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Structural and optical properties of Cu_2ZnSnS_4 thin film Prepared By Chemical Bath Deposition for Solar cell Application

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Abstract: Nanocrystalline Cu2ZnSnS4 (CZTS) thin film was successfully synthesized using a relatively simple and convenient Chemical Bath Deposition (CBD). The thin film was characterized by UV–Vis spectroscopy and X-ray Diffraction technique for confirmation of nanocrystalline material. The absorption spectra show in the visible range and the band gap of CZTS was about 1.68 eV, which was near the optimum value for photovoltaic solar conversion in a single-band-gap device. The polycrystalline CZTS thin films with Kesterite crystal structure have been obtained by XRD. The average crystalline size of CZTS thin film is 27 nm.

Keywords: CZTS, CBD, band gap, XRD etc

I. INTRODUCTION

Kesterite Copper zinc tin sulfide is a quaternary semiconducting compound which has received increasing interest since the late 2000s for applications in photovoltaic cells [1]. It is necessary to fabricate low cost, high conversion efficiency solar cells without material degradation for widely used electricity generation [2]. The band gap of CZTS is 1.5eV, and high optical absorption coefficient beyond 10^{-4}cm, due to great deal of interest in research of CZTS thin film solar cells [3].

CZTS thin films have been prepared by various techniques such as physical techniques sequential evaporation technique [4], sputtering [5], Thermal Evaporation method [6] E-Beam Evaporation [7], pulsed laser deposition [8], spray pyrolysis [9], Chemical vapor deposition [10], and chemical techniques such as Dr. Blade method [11], Spin coating [12], Electro-deposition [13], Sol Gel technique [14], Chemical Bath deposition (CBD) [15]. The CBD technique does not require a high quality target and vacuum, which is great advantage of industrial purpose.

In the present study, we report that the CZTS thin film has prepared by CBD method. The structural properties studied by X-ray Diffraction method (XRD) Bruker AXS, Germany (D8 Advanced). Optical absorption studies were carried out employing UV-VIS spectrophotometer (Hitachi model U-2900).

II. EXPERIMENTAL

The CZTS thin films have been deposited on the glass substrates using chemical method. The Cu_2SO_4, $ZnSO_4$, $SnSO_4$ and $Na_2S_2O_3$ are used as sources of Cu^+, Zn^{2+}, $Sn4^+$ and S^{2-} ions, respectively. The chemical bath containing 0.05 M Cu_2SO_4, 0.1 M $ZnSO_4$, 0.05 M $SnSO_4$ and 0.2 M $Na_2S_2O_3$ solutions in equal volume ratio was prepared by mixing them in a beaker. The solutions of aqueous ammonia added to it. The final pH of the resulting solution is 12. Previously cleaned glass substrate was immersed in the bath and then the bath was heated up to 40 ^{0}C for 75 min [15].

III. RESULTS AND DISCUSSION

Fig. 1 shows XRD patterns of as deposited CZTS thin films on glass substrate. The CZTS thin film shows the crystalline nature. The average crystalline size of CZTS thin film is around of 27 nm [15].

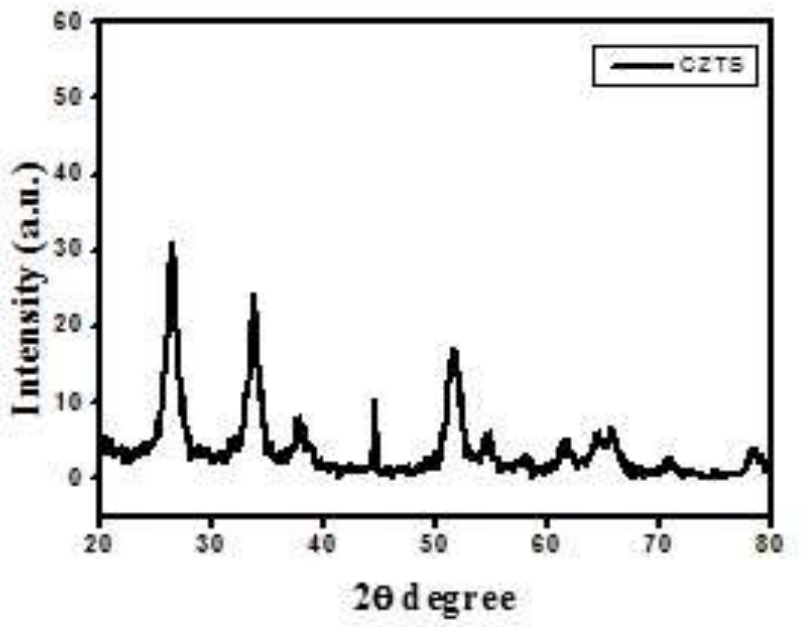

Fig. 1. XRD of CZTS thin film

The UV-ViS absorption and band gap spectra of each of the Copper Zink Tin Sulfide (CZTS) film. The absorption spectra range from 700 to 900 nm in visible range. The band gap of CZTS thin film is calculated show 1.68 eV, it is match or near to solar cell absorber layer [15]. Fig 2 and Fig 3 shows the absorption and band gap respectively.

