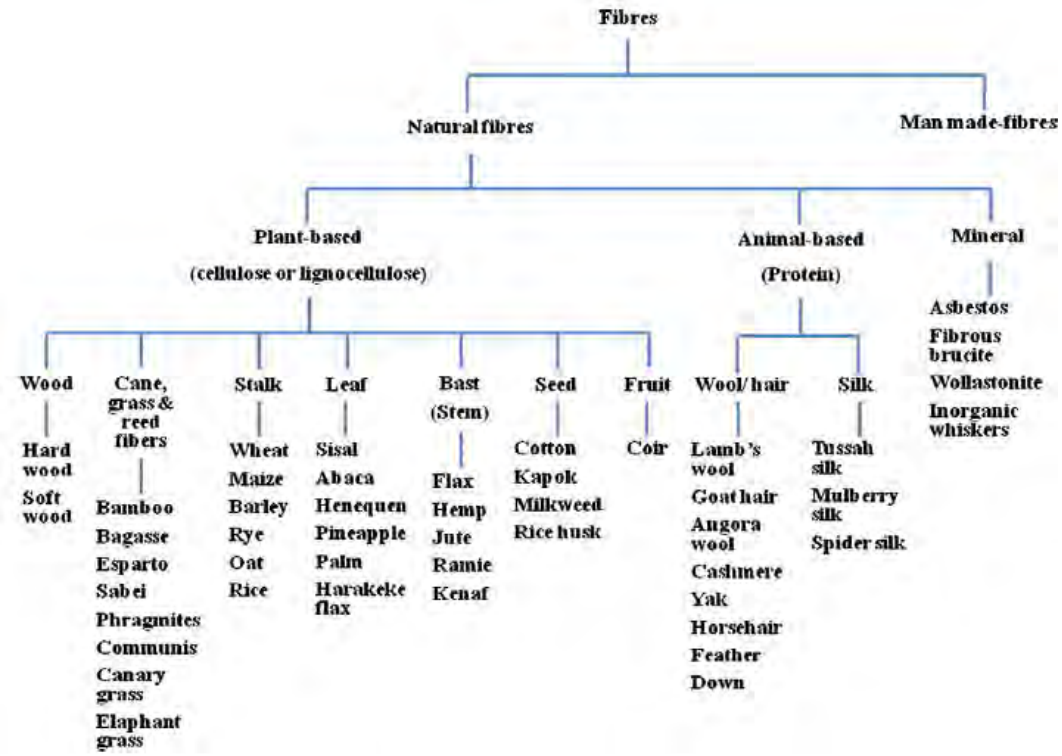

Figure 2. 1: Classification of different natural fibres(Mei-po Ho *et al*., 2012)

2.1.1 Kenaf

Kenaf is relatively commercially accessible and economics low-cost amid other natural fibre reinforcing the material. They are produced from species of Hibiscus cannabinus where the genus is Hibiscus and family Malvaceae obtained from the stem of plants. The properties of kenaf are hardy, threatening plant with a stringy stalk, strong, unaffected to insect harm and need a relatively low quantity of or no fungicide. Figure 2.2 shows the kenaf plantation and fibre.

a

b

Figure 2. 2: a)Typical images of plantation b) kenaf fibre (Saba, Paridah, & Jawaid, 2015)

According to Saba *et al*., (2015), factors that will alter the mechanical properties of kenaf fibre is fibre length, fibre content and fibre orientation. Table 2.1 shows the density and mechanical properties of kenaf fibre.