بسم اللّه الرحمن الرحيم

Ain Shams University Information Network

جامعة عين شمس

شبكة المعلومات الجامعية

@ ASUNET

Ain Shams University Information Network
جامعة عين شمس
شبكة المعلومات الجامعية
@ ASUNET

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

شبكة المعلومات الجامعية

Ain Shams University Information Network
جامعة عين شمس
شبكة المعلومات الجامعية
@ ASUNET

بعض الوثائق الأصلية تالفة

شبكة المعلومات الجامعية

Ain Shams University Information Network
جامعة عين شمس
شبكة المعلومات الجامعية
@ ASUNET

بالرسالة صفحات
لم ترد بالأصل

Ain Shams University
Faculty of education
Physics Department

Effect of Zn addition on some physical properties of Se-Te chalcogenide system

Thesis
Submitted for the degree of Master of Teacher Preparation in Science (Physics)

By

Shimaa Hassan Ibrahim Mabrouk

B.Sc. and Education, Gen. Diploma (Physics), Spec. Diploma (Physics).

To

Physics Department

Faculty of education-Ain Shams University

Supervised by

Prof.Dr. Heba Elgharip Atyia
Prof. physics Dept, faculty of education
Ain Shams University

Ass.prof. Mamduh Mohamed Abdel Aziz
Ass. Prof. physics Dept, faculty of education
Ain Shams University

Dr. Shenouda Shanda Shenouda Fam

Dr. physics Dept, faculty of education

Ain Shams University

2020

بسم الله الرحمن الرحيم

"وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون"

صدق الله العظيم

Ain Shams University
Faculty of education
Physics Department

Name of Student:

Shimaa Hassan Ibrahim Mabrouk

Title of Thesis:

Effect of Zn addition on some physical properties of Se-Te chalcogenide system.

Supervised By:
Approved

Prof. Dr. Heba Elghrip Atyia

Assistant prof. Mamduh Mohamed Abdel Aziz

Dr. Shenouda Shanda Shenouda Fam

ACKNOWLEDGMENT

All thanks for Allah, The Lord of all being.

First and foremost, the author likes to extend my sincere gratitude to my research guide prof. Dr. Heba Elghrip Atyia for her dedicated help, advice, inspiration, encouragement, continuous support, continuous supervision, valuable suggestions and fruitful discussion.

I am grateful to Dr. Mamduh Mohamed Abdel Aziz for his help, useful advice, valuable guidance and supervision.

My special words of thanks should also go to Dr. Shenouda Shanda Shenouda for his continuous support and supervision, cooperation, useful recommendations and valuables help.

Special thanks are given to Prof. Dr. Radwan Hamouda, Head of physics department, Faculty of Education, Ain Shams University for his rendering facilities.

I would like to extend my thanks to the staff members of the semiconductor laboratory for their help in offering me the resources in running the thesis.

Finally, I wish to thank my family members for their support and encouragement through my research.

CONTENTS

Page
List of figure **1**
List of table **6**
Abstract **8**
Summary **10**
Introduction **13**

Chapter (1)

Theoretical background and literature review

1.1 Amorphous semiconductor materials. **18**
1.2. Chalcogenide glasses **18**
1.3. Band theory of amorphous semiconductors **20**
1.4. Kinetics analysis **22**
1.4.1 Classical differential thermal analysis (DTA) 22
1.4.2 Calorimetric DTA 25
1.4.3 Differential Scanning Calorimetry (DSC) 25
1.5. DC Electrical conduction in amorphous semiconductors **27**
1.6 Electrical switching phenomenon **29**
1.6.1 Definition of switching phenomenon 29
1.6.2 Classification of switching and memory characteristics 30
1.6.3 Threshold switches features 32
1.6.4 Memory switches 33
1.6.5 Switching mechanisms 34
1.7.AC conductivity mechanisms in amorphous semiconductors **38**
1.7.1 AC conduction mechanisms 39
1.7.1.1Quantum-mechanical tunneling (QMT) model 39
1.7.1.2 Relaxation due to hopping 42
1.8. Dielectric properties of semiconductors. **46**
1.9. Optical properties of chalcogenide glasses. **50**
1.9.1 Absorption at fundamental absorption edge 50
1.9.2 Types of electronic transitions. 53

1.9.3 Determination of the optical constants 55
1.10 Some previous literature review 57

Chapter (2)
Experimental technique

2.1. Preparation of the studied compositions 64
2.1.1 Preparation of bulk form 64
2.1.2 Preparation of thin film form 66
2.2 Structural identification and thermal analysis of the prepared compositions. 69
2.2.1 X-ray diffraction (XRD) technique 69
2.2.2 Energy dispersive x-ray spectroscopy analysis. **69**
2.2.3 Differential thermal analysis (DTA). 71
2.3 Electrical measurements 73
2.3.1 Dc electrical conductivity measurements. 73
2.3.2 Ac conductivity and dielectric Properties measurements. 73
2.3.3 Switching phenomenon measurements. 76
2.4Optical measurements. 79

Chapter (3)
Result and discussion

3.1. Structure identification 82
3.1.1. Energy dispersive x-ray analysis 82
3.1.2. X-ray Diffraction 82
3.2. Thermal Analysis 86
3.2.1. Differential thermal analysis (DTA) thermogram 86
3.2.2. Glass transition kinetics aspects 88
3.2.2.1. Determination of critical heating rate β_c. 88
3.2.2.2. Determination of activation energy of glass transition E_g 93
3.2.3. Crystallization kinetics aspects 96
3.2.3.1. Determination of activation energy of crystallization E_c. 96

