INVESTIGATION ON THE TRIBOLOGICAL AND HARDNESS PROPERTIES OF NICKEL-QUARRY DUST COMPOSITE COATING PREPARED BY VARIOUS SURFACTANT CONTENTS

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This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering

by

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Name Date :

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the Degree of Bachelor of Manufacturing Engineering (Manufacturing Material). The member of supervisory is as follow:

…….....…

Dr. Intan Sharhida Binti Othman

(Project Supervisor)

…….....…

Dr. Rose Farahiyan Binti Munawar

(Project Co-Supervisor)

ABSTRAK

Kajian ini akan menyiasat kesan pelbagai kandungan surfaktan pada permukaan morfologi, kekerasan dan sifat memakai lapisan komposit Ni-QD pada aluminium 7075. Lima kandungan surfaktan berbeza disediakan pada 0.3g / L, 0.6g / L , 0.9g / L dan 1.2g / L. Proses elektrodeposisi dilakukan pada 1 jam dan haba dirawat pada 200˚C dan 400˚C. Dalam kajian ini, nikel digunakan sebagai matriks manakala debu kuari sebagai zarah pengukuhan. Debu quarry dihancurkan menjadi zarah yang lebih halus dengan menggunakan mesin penggilingan bola dan saiz zarah ditentukan dengan menggunakan Particle Size Analyzer (PSA). Lapisan komposit akan ditentukan dan diuji dengan menggunakan X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Mikroskopi Pengimbasan Elektron (SEM, ujian haus dan kekerasan.) Kekerasan lapisan komposit Ni-QD meningkat dengan rawatan haba. Terdapat beberapa kelebihan yang boleh diperolehi daripada kajian ini terutamanya dalam industri aeroangkasa dan automotif.

ABSTRACT

The study is about to investigate the effect of various surfactant contents on the on the surface morphology, hardness and wear properties of Ni-QD composite coating on aluminium alloy 7075. Five different surfactant contents were prepared at 0.3g/L, 0.6g/L, 0.9g/L and 1.2g/L. Electrodeposition process was carried out at 1 hour and heat treated at 200˚C and 400˚C. In the study, nickel use as a matrix while quarry dust as the reinforcement particles. The quarry dust is crushed into more finer particles by using ball milling machine and the size of the particles are determined by using Particle Size Analyzer (PSA). The composite coating will be determined and tested by using X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Scanning Electron Microscopy (SEM, wear and hardness test. The hardness of Ni-QD composite coating increased by heat treatment. There are some advantages that can be obtained from this study especially in aerospace and automotive industry.

DEDICATION

To

My beloved father, Badrulzaman Khan Bin Abdul Han

My lovely mother, Noraini Binti Jais

My caring siblings, Norull Azam Khan and Norull Aziq Khan

My supportive supervisor, Dr Intan Sharhida Binti Othman

All technicians and friends for giving me moral supports, cooperation and understandings

Thank You and Always Remember You All Forever

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Many thanks also to all friends that always help me in the project. To Ammar, Kak Emmy and Faizal, thank you for always being there when I need you for the guide and explanation. For me, you guys are awesome and very supportive. I will not forget all joys and happy moments that I spend with you guys,truly from my heart.

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LIST OF ABBREVIATION,SYMBOLS AND NOMENCLATURE

%	-	Percent
wt%	-	Weight percent
ºC	-	Degree Celcius
A/dm^2	-	Ampere per decimetre squared
AA7075	-	Aluminium Alloy 7075
Al	-	Aluminium
Al-Ni	-	Alumimium Nickel
$AlCl_3$	-	Aluminium Chloride
Al_2O_3	-	Aluminium Oxide
CaO	-	Calcium Oxide
CaF_2	-	Calcium Fluoride
CO_2	-	Carbon dioxide
CoF	-	Coefficient of friction
Cu	-	Copper

Cr_2O_3	-	Chromium(III) Oxide
DC	-	Directional Cast
FA	-	Fly Ash
Fe	-	Ferum
Fe_2O_3	-	Ferum Oxide
H_3BO_3	-	Boric acid
H_2O	-	Water
K_2O	-	Potassium Oxide
Mg	-	Magnesium
MgO	-	Magnesium Oxide
MMC	-	Metal Matrix Composite
Na_2O	-	Sodium Oxide
Ni	-	Nickel
Ni-FA	-	Nickel Fly Ash
Ni-QD		Nickel Quarry Dust
$NiCl_2$	-	Nickel chloride
$NiSO_4$	-	Nickel sulphate
PMC	-	Polymer Matrix Composite
PSA	-	Particle Size Analyzer
QD	-	Quarry dust
SCC	-	Stress Corrosion Cracking
SECD	-	Sediment Electro-co-deposition
SEM	-	Scanning Electron Microscopy
S_3N_4	-	Silicon Nitride

Si	-	Silica
SiO_3	-	Silica Oxide
TiO_2	-	Titanium Oxide
XRD	-	X-ray Diffraction
XRF	-	X-ray Fluorescence
Zn	-	Zinc
ZnO	-	Zinc oxide

CHAPTER 1

INTRODUCTION

1.1 Background Of Study

A coating is a process for covering that is applied to the surface of an object or substrate. Coatings are principally connected on surfaces for embellishing, defensive, or functional purposes. There are several uses of coating. Firstly, for mechanical applications where mating parts move against each other under high loads, for example, shaft/bushing sets, the mating surfaces of each will commonly be covered or treated to increase and improve the hardness of the mating surfaces, subsequently enhancing wear protection. These sorts of parts can be profoundly helpless to surface wear and surface harm. On the off chance that left unchecked, this can result to a failure of the material because of breaks that start at the surfaces of the mating parts.