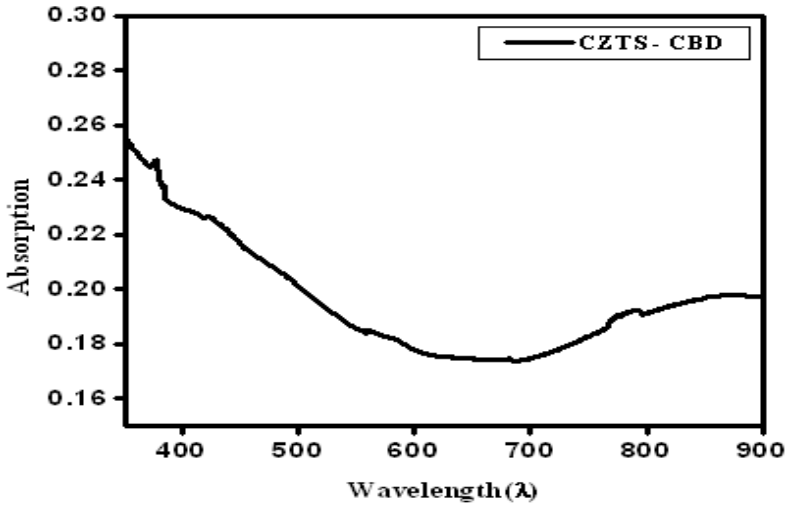

Fig. 2. Absorption of CZTS thin film

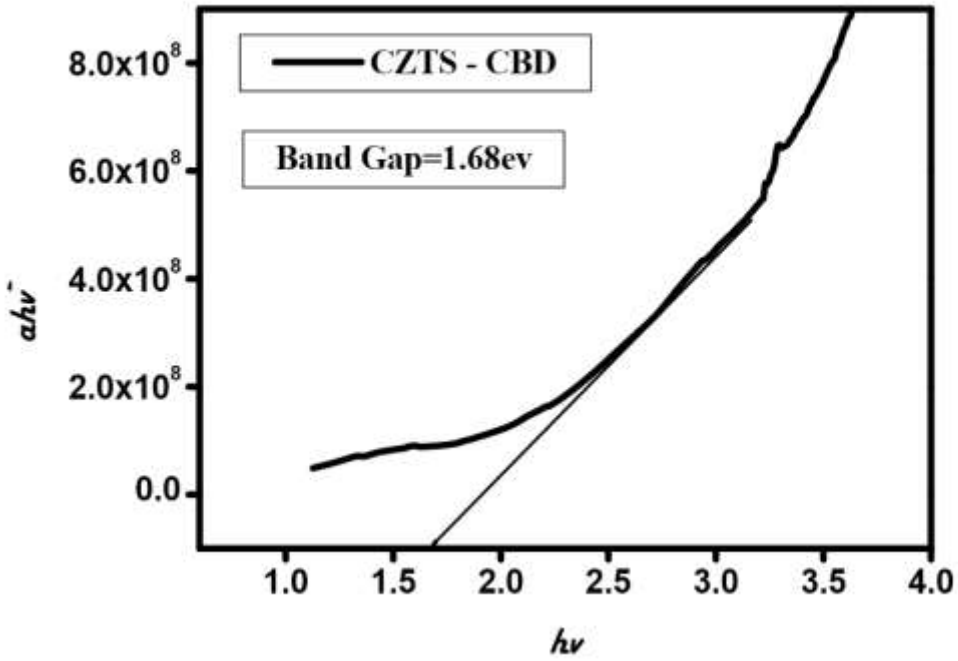

Fig. 3. Band gap of CZTS thin film

IV. CONCLUSION

The CZTS thin film has prepared by chemical bath deposition at 40 ^{0}C for 75 min on glass substrate. The XRD show the CZTS has polycrystalline nature and the crystalline size 27 nm. The band gap of CZTS thin film was 1.68eV found by optical properties. The chemically prepared nanocrystalline CZTS is polycrystalline nature and band gap is suitable for solar cell application.

