UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF LASER ENGRAVING PARAMETERS ON SURFACE MORPHOLOGY AND QUALITY ON GALVANIZED STEEL

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Faculty of Mechanical and Manufacturing Engineering Technology

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in fulfillment of the requirements for the degree of
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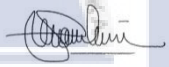
DECLARATION

I declare that this Choose an item. entitled " Effect Of Laser Engraving Parameters On Surface Morphology And Quality On Galvanized Steel " is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

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

Signature : 

Supervisor Name : Profesor Madya Ir. Dr. Mohd Hadzley Bin Abu Bakar

Date : 17 JANUARY 2022

DEDICATION

This study is wholehearty dedicated to my beloved parents, who have been my source of inspiration and gave me strength when thought of giving up,who continually provide their moral support, spiritual, emotional and financial support. To my sister, relatives, mentor, friends and classmates who shared their words of advice and encouragement to finish this study. Unforgettable, to my respected supervisor Whose compassion, motivation, and unending support throughout the completion of my project.

ABSTRACT

This research is to study the effect of laser engraving parameters on surface morphology and quality on galvanized steel. A laser is a device that causes atoms or molecules to generate light at certain wavelengths and then amplifies that light, resulting in a very narrow beam of radiation. The emission usually only extends to a small spectrum of visible, infrared, or ultraviolet wavelengths. The main objective of this research is to analyze the effect of laser engraving parameters on surface morphology on galvanized steel, to evaluate the effect of laser engraving parameters on surface quality of on galvanized steel and to observe the quality of laser engraving on galvanized steel.The raw material used for the specimen is galvanized steel dimension 110mm x110mm x 0.5mm . There are four important parameters of laser engraving process that being recognised which are laser speed, laser power, laser frequency, and loop count. Adobe Illustrator used to create the required design for engraving process. The specimens were engraved by Fiber laser machine at the specified engraving parameters to obtain the surface morphology and quality on galvanized steel using different parameters. Additionally, surface roughness was determined using a Mitutoyo Surftest SJ-301 stylus profilometer and surface characterisation was performed using a Nikon Eclipse LV100. The greatest Ra value is 1.480m at 700 mm/s, 30% and 80 kHz, while the worst average value is 1.002m at 700 mm/s, 30% and 200 kHz. As a result, the surface finish was generalised when some burn scars were present and a nice square shape was produced with and without rusting appearances (depend on parameters).

ABSTRAK

Penyelidikan ini adalah untuk mengkaji kesan parameter ukiran laser pada morfologi permukaan dan kualiti pada keluli tergalvani. Laser adalah alat yang menyebabkan atom atau molekul menghasilkan cahaya pada panjang gelombang tertentu dan kemudian memperkuat cahaya itu, mengakibatkan sinaran yang sangat sempit. Pelepasan biasanya hanya meluas kepada spektrum kecil panjang gelombang yang kelihatan, inframerah, atau ultraviolet. Objektif utama penyelidikan ini adalah untuk menganalisis kesan parameter ukiran laser pada morfologi permukaan pada keluli tergalvani, untuk menilai kesan parameter ukiran laser pada kualiti permukaan keluli tergalvani dan untuk memerhatikan kualiti ukiran laser pada keluli tergalvani. Bahan mentah yang digunakan untuk spesimen tergalvani dimensi keluli 110mm x110mm x 0.5mm. Terdapat empat parameter penting proses ukiran laser yang diiktiraf iaitu kelajuan laser, kuasa laser, kekerapan laser, dan kiraan gelung. Adobe Illustrator digunakan untuk membuat reka bentuk yang diperlukan untuk proses ukiran. Spesimen telah terukir oleh mesin laser Gentian pada parameter ukiran yang ditentukan untuk mendapatkan morfologi permukaan dan kualiti pada keluli tergalvani menggunakan parameter yang berbeza. Di samping itu, kekasaran permukaan ditentukan menggunakan profilometer stylus Mitutoyo Surftest SJ-301 dan pencirian permukaan dilakukan menggunakan Nikon Eclipse LV100. Nilai Ra terbesar ialah 1.480m pada 700 mm / s, 30% dan 80 kHz, manakala nilai purata terburuk ialah 1.002m pada 700 mm / s, 30% dan 200 kHz. Akibatnya, penamat permukaan umum apabila beberapa parut terbakar hadir dan bentuk persegi yang bagus dihasilkan dengan dan tanpa penampilan berkarat (bergantung kepada parameter).

