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Effect of Annealing Time on Electrodeposited ZnS Thin Films

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INTRODUCTION

ZnS is a direct band gap semiconductor with a wide band gap (3.68-3.80 eV)[1]. It is generally observed in two phases: cubic or zinc blende and hexagonal or Würtzite. The cubic phase is the most stable at low temperatures and low pressure[1]. Due to its physical properties, high chemical stability to processing and photoelectric properties, ZnS is well suited for various applications such as catalysts, gas sensors and photovoltaic applications. Today, ZnS is one of the materials considered as an alternative for buffer layers in solar cells. Compared to CdS, ZnS is a non-toxic and an environment friendly material[2]. In the present work, we will elaborate series of ZnS samples, using electrodeposition method to study the effect of the annealing time on their structural and optical properties.

EXPERIMENTAL STUDY

In this work, we studied the effect of annealing time on the structural and optical properties of zinc sulfide (ZnS) thin films growth by electrodeposition method. The ZnS films were deposited on ITO substrate at 65°C during 45 min from an aqueous solution of ($ZnSO_4.7H_2O$). We have elaborated two samples; each of the as-deposited films was locked up with 30 mg of sulphur powder into a glass capsule (**Fig.1**), filled with argon-neon gas mixture (75% argon and 25% neon) at a fixed pressure of 10 mbar. In order to investigate the effect of annealing time, the two capsules were annealed in the furnace at 550 °C during 60 and 120 min.

RESULTS AND DISCUSSION

The structural and optical properties of the elaborated films were studied, respectively, using X-ray diffraction (XRD) and Raman spectroscopy methods. After annealing, the XRD diagrams of the films present one phase; ZnS under its hexagonal Würtzite structure (File N°: 01-089-2194)[3]. The average grain size is estimated using Scherrer's formula; and it is equal to 20.6 and 23.6 nm for the films annealed respectively during 60 and 120 min (**Fig.2 (a)** and **(b)**).

The Raman spectra of the films present the lines situated at 275, 344, 414, 627, 694, 981, 1042 and 1389 cm^{-1}, (**Fig.2 (c)**) which are the modes observed for ZnS under its hexagonal structure[4].

We have found that the intensities of the characteristic peaks of the ZnS phase increased as the annealing time increased.

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Fig.1: Photography images of (**a**): the films in the capsule, and (**b**): sample after annealing under sulfur atmosphere.

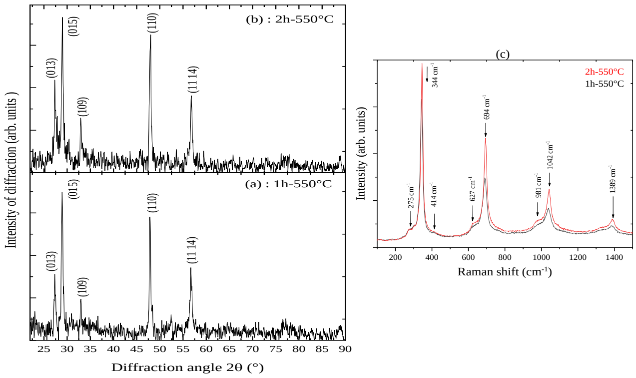

Fig. 2: X-ray diffraction patterns of ZnS films after thermal annealing at 550 °C during (**a**): 60 and (**b**): 120 min, **(c)**: Raman spectra of the two films.

CONCLUSION

The XRD investigation indicated that the second film (annealed during 120 min) presents the best crystallinity. Raman spectroscopy shows that all the ZnS films synthesised in this work possess a hexagonal structure. The obtained results suggest that the elaborated ZnS films have suitable properties for used as a buffer layer in solar cells.

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