O01

Effect of the Substrate on the Structural Properties of Cu_2ZnSnS_4 Thin FilmsSynthesized by Electrodeposition

Loumafak Hafaifa[1], Fatiha Daoudi[2], Radia Boudaira[3], Omar Meglali[2,4,*] and Assia Bouraiou[2]

[1]Department of Physics, Ziane Achour University, Algeria.

[2]Materials Science and Informatics Laboratory, Ziane Achour University, Algeria.

[3]Department of Physics / Mentouri University, Algeria.

[4]Faculty of Sciences / Mohamed Boudiaf University, Algeria.

*Corresponding author

Introduction

The quaternary compound Cu_2ZnSnS_4 semiconductor have gained much attention in recent years due to its promising optical properties[1]. Moreover, low cost, cheap, earth-abundant as well as non-toxicity of its elements[1,2]. In addition, this semiconductor is considered as one of the potential absorber materials for the next-generation solar cells[3].

The aim of the present work is to deposit the CZTS thin films on the ITO and the FTO substrates by the one-step electrodeposition method followed by the sulphurization. The influence of the ITO and FTO on structural properties of the elaborated CZTS film was then investigated.

Experimental

Two samples named $CZTS_{ITO}$ and $CZTS_{FTO}$ were grown respectively on ITO/glass and FTO/glass substrates by electrodeposition process. Copper chloride, zinc sulfate heptahydrate, tin chloride dehydrate and sodium thiosulphate pentahydrate were used respectively as Cu, Zn, Sn and S ions sources. In order to obtain a pH of nearly 4.2 for all the electrolyte bath tartaric acid solution is added to the used complexing agent trisodium citrate. The deposition was carried out at room temperature for 40 min with an applied potential of -7.2 V. After deposition, the samples were rinsed by deionized water and dried under the air.

The $CZTS_{ITO}$ and $CZTS_{FTO}$ elaborated films were locked up with 30 mg of sulphur powder into a glass capsule, filled with argon-neon gas mixture at a fixed pressure of 10 mbar, then the glass capsules were annealed in the furnace at 550°C during 60 min and under a fixed heating rate of 20°C min^{-1}. Finally, the capsules were cooled down naturally to room temperature in the furnace. The structural properties were investigated by X-ray diffraction (XRD).

Results and Discussion

The results of X-ray diffraction analyses indicated that the two elaborated films have kesterite tetragonal crystal structure. From the XRD patterns of $CZTS_{ITO}$ and $CZTS_{FTO}$ films (**Fig. 1** (**a**) and (**b**)), we observed the peaks located at $2\theta \approx 28.43, 32.83, 47.31, 56.07°$. These peaks are assigned to (112), (004)/(020), (220)/(024) and (132)/(116) planes, which are characteristic of CZTS phase under its kesterite structure (JCPDS 98-017-1983). The crystalline parameters ***a*** and ***c*** are 5.460 Å and 10.969 Å for $CZTS_{ITO}$ and 5.442 Å and 10.915 for $CZTS_{FTO}$. The crystallite size C_s, lattice strain ε and dislocation density δ are calculated. The crystallite size of $CZTS_{ITO}$ and $CZTS_{FTO}$ is 113.6 and 347 nm.

DOI: 10.21467/abstracts.122 ISBN: 978-81-954993-3-5

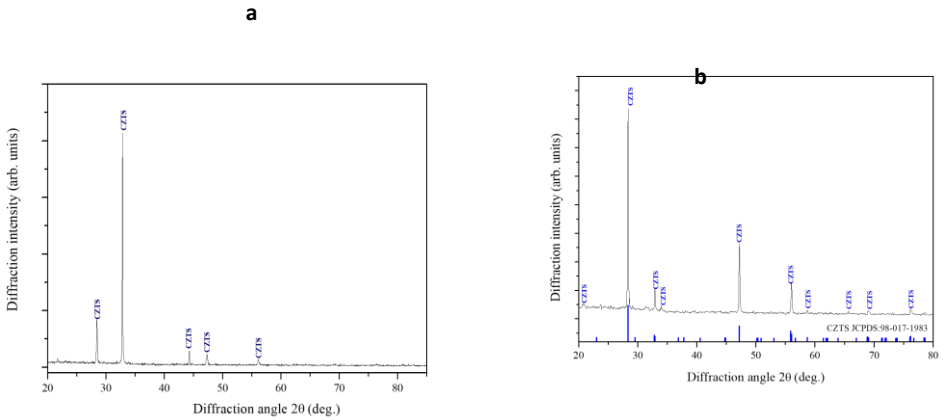

Fig.1: XRD patterns of sulphurized CZTS thin Films at 550°C deposited on: (a) ITO/glass substrate, (b) FTO/glass substrate.

Conclusion

In summary, copper zinc tin sulfide CZTS thin films were successfully synthesized on the ITO/glass and FTO/glass substrates by one-step electrodeposition process followed by sulphurization at 550°C for 60 min. For both substrates (ITO and FTO), XRD characterization confirms the formation of CZTS phase under its kesterite structure. We have also found that the $CZTS_{FTO}$ film exhibits better crystal quality and high purity.

References

1. Song X, Ji X, Li M, Lin W, Luo X, Zhang H. «A review on development prospect of CZTS based thin film solar cells» *International Journal of Photoenergy*. 2014; 2014: 1-11.
2. Kong L, Deng J X. «First-Principles Study on Electronic and Optical Properties of Kesterite and Stannite Cu_2ZnSnS_4 Photovoltaic Absorbers» *Materials Science Forum, Trans Tech Publ.* 2015; 815:80-88.
3. Boudaira R, Meglali O, Bouraiou A, Attaf N, Sedrati C, Aida M S. «Optimization of sulphurization temperature for the production of single-phase CZTS kesterite layers synthesized by electrodeposition» *Surface Engineering.* 2020; 36: 1000-1011.

ISBN: 978-81-954993-3-5
DOI: 10.21467/abstracts.122
Series: AIJR Abstracts