STUDY OF SOME PHYSICAL PROPERTIES FOR SOME SOLID FILMS

THESIS

Submitted for the Degree of

DOCTOR OF PHILOSOPHY

in

PHYSICS

Presented by

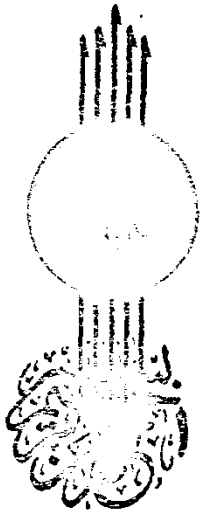
HODA SHEHATA SOLIMAN

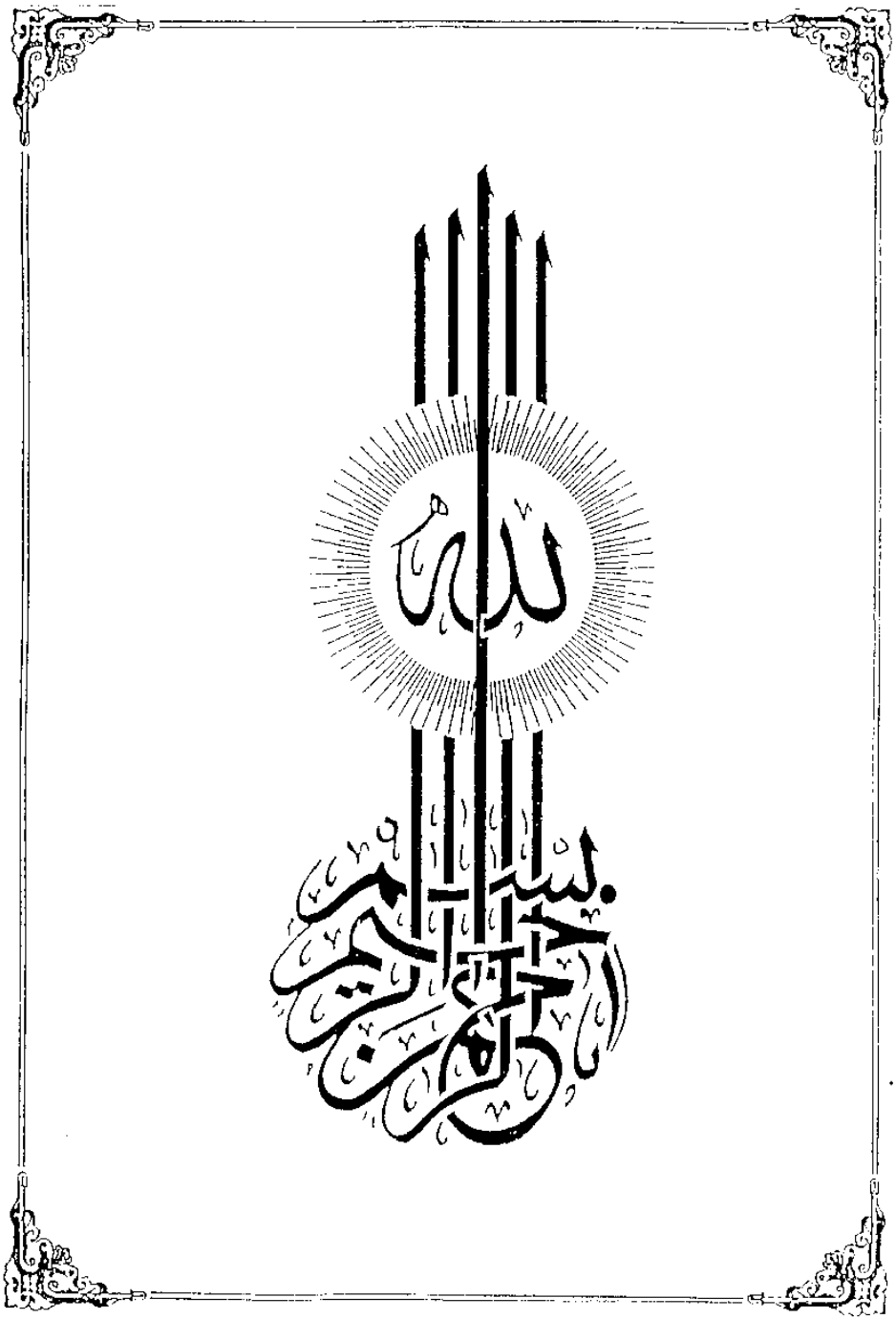
Faculty of Girls

Ain Shams University

Cairo - Egypt

1983





ACKNOWLEDGEMENT

The author would like to express her sincere gratitude to professor Dr. M.A. Kenawy, Chairman of Physics, University College for Girls, Ain Shams University, for his close supervision, guidance and stimultating discussions throughout the period of this work.