Electrodeposition is used as it is high energy efficiency, ability to coat component with irregular shape and larger component can be scale-up. The properties of material can be improved or enhanced from times to times. Zincating is an important step in electrodepositing process. This is because the process will chemically evacuate the oxide layer and at the same time replace it with layer of zinc oxide.

Nickel is a compound component denoted as Ni. Its atomic number is 28. It is a silvery white brilliant metal. Nickel has a place with the transition metals and is hard and bendable. Nickel contain materials that play important role part in our regular day

to day existences. Examples of Ni applications are hardware for food preparation, cell phones, transportation, buildings, medical equipment and power generation or production. Ni is chosen due to better corrosion protection, better durability and better quality at high and low temperatures.

Quarry dust, is a by-product created from a crushing process of stone. Rock will be crushed to small size of rocks and dust type particles called quarry dust will be formed during the process of exploding which is going to be as a waste. In order to reduce and avoid the production of waste, quarry dust is used as a reinforcement material in the coating process due to its good properties to make the coating more stronger and high wear resistance. Therefore, this study is conducted to study the properties of Ni-QD composite coating on the hardness of the coating.

1.2 Problem Statement

When the material is in a bare condition, it easily get corrodes and the wear resistance also lower. It is because there is no other layer that protect the surface of the material. Thus, coating play an important role as coating gives many advantages towards the material. Although coating gives more advantages but the properties can be enhanced by adding a reinforcement material. Properties of reinforced metal-matrix can be modified or enhanced by the addition of hard oxides such as silica and alumina. Addition of these second phase particle can increase the wear resistance or in other word to reduce the friction. Previously, one way to protect the substrate or material is by preparing the pure metal coating. However, the strength and wear resistance still weaker. Thus, some improvement can be made by preparing Ni coating with addition of quarry dust. Thus, addition of quarry dust as a reinforcement will improve the properties of the coating. For example, AA7075 has a low corrosion resistance and hardness. By applying Ni-QD composite coating, the properties of composite coating can be improved.

Previous study was conducted on the influence of different proportion of sand with quarry dust on the properties of concrete. The fly-ash was used as reinforced material. However, there is no study conducted by using quarry dust. The utilization of fly ash has positive ecological effects, as it saves landfill space, reduce energy and water utilization, and diminishes greenhouse gasses. So, a new method is proposed by replacing the fly ash with a quarry dust as it has similar role with the fly ash. Quarry dust is a product that releases from the blasting process of stones. So, a new approach by testing a quarry dust as the reinforcement material is carry out. This study focused on the effects of surfactant content towards the Ni-Quarry Dust. This is to reduce the waste that produced from the process of crushing the stones. Waste can cause environmental pollution and affects life. Next, natural resources can be used in a proper way without harm and disposed in landfills. Besides, to save the cost of usage.

By the utilization of quarry dust, the need of land fill area can be reduced and avoided thus tackle the issue of natural insufficiency. The accessibility of sand in concrete is not suitable and need to find an option material to replace it. Thus, quarry dust fulfills the explanation for the required material as it can be a substitution for sand requiring lower cost. It even makes a burden for dump the crusher at one place which can causes natural contamination. Recent researches study and investigate about the quarry dust as a replacement for fly ash for the enhancement of coating properties in term of tribological properties.

The project is carry out by several steps which includes the electrodeposition process. Electrodeposition is used as it is high energy efficiency, ability to coat component with irregular shape and larger component can be scale-up. The coating consists of two different electrodes which are anode and cathode. Nickel is at the anode and AA7075 acts as a cathode. Quarry dust will be added into the Watt's Bath solution. Surfactant (Sodium Dodecyl Sulfate) will be added into the solution as it will help the deposition of the quarry dust and nickel towards the coating area at AA7075. The properties of material can be improved or enhance from times to times as new approach or research will be tested based on the nickel-quarry dust composite coating on the AA 7075 with various surfactant contents which may lead to more economical, safe and better tribological properties and corrosion resistance. Previous research about the presence and absence of surfactant has been studied. It says that the

presence of the surfactant has significant effect on the surface morphology, composition of the coating and the mechanical properties.

1.3 Objectives of the project

There are several objectives of this research. The objectives are :

1. To study the effect of various surfactant contents on the surface morphology, hardness and wear properties of Ni-Quarry dust composite coating

2. To examine the effect of various surfactant contents on the hardness and wear properties of Ni-Quarry dust composite coating

3. To investigate the effect of various heat treatment on the surface morphology, hardness and wear properties of Ni-Quarry dust composite coating

1.4 Scope of the project

To ensure the objectives above can be achieve successfully, there are several elements that need to be followed and concerned as well.

1. This project is mainly focused on the enhancement and improvement in tribological of coating material with the presence of reinforcement material in term of wear resistant and corrosion resistant