UNIVERSITI TEKNOLOGI MARA

SURFACE MODIFICATION OF ALUMINIUM WITH COPPER COATINGS FOR CORROSION PROTECTION IN 3.5 % NaCl SOLUTION

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ABSTRACT

The presence of chloride ions accelerates the corrosion of aluminium in aqueous media; cause pitting attack. One way of protecting the aluminium is through coating with less reactive metal (i.e.:copper). Unfortunately, direct metallic coating on aluminium surface is hardly to carry out due to the presence of oxide layer. Thus, in this study, prior to copper coating, aluminium was pre-treated by cleaning, chemical etching and conversion coating (i.e.: zincating and nickel underlayer) in order to make copper coating process much easier. The effects of deposition temperature and pH solutions for conversion coating process were investigated. Meanwhile, for copper top coatings, the effect of electrodeposition modes were investigated by means of cyclic voltammetric (CV), chronoamperometric (CA) and chronopotentiometric (CP) technique in 0.1 M $CuSO_4$ + 0.1 M MSG + 0.01 M NaOH + 0.01 M C_6H_5 $Na_3O_7.2H_2O$ solution (pH 6) at 25°C. All coating samples were characterized using FESEM, EDX and XRD analysis. The adhesion strength of copper coating formed on the pre-treated aluminium was analyzed by Scotch® tape test. The corrosion resistance of aluminium coated with copper was analyzed by Tafel analysis and electrochemical impedance spectroscopy (EIS) in a corrosive medium of 3.5% NaCl solution. It has been proven that deposition temperature and pH of electrolyte solution was influenced the deposition of zinc on aluminium surface.The best zincating process on aluminium surface with grain-like microstrucutre morphology and the highest zinc composition (i.e.: 42.49 wt%) was done by immersing the aluminium substrate in 0.5M $Zn(NO_3)_2$ + 0.1M $NaPH_2O_2$ solution (pH 4) for 1hour at 50°C. Meanwhile, the deposition of nickel underlayer was performed by applying constant potential of -1.1 V from 0.1M $NiSO_4$ + 0.01 M NaOH + C_6H_5 $Na_3O_7.2H_2O$ solution (pH 6). It was also found that copper top coatings can be successfully coated on the nickel zincated Al surface either by CV (by cycling from -0.4 V to -0.9 V), CA (by applying constant potential of -0.7 V) or CP (by applying constant current density of -0.003 A/cm^2). All copper coatings prepared by different modes are strongly adhered to the modified aluminium surface with smooth and compact morphologies, higher copper composition with cubic crystalline structure. Nevertheless, copper coating prepared by CA mode showed the the highest corrosion protection efficiency (99.34%) of aluminium in chloride containing solution with the lowest corrosion rate (i.e: 0.002078 mm/yr) as measured by Tafel extrapolation method. The highest polarization resistance of 8877.2 Ω cm^2 was determined by EIS analysis with 91.88% protective polarization resistance efficiency in 3.5% NaCl solution.

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TABLE OF CONTENTS

		Page
CONFIRMATION BY PANEL OF EXAMINERS		**ii**
AUTHOR'S DECLARATION		**iii**
ABSTRACT		**iv**
ACKNOWLEDGEMENTS		**v**
TABLE OF CONTENTS		**vi**
LIST OF TABLES		**x**
LIST OF FIGURES		**xi**
LIST OF ABBREVIATIONS		**xvi**
CHAPTER ONE: INTRODUCTION		1
1.1	Background of Study	1
1.2	Problem Statements	3
1.3	Objectives of Study	5
1.4	Significance of Study	5
1.5	Scope and Limitations of Study	6
CHAPTER TWO: LITERATURE REVIEW		7
2.1	Introduction	7
	2.1.1 Properties of Aluminium	7
	2.1.1.1 Lightness with Strength	7
	2.1.1.2 Thermal Conductivity	8
	2.1.1.3 Corrosion Resistance	8
	2.1.1.4 Suitability for Surface Treatment	8
	2.1.1.5 Hygienic and Recycling Metal	9
2.2	Corrosion of Aluminium	9
	2.2.1 Elementary Electrochemical Reaction of Corrosion	10
	2.2.2 The Electrochemical Reaction in Corrosion of Aluminium	10
	2.2.3 Electrochemical Equilibrium (Pourbaix) Diagram of Aluminium	13
2.3	Surface Modification of Aluminium for Corrosion Protection	15

2.3.1 Metallic Coating 16
2.3.2 Pre-treatment by Chemical Etching 17
2.3.3 Conversion Coating 18
2.3.4 Nickel Underlayer Coating 20
2.4 Electrochemical Deposition 21
2.4.1 Electrochemical Cell 21
2.4.2 Electrodeposition Technique 22
2.4.2.1 Cyclic Voltammetry (CV) 24
2.4.2.2 Chronoamperometry (CA) 27
2.4.2.3 Chronopotentiometry (CP) 30
2.5 Copper Coating on Treated Aluminium Surface 31
2.6 Electrochemical Study on Corrosion Rate Measurement 34
2.6.1 Corrosion Rate Calculation Using Polarization Method 34
2.6.2 Electrochemical Impedance Spectroscopy (EIS) Study 36

CHAPTER THREE: METHODOLOGY 41
3.1 Introduction 41
3.2 Materials and Chemicals 43
3.2.1 Materials and Apparatus 43
3.2.2 Chemicals 43
3.3 Instruments 43
3.4 Aluminium Surface Pre-treatment 44
3.4.1 Aluminium Surface Polishing 44
3.4.2 Chemical Etching Process 44
3.4.3 Conversion Coating 45
3.4.3.1 Zincating 45
3.4.3.2 Underlayer Nickel Coating 46
3.5 Copper Top Coating 47
3.6 Electrodeposition of Nickel Underlayer and Copper Top Coating on Treated Aluminium 47
3.7 Characterization of Coatings Sample 50
3.8 Electrochemical Properties 50
3.8.1 Corrosion Rate Measurement 51