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LIST OF SYMBOLS AND ABBREVIATIONS

CO_2	-	Carbon dioxide
D,d	-	Diameter
etc	-	Extra
FYP	-	Final Year Project
LEM 01	-	Laser Engraving Machine 01
mm	-	Millimeter
mm/s	-	Milimeter per second
Nd:YAG	-	Neodymium-doped Yttrium Aluminum Garnet
Ra	-	Roughness value
Re	-	Reynold Number
Rz	-	Roughness depth
UTeM	-	Universiti Teknikal Malaysia Melaka

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter is well defined about background of study, statement of purposed, problem statement, objectives, and scope of study. The introduction is simply brief about the general concept of the laser engraving process and how laser is founded and invented.

1.1 Background

A laser is a device that causes atoms or molecules to generate light at certain wavelengths and then amplifies that light, resulting in a very narrow beam of radiation. The emission usually only extends to a small spectrum of visible, infrared, or ultraviolet wavelengths. Many different types of lasers are being created, each with its own set of properties. “Light Amplification by Stimulated Emission of Radiation” is what laser stands for. A laser is an unusual light source if compared with flash light. Lasers produce a very narrow beam of light. This light commonly used in many technologies such as optical disk drives, laser printers, barcode scanners, DNA sequencing instruments, fiber-optic, semiconducting chip manufacturing (photolithography). Today's laser turns into an amazing blade capable of slicing through iron as easily as mud. (Kumar et al., 2018).

According to (Lawrence Livermore National Security, LLC, for the Department of Energy's National Nuclear Security Administration., n.d.) Electrons in particular glasses, crystals, or gases are "stimulated" and form a laser when they absorb energy from an electrical current or another laser. This electron moves from a lower to a higher energy level as it travels around the nucleus of the atom. Lasers, unlike light, have only one wavelength

and a single shade. A laser produces a narrow beam of light with all of its peaks aligned that travels together. This is the only reason laser beams are so narrow, brilliant, and can be concentrated into such a small area. Laser beams may travel great distances because laser light remains focused and does not spread out as much as a flashlight. It may also focus a large amount of energy in a tiny region.

Moreover, laser is widely used in industry such as laser engraving. Laser engraving are introduced early in 1965 by a company called Western Electric. Laser engraving is a procedure of marking an object by removing the surface of the product itself to a certain depth. The laser engraving process may be very complicated, and the motions of the laser head are often controlled by a computer system. There are no inks or tool bits that touch the engraving surface and wear out in the laser engraving method. (Harsh S. Mehta, 2015).

Lasers are utilised in a variety of disciplines, including medicine, welding, and cutting, as well as communications. When compared to traditional engraving techniques, laser engraving has a number of benefits, including no tool wear, high automation, free programming, and character selection (Harsh S. Mehta, 2015). One of the most important factors driving the development of laser machining technology is its ability to produce exquisitely precise machining as well as complicated forms and machining of different materials such as metal, wood, polymer, ceramics, and leather (Jiang et al., 2015).

1.2 Problem Statement

The purposed of this research is to analyze the effect of Laser Engraving Parameters on Surface Morphology and Quality on Galvanized Steel. Technology evolved according to the passage of time, same goes to laser. Laser engraving can be used on of hard and durable materials such as steel, aluminum, plastic, galvanized, and more. However, with the

dumping of laser technology in the market, this has emerged a quality gap in this industry. Some of the company provide high price for a low quality of the engraving. The quality of the engrave surfaces is a significant aspect in practical laser engraving applications.

Methods for analyzing the impact of the primary process factors on quality have recently been developed, with the goal of improving quality rather than explaining the engraving mechanism. In this study, laser engraving of ceramic tiles is done at various levels of laser engraving parameters such as engraving speed, power, work piece thickness, and loop count. Manual procedures, on the other hand, are engraving speed and power, as well as engrave loop count.

Internal and undercut profiles (with the potential exception of internal circles) are practically hard to construct with 3D and 2D patterns; more advanced approaches must be used to obtain these profiles. Traditional methods for creating complicated geometrical patterns in ceramic tiles include diamond sawing, hydrodynamic machining, and ultrasonic machining, however these methods are both costly and time consuming.

The most common problem that occurs after using the laser engraving technique to engrave galvanized steel is a crack on the surface and a lack of clarity in the design, which is primarily caused by different loop count, speed, and power, as well as a high temperature gradient within the galvanized steel substrate during the engraving process. These issues can diminish the strength of the plate and provide opportunities for significant fracture propagation, resulting in partial or full tile failure.

1.3 Research Objective

The main objective of this research is to analyze the effect of laser engraving parameters on surface morphology and quality on galvanized steel. Some of the objectives are state as below: Specifically, the objectives are as follows:

a) To evaluate the effect of laser engraving parameters on surface morphology on galvanized steel.

b) To evaluate the effect of laser engraving parameters on surface quality of on galvanized steel.

c) To observe the quality of laser engraving on galvanized steel.

