EFFECT OF POLYAMIDE 12 MECHANICAL PROPERTIES BEHAVIOR OF SELECTIVE LASER SINTERING MACHINE IN AUTOMOTIVE INDUSTRY

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY)

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A report submitted
in fulfillment of the requirements for the degree of
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2022

DECLARATION

I declare that this report entitled "Comparison and Validation 3D Scanner Percentage Data Accuracy by Analizing SLS 3D Printer Material Composition" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Name	:	Nur Ainani Amalia Binti Zulkefli
Date	:	17th January 2022

APPROVAL

I hereby declare that I have checked this report and in my opinion, this report is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology).

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Date : 17/1/2022

DEDICATION

This research work and project is dedicated to all my families for their encouragement and for those who have supported me throughout my education. Besides that, my supervisor for his support, advice and sharing during this project. Not to be forgotten, my friends that always give support physically and mentally to finish this project.

ABSTRACT

Even though numerous 3D printed objects have been produced, there are still concerns with the physical qualities of the printed product. The effects of significant Selective Laser Sintering (SLS) 3D printer settings on the material strength of Polyamide-12 are investigated in this study. For the Polyamide-12 material compositions, a mixture of virgin and recycled materials was used. The test specimens were produced using the SLS 3D printer at various process settings and material composition percentages. Torsional stress, compression strength, and surface roughness were all evaluated. Torsion test findings revealed that the composition of the 100% Virgin Material samples seemed stronger, with lower plastic deformation at maximum torsion (1.81Nm) and the highest Compressive Stress at 151.85 MPa. The mixed material samples looked to be stiffer since they have a torsion value of 1.69 Nm, a stress value of 145.33 MPa, and the smoothest surface of 9.334 μm. Finally, the best outcome for the SLS 3D printing guideline is a mixture powder composition.

ABSTRAK

Walaupun banyak objek cetakan 3D telah dihasilkan, masih terdapat kebimbangan mengenai kualiti fizikal produk bercetak. Kesan tetapan pencetak 3D Selective Laser Sintering (SLS) yang ketara pada kekuatan bahan Poliamida-12 disiasat dalam kajian ini. Untuk komposisi bahan Polyamide-12, campuran bahan dara dan kitar semula telah digunakan. Spesimen ujian telah dihasilkan menggunakan pencetak SLS 3D pada pelbagai tetapan proses dan peratusan komposisi bahan. Tegasan kilasan, kekuatan mampatan, dan kekasaran permukaan semuanya dinilai. Penemuan ujian kilasan mendedahkan bahawa komposisi sampel 100% Bahan Dara kelihatan lebih kuat, dengan ubah bentuk plastik yang lebih rendah pada kilasan maksimum (1.81Nm) dan Tegasan Mampatan tertinggi pada 151.85 MPa. Sampel bahan campuran kelihatan lebih kaku kerana ia mempunyai nilai kilasan 1.69 Nm, nilai tegasan 145.33 MPa, dan permukaan paling licin 9.334 µm. Akhir sekali, hasil terbaik untuk garis panduan percetakan 3D SLS ialah komposisi serbuk campuran.

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CHAPTER 1

INTRODUCTION

1.1. Project Overview

Different industries have identified 3D printing as the future production approach. It is the process of turning a computer model into a three-dimensional solid item of nearly any shape (Mpofu, 2014). Manufacturers are increasingly using 3D printing. Because of some of the revolutionary benefits it may give, demand is increasing. More complex designs may be created and manufactured using 3D printing than with traditional production methods. When 3D printing is employed, traditional technologies impose design limitations that are no longer applicable. 3D printing, which can generate parts in hours, speeds up the prototype process. As a result, each step may be done faster.

SLS is an additive method that facilitates the manufacture of 3D things by melting a powdered material layer by layer using a laser according to the product's shape (Rosso, 2020). The process is in which a small layer of powder material is placed onto a heated build surface (usually warmed), and then a CO_2 laser is used to selectively solidify the powder (Cook, 2015).

The effects of virgin and reused PA12 powders on the microstructure and mechanical characteristics of printed objects has been studied (Rosso, 2020). In addition, 3D printing technology allows users to manufacture a broad range of items, including blades, arms, and potentially dangerous objects. As a result, 3D printing should be limited to a small number of people in order to prevent extremists and criminals from smuggling weapons into the nation covertly. However, there are drawbacks to 3D printing technology, and it is not always the ideal solution for product development in your project. This project includes the study of the percentage of material composition of polyamide-12, the investigation of the consequences of the percentage and the dimension accuracy of the 3D part and the guidelines produced for SLS 3D printing.

1.2. Problem Statement

3D printing is currently widely utilized around the world. 3D printing technology is quickly being utilized for mass customization and manufacture of some type of open-source architecture in the industries of agriculture, healthcare, automotive, and aerospace.