3.2.3.2. Determination of Avrami exponent n_a and the order of dimensional growth m_a. 101

3.2.4 Thermal Stability 104

3.3DCelectricalconductivity 108

3.4 Switching phenomenon. 111

3.4.1 Current–Voltage characteristic curves 111

3.4.2 Threshold resistance R_{th} 114

3.4.3 Threshold power P_{th} 118

3.4.4 Threshold electric field E_{th} 119

3.4.5 Evaluation of the Switching mechanism 119

3.4.5.1. Film thickness dependence of threshold voltage V_{th} 121

3.4.5.1. Temperature dependence of threshold voltage V_{th} 124

3.4.5.3. Breakdown temperature difference $\Delta T_{breakdown}$ 129

3.5 Ac electric conductivity and dielectric properties. 131

3.5.1. Temperature and frequency dependences of ac conductivity σ_{ac} 131

3.5.1.1 Temperature dependence of the ac conductivity σ_{ac} 131

3.5.1.2 Frequency dependence of the ac conductivity σ_{ac} 136

3.5.2 Dielectric properties of amorphous $Se_{88}Te_{12}$ and $Se_{88}Te_8Zn_4$ films. 140

3.5.2.1 Frequency and temperature dependence of dielectric constant ε_1 140

3.5.2.2 Frequency and temperature dependence of dielectric loss ε_2 142

3.6. Optical properties 147

3.6.1. The spectral distributions of the transmittance $T(\lambda)$ and reflectance $R(\lambda)$. 147

3.6.2. Determination of optical constants. 149

3.6.3. The spectral distribution of the absorption coefficient (α) 149

3.6.4. Dispersion energy parameters E_0 and E_d . 155

3.6.5 Determination of some optoelectric parameters 157

Conclusion **165**

Reference **169**

Arabic Summary

List of Figures

Page
Fig. 1.1 Aschematic density of state distribution, where the number of states per unit volume in unit energy interval, N(E), is plotted against the electron energy, E. **22**
Fig. 1.2 Differential thermal analysis DTA (a) classical parameter; (b) heat flux configuration; (c) typical DTA curve **24**
Fig. 1.3 Differential scanning calorimetry; (a) Apparatus; (b) typical DSC curve **26**
Fig. 1.4 Classification of switching and memory characteristic.(a) Negative resistance device, (b) Negative resistance device with memory, (c) switching device, (d) switching device with memory. **31**
Fig. 1.5 The characteristic curve for thin film of amorphous semiconductors (a) threshold switching (b) memory switching **35**
Fig. 1.6 Spectral dependence of the optical absorption coefficient α in amorphous semiconductor. **52**
Fig. 1.7 Types of electronic transitions. **54**
Fig. 2.1 The electric sensitive balance. **65**
Fig. 2.2 Schematic representation for the oscillatory furnace. **65**
Fig. 2.3 The Coating unit. **68**
Fig. 2.4 The evaporative molybdenum boat **68**
Fig. 2.5 The x-ray diffraction unit. **70**
Fig.2.6 (a) A micro-DTA Shimadzu apparatus (DTA-50) model (b)A typical DTA thermo gram. **72**
Fig. 2.7 The programmable automatic RCL meter (PM 6304 Philips). **74**
Fig. 2.8 The schematic view of fabrication of sandwich structure. **75**

Fig.2.9 A schematic illustrate the cell used for I-V measurements **77**

Fig. 2.10 The circuit used for measuring the I-V characteristic curves **78**

Fig. 2.11 The double beam spectrophotometer (Jasco, model V-750) **80**

Fig. 3.1. EDX spectrum of (a) $Se_{88}Te_{12}$ and (b) $Se_{88}Te_{8}Zn_{4}$ compositions **83**

Fig. 3.2. SEM images for the (a) $Se_{88}Te_{12}$ and (b) $Se_{88}Te_{8}Zn_{4}$ compositions **84**

Fig. 3.3. XRD patterns of $Se_{88}Te_{12}$ and $Se_{88}Te_{8}Zn_{4}$ In (a) Powder and (b) thin film forms. **85**

Fig.3.4 Differential thermal analysis thermogram of (a) $Se_{88}Te_{12}$ and (b) $Se_{88}Te_{8}Zn_{4}$ glassy composition at different heating rates. **87**

Fig. 3.5. Heating rate dependence of (a) the crystallization and (b) glass transition temperatures for $Se_{88}Te_{12}$and $Se_{88}Te_{8}Zn_{4}$ glassy compositions. **91**

Fig. 3.6. Plots of a function F, ($F= \ln(\beta/T_p)$, $\ln(\beta/T^2_p)$ and $\ln(\beta)$) versus $1000/T_g$ for $Se_{88}Te_{12}$ and Se88Te8Zn4 glassy compositions. **95**

Fig. 3.7. Plots of a function G, ($G= \ln(\beta/T_p)$, $\ln(\beta/T^2_p)$, $\ln(\beta/T_p\text{-}T_{c-})$, and $\ln(\beta)$) versus $1000/T_p$ for $Se_{88}Te_{12}$ and $Se_{88}Te_{8}Zn_{4}$ glassy compositions. **99**

Fig. 3.8. Extent of crystallized volume fraction χ as a function of temperature at different heating rates for (a) $Se_{88}Te_{12}$ and(b) $Se_{88}Te_{8}Zn_{4}$ glassy compositions. **100**

Fig. 3.9. Plots of a $\ln[-\ln(1-\chi)]$ versus (a,b) 1000/T at different heating rate and (c,d) versus $\ln \beta$ at different fixed temperatures for $Se_{88}Te_{12}$ and $Se_{88}Te_{8}Zn_{4}$ glassy compositions. **102**

Fig.3.10 The temperature dependence of the dc electrical conductivity of (a) $Se_{88}Te_{12}$ and (b) $Se_{88}Te_{8}Zn_{4}$ films with different thicknesses. **109**