

Ain Shams University College of Women for Arts, Science and Education Physics Department

Preparation and characterization of pure and doped ZnO thin films

Thesis

Submitted to Physics department College of Women for Arts, Science and Education Ain shams university

For The Degree of Master of Science (Solid state physics)

Presented by

Hagar Mohamed Abd El Wahab (B.SC .Physics, 2008)

Supervision

Prof. Dr. Massarat Bakr seddek Osman

Prof. of Solid State Physics - Physics Department - College of Women for Arts, Science and Education - Ain Shams University.

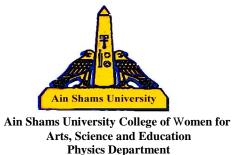
Assistant. Prof. Dr. Fawzy Abd El Hamid Mahmoud

Assistant Prof. of Physics - Solid State Department - National Research Center.

Assistant. Prof. Dr. Mostafa Abd El Moemen Boshta

Assistant. Prof. of Physics - Solid State Department - National Research Center.

2015



Thesis for the Degree of Master of Science

(Solid state physics)

Presented by

Hagar Mohamed Abd El Wahab

Title of the thesis

Preparation and characterization of pure and doped ZnO thin films

Thesis Supervision:

Prof. Dr. Massarat Bakr seddek Osman

Prof. of Solid State Physics - Physics Department - College of Women for Arts, Science and Education - Ain Shams University.

Assistant. Prof. Dr. Fawzy Abd El Hamid Mahmoud

Assistant Prof. of Physics – Solid State Department - National Research Center.

Assistant. Prof. Dr. Mostafa Abd El Moemen Boshta

Assistant Prof. of Physics – Solid State Department - National Research Center.

Date of Research: / / 2015

Date of Approval: / / 2015 Approval Stamp:

Approval of Faculty Council: / /2015 Approval of University Council: / /2015



Physics Department

Student name: Hagar Mohamed Mohamed Abd El Wahab

Scientific degree: Bachelor of Science (Electronics Physics).

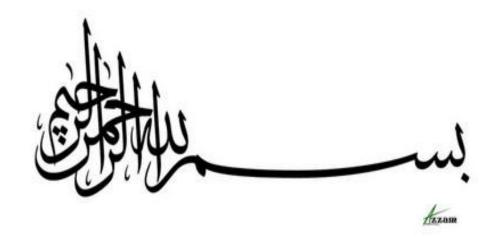
Department: Physics Department.

Faculty: College of Women for Arts, Science and Education.

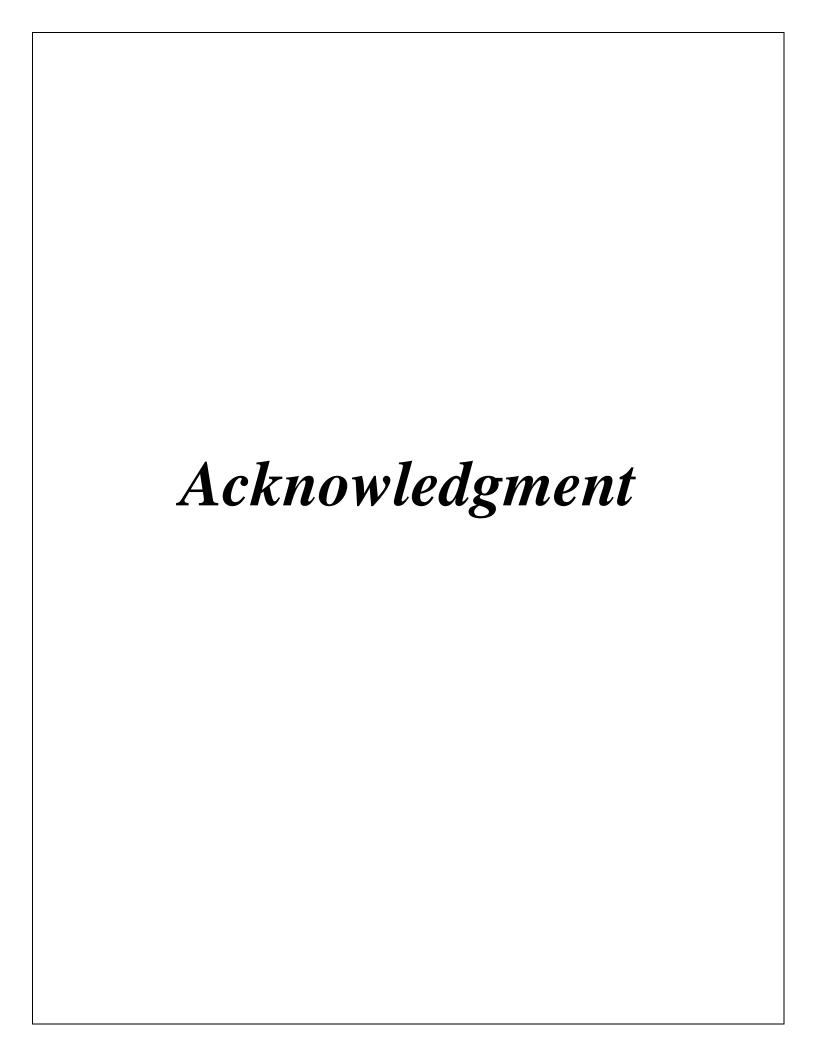
University: Ain Shams University.