Dimensional inaccuracies induced by thermo-mechanical deformation, on the other hand, are a disadvantage of the SLS printing method. (Kozak & Zakrzewski, 2018) stated that the variables in this printing might affect dimensional accuracy:

i. Geometry of the parts.

ii. Powder composition, particle size and powder reuse.

iii. Laser power, laser spot diameter and mode of radiation.

iv. Machine tool specifications, machine optic-mechanical systems and work chamber features.

Figure below show common 3D printing troubleshooting problems as they are the problems occur in the printing activity.

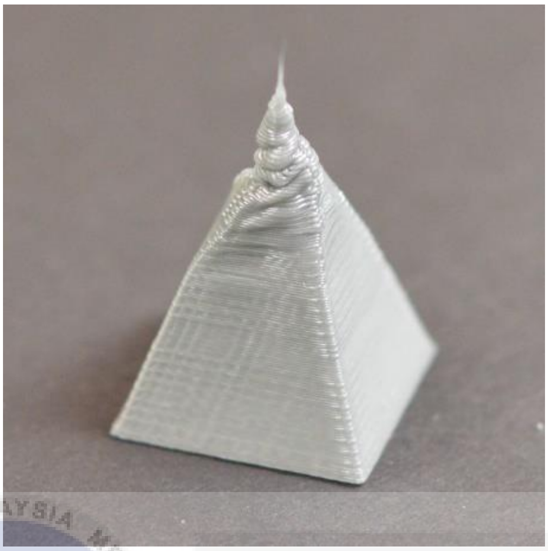

Figure 1. 1 Overheating (www.simplify3d.com)

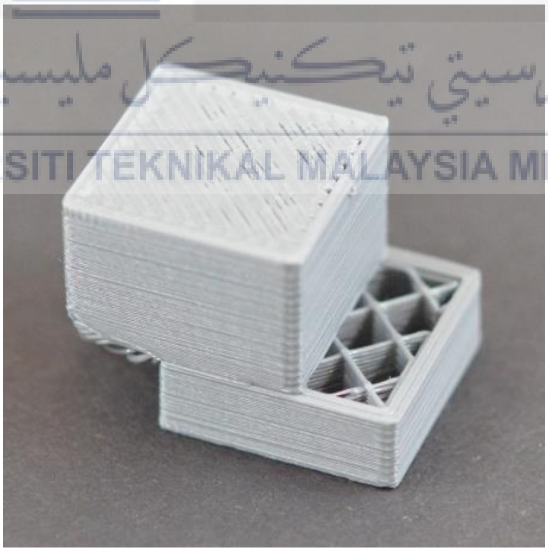

Figure 1. 2 Layer Shifting (www.simplify3d.com)

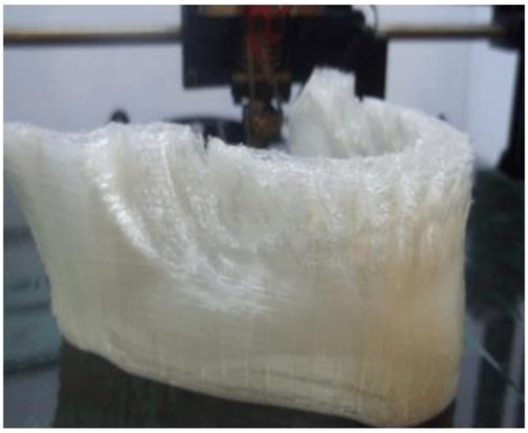

Figure 1. 3 Over-extrusion (www.simplify3d.com)

Figure 1. 4 Warping (www.simplify3d.com)

1.3. Research Objective

1. To study the percentage of material composition of polyamide-12.
2. To investigate the consequences of the percentage and the dimension accuracy of the 3D part.
3. To produce guidelines of SLS 3D printing for automobile parts.

1.4. Scope of Research

1. The Polyamide-12 material composition consist of Virgin, Recycle and Mixture material by using SLS 3D Printer.
2. Analyse the effect of the material properties on Torsion test, Roughness test and Compression test.
3. The study that focusses on data obtained in order to produced guidelines of 3D printing for automobile parts.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

In this chapter, an overview of testing, optimization and calibration of a Selective Laser Sintering 3D Printer will be elaborated. The main idea, problem statement, objective and scope of this project will also be introduced. The flow of this project is shown as Figure 2.1 below.