1.4 Scope of Research

The purpose of this research is to investigate the impact of Laser Engraving Parameters on Galvanized Steel Surface Morphology and Quality. Due to its high output power, excellent optical quality, and small size, it was performed at the laboratory at Technical University of Malaysia Malacca (UTeM). It's also about dependability and minimal ownership costs. The thickness of the metals plate that uses a different measurement, such as speed and power of the machine operating during the operation, is used to assess the impact of laser engraving parameters on surface quality of metals. The material will be harmed if the speed and power are exceeded, resulting in burns.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

(Grimes, 2019) explained that the history of laser engraving begins with the story of the first lasers. Charles Townes and Arthur Schalow invented “Maser” in 1954. Maser stand for “Microwave Amplification by Stimulated Emission of Radiation”. In 1958, they had a breakthrough which lead them creating more advance form technology. They then wrote a paper which inspired a lot of people to explore about laser. The very first ruby laser, also known as an optical laser, was developed by Theodore Mainman in 1960. Gordon Gould started experimenting with lasers in 1958, using an overturned original light laser. However, Gordon was unable to protect the pattern, allowing other scientists to enter the area. However, Gordon will be able to pattern it in 1977. A firm named Western Electric created the first laser for production in 1965. Elisha Grey, an American electrical engineer, established the business. In 1967, focused Carbon dioxide laser beams were developed, which led to the development of a contemporary Carbon dioxide laser cutter in 1975. With these advancements, laser engraving has been able to expand into a broad variety of sectors (Grimes, 2019).

According to (Stipo, 2019), laser is an artist tool where laser engraving can be paint ton anything by using light and heat to burn the surface of the canvas. Laser engraving also offer varieties of benefits such as non-contact method which means the laser is not physically touching the surface of the materials instead relying on heat to achieve the desired results. Laser engraving is known as highly efficient because it safe to change from materials to

materials. Actually, laser engraving is considered a safe process because it can be conducted from computer that is far away from the subject. Laser engraving technology are widely used in other industry such as jewelry engraving, wood engraving, glass engraving, acrylic cutting and etc.

2.2 Laser Engraving

(LYDIA SOBOTOVA, 2015) laser are widely used on marking process, as shown in the figure where marking are in the first place which hold 25% of the industries followed by cutting 25%, Welding and engraving 13%, micro-process 12%, others 8% and drilling 3%.

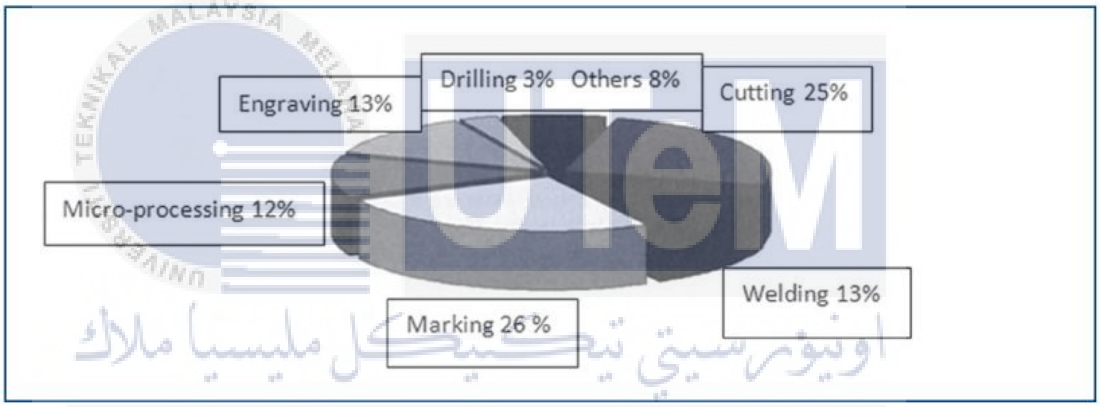

Figure 2.1 : Percentage of laser used in technologies (Fedorycheva, I., & Hammer, 2015)

The technique of laser engraving involves removing material from the top surface to a particular depth. There are no inks used in this procedure, and there are no tool bits that come into touch with the engraving surface and wear out. The laser is mostly used to etch an item. It also featured certain hue shifts as a result of chemical or molecular changes. Because of the easy technique of engraving on the surface of the materials, this approach is considered quick and efficient. Computers may be used to control and design the engraving process. The number of laser beams passing on the material's surface can be used to