Year of graduation: 2008

Year of Approval: 2015







Acknowledgment

In the name of Allah, Praise is to Allah, who guided me to do this work.

I would like to express my sincere thanks and grateful appreciations to:

Prof. Massarat Bakr seddek Osman, Prof. of solid state physics, College of
Women for Arts, Science and Education, Ain Shams University, for her
guidance, supervision, assistance and fruitful scientific discussion through this
thesis, this work would not have been possible without the encouragement and
support of her.

Associate. Prof. Fawzy Abd El Hamid Mahmoud, Department of Solid State Physics, National Research Center, for suggested the point of research and scientific discussion through this thesis. This work would not have been possible without the encouragement and support of him.

Associate. Prof. Mostafa Abd El Moemen Boshta, Department of Solid state Physics, National Research Center, for his guidance, supervision, assistance and fruitful scientific discussion through this thesis, This work would not have been possible without the encouragement and support of him.

Lastly, and most importantly, I would like to thank my family members, especially my father, my mother, brother and sisters for supporting and encouraging me to pursue this degree. Without my family encouragement, I would not have finished this thesis ever. Sincere thanks to my sister **Dina Mohamed** for her support during my study, who as a good ideal to me, she always helping me and give her best suggestions.

I would also like to thank all my friends whose have helped, supported and inspired me during my master study.

List of Contents

Title	Page
List of Content	I
List of Figures	IV
List of Tables	VII
Abstract	VIII
Introduction	1
Chapter 1 : General Background	3
1. 1. Transparent Conducting Oxide	3
1.1.1 Background Transparent Conducting Oxide:	3
1.1.2 General properties of TCO	5
1.1.3 Electrical conductivity of TCO	6
1.1.4 Optical properties of TCO	7
1.1.3 Transparent Conducting Oxide Materials	8
1.2 Zinc Oxide thin film (ZnO)	11
1.2.1 Introduction to ZnO	11
1.2.2. Properties of ZnO	13
1.2.3. Zinc Oxide as a Better TCO	15
1.2.4. Zinc Oxide in Optoelectronics	16
1.3. Doping Technique in Zinc Oxide	17
1.3.1. Doping Zinc Oxide as n-type	17
1.4. Deposition Techniques	19
1.4. 1.Chemical spray pyrolysis (CSP)	21
1.4.2. Introduction to the CSP	21

Title	Page
1.4.3. Description of the Chemical spray pyrolysis	23
1.4.4. Advantages and disadvantages of the CSP	24
Chapter 2 : Literature Survey	25
2.1. Reviews of TCO	25
2.3. Review of Zinc Oxide thin film	27
2.3. Review of doped Zinc Oxide thin film	33
Chapter 3 : Experimental Technique and Characterization Methods	44
3.1. Spray pyrolysis deposition technique	44
3.1.1. Spray pyrolysis set up	44
3.1.2. Substrate heating	45
3.1.3. Solution flow control	45
3.1.4. Carrier gas control	46
3.1.5. Cleaning procedure	46
3.1.6. Nozzle-Substrate Distance	46
3.1.7. Reduction of the Experimental Variables	47
3.2. Mechanism of thin film formation by spray pyrolysis method	47
3.3. Preparation of pure and doped ZnO thin films	49
3.4. Characterization methods	49
3.4.1. Crystal Structure analysis:	50
2.4.2. Scan Electron Microscope (SEM)	54
3.4.3. Energy Dispersive X-ray Spectroscopy (EDX)	57
2.4.4. Atomic Force Microscopy (AFM)	57
3.4.5. Thin film thickness	59
3.4.6. Optical properties	60

Title	Page
2.4.7. Electrical studies	63
Chapter 4 :Results and Discussion	65
4.1. Pure Zinc Oxide thin films	65
4.1.1 Structural Characterization	65
4.1.2 Morphological characterization	69
4.1.3 Optical Characterization	71
4.1.4 Electrical Characterization	77
4.2. Aluminum doped Zinc Oxide thin films (AZO)	80
4.2.1 Structural Characterization	80
4.2. 2. Morphological characterization	83
4.2.3 Chemical composition characterization	84
4.2.4 Optical Characterization	85
4.2.5 Electrical Characterization	93
Conclusion	95
References	97
Arabic Conclusion	1