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REFERENCES

[1] Sandip Mahajan, Elias Stathatos, Nanasaheb Huse, Ravikiran Birajdar, Alexandros Kalarakis, Ramphal Sharma, Low cost nanostructure kesterite CZTS thin films for solar cells application, Materials Letters 210 (2018) 92–96.

[2] Renuka Digraskar, Swapnali Dhanayat, Ketan Gattu, Sandeep Mahajan, Deepak Upadhye, AIP Conf. Proc. 1512, 236 (2013).

[3] Sandip Mahajan, Dimitra Sygkridou , Elias Stathatos, Nanasaheb Huse, Alexandros Kalarakis, Ramphal Sharma, Enhancement in the efficiency of crystalline Cu_2ZnSnS_4 thin film solar cell by using various buffer layers, Superlattices and Microstructures 109 (2017) 240-248.

[4] G. Gordillo, C. Calderón, P. Bartolo-Pérez, XPS analysis and structural and morphological characterization of Cu_2ZnSnS_4 thin films grown by sequential evaporation, Applied Surface Science 305 (2014) 506–514.

[5] Feng Jiang, Honglie Shen, Fabrication and photovoltaic properties of Cu_2ZnSnS_4/i-a-Si/n-a-Si thin film solar cells, Applied Surface Science 280 (2013) 138– 143.

[6] Zaihasraf Zakaria, Puvaneswaran Chelvanathan, Mohammad Junaebur Rashid, Md Akhtaruzzaman, Mohammad Mezbaul Alam, Zeid Abdullah Al-Othman, Abdulrahman Alamoud, Kamaruzzaman Sopian, and Nowshad Amin, Effects of sulfurization temperature on Cu2ZnSnS4 thin film deposited by single source thermal evaporation method, Japanese Journal of Applied Physics 54, 08KC18 (2015).

[7] Claudia Malerba, Francesco Biccari, Cristy Leonor Azanza Ricardo, Matteo Valentini, Rosa Chierchia, Melanie Müller, Antonino Santoni, Emilia Esposito, Pietro Mangiapane, Paolo Scardi, Alberto Mittiga, CZTS stoichiometry effects on the band gap energy, Journal of Alloys and Compounds 582 (2014) 528–534.

[8] Nurul Suhada Che Sulaiman, Chen Hon Nee, Seong Ling Yap, Yen Sian Lee,Teck Yong Tou, Seong Shan Yap, The growth of nanostructured Cu_2ZnSnS_4films by pulsed laser deposition, Applied Surface Science 354 (2015) 42–47 .

[9] S.A. Khalate, R.S. Kate, J.H. Kim, S.M. Pawar, R.J. Deokate, Effect of deposition temperature on the properties of Cu2ZnSnS4 (CZTS) thin films, Superlattices and Microstructures 103 (2017) 335-342.

[10] Mohd Zubair Ansari, Neeraj Khare, Structural and optical properties of CZTS thin films deposited by ultrasonically assisted chemical vapour deposition, J. Phys. D: Appl. Phys. 47 (2014) 185101 (6pp).

[11] Prashant R Ghediya, Tapas K Chaudhuri, Dark and photo-conductivity of doctor-bladed CZTS films above room temperature, J. Phys. D: Appl. Phys. 48 (2015) 455109 (9pp).

[12] Shasha Zhang, Chunrui Wang, Lin Sun, Aijiang Lu, Xiaofeng Xu, Huaizhong Xing, Xiaoshuang Chen, Fabrication of single-crystal/phase Cu2ZnSnS4 nanorods via a two-step spin coating route, Applied Physics Express 8, 035202 (2015).

[13] Md Ibrahim Khalil, Roberto Bernasconi, Luca Magagnin, CZTS layers for solar cells by an electrodeposition-annealing route, Electrochimica Acta 145 (2014) 154–158.

[14] G. L. Agawane, S. W. Shin, S. A. Vanalakar, M. P. Suryawanshi, A. V. Moholkar, Jae Ho Yun, Jihye Gwak, Jin Hyeok Kim, Synthesis of simple, low cost and benign sol–gel Cu_2ZnSnS_4 thin films: influence of different annealing atmospheres, J Mater Sci: Mater Electron (2015) 26:1900–1907.

[15] N.M. Shinde, C.D. Lokhande, J.H. Kim, J.H. Moon, Low cost and large area novel chemical synthesis of Cu_2ZnSnS_4 (CZTS) thin films, Journal of Photochemistry and Photobiology A: Chemistry 235 (2012) 14– 20.