NANO POROUS ALUMINUM OXIDE FILM FABRICATION AND CHARACTERIZATION

By

Mohamed Abdel-Hameed Ragab Mohamed Hassan

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Metallurgical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

NANO POROUS ALUMINUM OXIDE FILM FABRICATION AND CHARACTERIZATION

By

Mohamed Abdel-Hameed Ragab Mohamed Hassan

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Metallurgical Engineering

Under the Supervision of

Prof. Dr. Saad El-Raghy

.....
Prof. of Metallurgical Engineering
Mining, Petroleum and Metallurgy Department
Faculty of Engineering-Cairo University

Prof. Dr. Randa Abdel-Karim

.....
Prof. of Metallurgical Engineering
Mining, Petroleum and Metallurgy Department
Faculty of Engineering-Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

NANO POROUS ALUMINUM OXIDE FILM FABRICATION AND CHARACTERIZATION

By
Mohamed Abdel-Hameed Ragab Mohamed Hassan

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Metallurgical Engineering

Approved by the
Examining Committee

Prof. Dr. Saad Megahed El-Raghy Prof. of Metallurgical Engineering Faculty of Engineering-Cairo University	(Main Supervisor) ……
Prof. Dr. Randa Mohamed Ahmed Abdel-Karim Prof. of Metallurgical Engineering Faculty of Engineering-Cairo University	(Supervisor) ……
Prof. Dr. Omar El-Farouk Abdel-Salam Prof. of Chemical Engineering Faculty of Engineering-Cairo University	(Member) ……
Prof. Dr. Abdel-Ghany Abdel- Azim Ibrahim El-Hosary Prof. Dr. in National Research Center	(Member)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Engineer: **Mohamed Abdel-Hameed Ragab Mohamed Hassan**
Date of Birth: **28/ 09/ 1990**
Nationality: **Egyptian**
E-mail : **m.hasan.cu.e@gmail.com**
Phone. : **01003415105**
Address : **30 Mahmoud Ramadan street, Giza, Egypt**
Registration Date : **09/ 2012**
Awarding Date : **/**
Degree: **Master of Science**
Department : **Mining, Petroleum and Metallurgy**
Supervisors: **Prof. Dr. Saad Megahed El-Raghy**
Prof. Dr. Randa Mohamed Ahmed Abdel-Karim

Examiners: **Prof. Dr. Saad Megahed El-Raghy**
Prof. Dr. Randa Mohamed Ahmed Abdel-Karim
Prof. Dr. Omar El-Farouk Abdel-Salam
Prof. Dr. Abdel-Ghany Abdel- Azim Ibrahim El-Hosary (National Research Center)

Title of Thesis: **Nano porous Aluminum Oxide Film Fabrication and Characterization**
Key Words: **Nanoporous Film, Anodization parameters, Characterization, Capacitance, Impedance spectroscopy.**

Summary:

Porous anodic aluminum oxide is a result of anodizing of aluminum in mild acidic solution and has a wide spectrum of applications including electronic, magnetic, optical and biological application. In this thesis, the effect of variation of anodization voltage, temperature and electrolyte concentration on anodization of commercially pure aluminum was studied. The resulted porous anodic alumina film was characterized by SEM, EDX, XRD, image analysis, capacitance measurement, and impedance measurements for each condition. Theoretical calculations concerning weight change and anodization efficiency were conducted. SEM image analysis showed that increasing anodizing voltage, temperature, or electrolyte concentration affects in a significant way pore diameter, interpore distance and film porosity. EDX analysis showed that the porous alumina oxide layer formed contains oxygen, aluminum and sulfur elements. X-rays diffraction showed non-crystallinity of alumina film and peaks revealed are related to the aluminum substrate. Capacitance measurements showed a high ability of porous alumina layer to store electric charges and this ability decrease as any or all of anodization voltage, temperature, and electrolyte concentration increased. AC-Impedance spectroscopy confirmed all what obtained from capacitance measurements. As a conclusion, the variation in anodization voltage, temperature and electrolyte concentration are crucial to be controlled to achieve the required porous film morphology and properties.

Acknowledgments

First and foremost, I have to thank my research supervisors, **Prof. Saad El-Raghy** and **Prof. Randa Abdel-Karim**. Without their assistance and dedicated involvement in every step throughout the process, this thesis would have never been accomplished. I would like to thank you very much for your support and understanding over these past two years.

Prof. Abdel-Aziz Waheed and Dr. Kalthom Ismail Osman at the Egyptian Nuclear Research Center kindly assisted me with the AC-impedance experimental and analysis in this dissertation and they were very patient with my knowledge gaps in the area. I must also thank two colleagues at the Department, namely; Aliaa Abdel-Fatah and Alaa Yehya, for giving me the retreat to have this thesis rushed to the printer.

Most importantly, none of this could have happened without my family; my father, my mother and my wife who offered me encouragement through everything limited devotion to correspondence. Every time I was ready to quit, they did not let me and I am forever grateful. This dissertation stands as a testament to their unconditional love and encouragement.

Table of Contents

List of Tables