Thanks are also due to Dr. A.A.EL-Shazly, professor of solid state physics, Faculty of Education, Ain Shams University, for valuable suggestion, guidance, and fruitful discussions during the period of this work.

The author wishes to express his deep thanks to Dr. H.T.M.EL-Shaer, and Dr.M.M.EL-Nahass, Faculty of Education, Ain Shams University for their valuable advice, successful efforts and interesting discussions.

The author wishes to express sincere appreciation and thanks to Dr.E.A.Abou Seif, Associate Professor of Physics, National Research Centre, Cairo for this useful help and advice.

Finally, thanks are also due to the colleagues at the Physics Department, Faculty of Education, where this work was fulfilled.

C O N T E N T

Page

Page

ABSTRACT

The zinc selenide film structure was investigated using both the x-ray diffraction and the electron microscope techniques. Through out this investigation, it was found that zinc selenide thin films either in the polycrystalline form or in single crystalline form have two crystalline structures; wurtzite (hexagonal) and zinc blende (cubic) phases. The grain size of ZnSe thin films depends on some deposition parameters such as: the film thickness, the substrate temperature during the deposition process, the annealing temperature, the angle of deposition and the substrate type, which are investigated.

Zinc selenide thin films were found to have direction of preferred orientation of the crystallites about the (111) plane when deposited on amorphous glass substrates, while it is randomly oriented when deposited on mica substrate. The crystallite size increases with increasing the substrate temperature up to 150°C and then decreases gradually; while it decreases with increasing the annealing temperature up to 100°C above which it starts to increase.

The optical constants of the ZnSe thin films were determined in a wide range of the spectrum (400-1600nm in case of glass substrates, 300-1600nm in case of quartz substrates). It was found that ZnSe thin films have two direct energy band gaps 2.67 eV and 3.02 eV. It was found also that the optical constants (the refractive index n, the absorption index k and the absorption coefficient α) of ZnSe thin films are independent of the film thickness, the substrate temperature and the annealing temperature i.e. there is no dependence of the optical constants on the film structure.

The dark electrical resistivities of ZnSe thin films deposited either on glass substrates or on mica substrates were measured. The effect of the substrate temperature and the annealing temperature on the dark electrical resistivity of these films was also investigated. It was found that these parameters affect strongly the dark electrical resistivity. Therefore one can conclude that the dark electrical resistivity of ZnSe thin films is affected strongly by the variations in film structure.

The photovoltaic effect was discovered for the first time, in ZnSe thin films obliquely deposited

in vacuum. The photovoltages generated in ZnSe thin films were affected by different experimental parameters such as: the film thickness, the angle of deposition, the substrate temperature during the deposition process, the annealing temperature either in air or in vacuum and the type of substrate which are investigated in this work. The variations in the magnitude and polarily of the photovoltages produced in ZnSe thin films obliquely deposited in vacuum are attributed to the changs taking place in the film structure.

INTRODUCTION

INTRODUCTION

As all the II-VI compounds, zinc selenide thin films have a wide energy band gap. Because of its wide band gap zinc selenide is a promising semiconductor for electroluminescent applications. As well known, the optical and electrical properties of II-VI thin layer compounds may depend to some extent on the crystal structure of such thin layers.

Therefore, much of this work was directed toward the goal of understanding the role of the ZnSe film structure in the optical properties, the electrical properties and the photovoltages produced in ZnSe thin films.

Thus it is important to investigate the ZnSe film structure, taking into account the experimental parameters which may affect it such as: the film thickness, the angle of deposition, the substrate temperature during the deposition process, the annealing temperature and the type of substrate.

Then the optical constants (the refractive index n, the absorption index k and the absorption coefficient α) of thin ZnSe films deposited by thermal evaporation in vacuum were determined in a wide range of spectru

(300-1600 nm). These investigations include the effect of structural parameters or in other words the deposional parameters on the ZnSe optical constants.

Similarly, the dark electrical resistivity of ZnSe thin films was determined taking into account the experimental parameters affecting it.

Finally, the photovoltaic effect in ZnSe thin films obliquely deposited in vacuum has received a great interest. This work represents what we believe to be the first observations of the anomomalous photovoltaic effect in films of zinc selenide. Our observations illustrate how the photovoltages generated in ZnSe thin films were affected by some experimental parameters such as: the film thickness, the angle of deposition, the substrate temperature during the deposition process, the annealing temperature in air and in vacuum, as well as the type of the substrate. Then an attempt was made to explain the variation of both the magnitude and polarity of the photovoltages produced in ZnSe thin film obliquely deposited in vacuum with variation of the film structure.