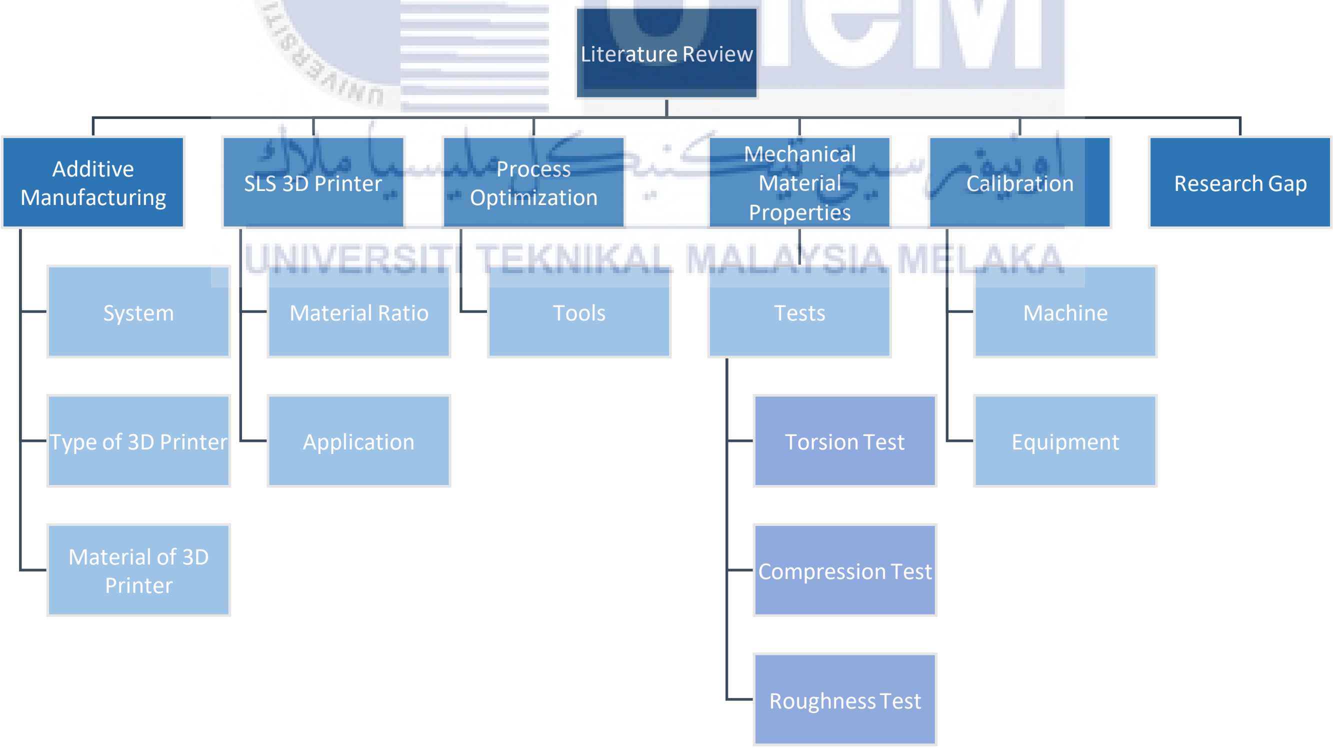

Figure 2. 1 K-chart of Research

2.2. Additive Manufacturing

2.2.1. Additive Manufacturing System

Additive manufacturing (AM) technology has been researched and developed for more than two decades. Rather than removing components, AM techniques stack materials to produce three-dimensional parts directly from CAD templates, allowing for geometric and material complexity that would be hard to accomplish with subtractive manufacturing. Additive manufacturing is a broad term for the layer-by-layer construction of diverse materials into three-dimensional components. Computer-aided design (CAD) is used to produce the pieces, making additive manufacturing an effective technology for quick prototyping and a number of other applications (Guo & Leu, 2013).

Polymers, ceramics, and metals are treated using laser or electron beam freezing, hot extrusion, polymerization, or joining agents, among other ways. By layering material on top of one other, 3D printing may turn geometrical representations into real items. Additive manufacturing generates "things" from a digital "model" by depositing component materials in a layer-by-layer way utilizing digitally managed and regulated material laying equipment. This layer-by-layer manufacturing technology enables unrivalled accuracy and control in the production of huge, composite, and hybrid systems that would be difficult to produce using traditional methods.

2.2.2. Types of 3D printer

3D printing, also known as additive manufacturing, is the process of creating a three-dimensional structure from a CAD model or a digital 3D model. The term "3D printing" refers to a number of processes for creating a three-dimensional structure by depositing, connecting, or solidifying material layer by layer under machine control. There are seven types of 3D printers including:

i. Stereolithography (SLA)

ii. Selective Laser Sintering (SLS)

iii. Fused Deposition Modelling (FDM)

iv. Digital Light Process (DLP)

v. Multi Jet Fusion (MJF)

vi. Direct Metal Laser Sintering (DMLS)

vii. Electron Beam Melting (EBM)