An Experimental and Theoretical Study of $Cu_{0.2}Zn_{0.8}S$ Thin Film Grown by Facile Chemical Bath Deposition As an Efficient Photosensor

Published: 18 July 2018

Volume 47, pages 6128–6135, (2018) Cite this article

Journal of Electronic Materials

Aims and scope

Submit manuscript

Ghamdan M. M. Gubari, Ibrahim Mohammed S. M., Nanasaheb P. Huse, Avinash S. Dive & Ramphal Sharma

Abstract

We have successfully deposited $Cu_{0.2}Zn_{0.8}S$ thin films onto a glass substrate by facile chemical bath deposition at 60°C. The structural, morphological, optical, electrical and electronic properties of the as-grown $Cu_{0.2}Zn_{0.8}S$ thin film were studied. The x-ray diffraction pattern confirmed the formation of the $Cu_{0.2}Zn_{0.8}S$ composition when compared with standard JCPDS

card. The Raman spectrum shows a major peak at 470 cm^{-1} along with few other which are attributed to $Cu_{0.2}Zn_{0.8}S$ phase. The field emission scanning electron microscopy result shows the uniform growth of material over the entire glass substrate with dense morphology containing irregularly shaped grains. From the optical absorption spectrum, a clear band edge around ~ 430 nm was observ,ed which results in a wide energy band gap of ~ 2.9 eV. The obtained band gap is in good agreement with the earlier reports. The electrical properties were measured at room temperature in the voltage range ± 2 V and showed a drastic enhancement in current under light illumination with the highest photosensitivity of ~ 91% for 260 W. The electrical properties suggest its promising candidature for optoelectronic devices. The electronic properties like band structure, the partial and total density of states were studied with density functional theory formalism with generalized gradient approximation which suggests that $Cu_{0.2}Zn_{0.8}S$ is a direct band semiconductor with a band gap of ~ 1.64 eV.

References

1. M. Ali Yıldırım, *Opt. Commun.* 285, 1215 (2012).

Article Google Scholar

2. M. Ali Yildirim, A. Ateş, and A. Astam, *Phys. E Low Dimens. Syst. Nanostruct.* 41, 1365 (2009).

Article Google Scholar

3. P.J. Parbrook, B. Henderson, K.P.O. Donnell, P.J. Wright, and B. Cockayne, *Semicond. Sci. Technol.* 6, 818 (1991).

Article Google Scholar

4. N.P. Huse, D.S. Upadhyea, A.S. Dive, and R. Sharma, *Invert. J. Renew. Energy* 6, 74 (2016).

Article Google Scholar

5. M.S. Sreejith, D.R. Deepu, C. SudhaKartha, K. Rajeevkumar, and K.P. Vijayakumar, *J. Renew. Sustain. Energy* 8, 023502 (2016).

Article Google Scholar

6. M.I. Hossain, *Chalcogenide Lett.* 9, 231 (2012).

Google Scholar

7. V. Laxminarasimha Rao, T. Shekharam, T. Mohan Kumar, and M. Nagabhushanam, *Mater. Chem. Phys.* 159, 83 (2015).

Article Google Scholar

8. S.M. Taheri Otaqsara, *Mater. Sci. Semicond. Process.* 16, 963 (2013).

Article Google Scholar

9. M.S. Sreejith, D.R. Deepu, C.S. Kartha, K. Rajeevkumar, and K.P. Vijayakumar, *Appl. Phys. Lett.* 105, 202107 (2014).

Article Google Scholar

10. M. Adelifard, *Opt. Commun.* 285, 4400 (2012).

Article Google Scholar

11. W.-S. Ni and Y.-J. Lin, *Appl. Phys. A* 119, 1127 (2015).

Article Google Scholar

12. K. Yang, Y. Nakashima, and M. Ichimura, *J. Electrochem. Soc.* 159, H250 (2012).

Article Google Scholar

13. M. Ichimura, *AIP Conf. Proc.* 1788, 020005 (2017).

Article Google Scholar

14. M. Dula, K. Yang, and M. Ichimura, *Semicond. Sci. Technol.* 27, 125007 (2012).

Article Google Scholar

15. M. Ichimura and Y. Maeda, *Solid State Electron.* 107, 8 (2015).

Article Google Scholar

16. E. Berretti, S. Cinotti, S. Caporali, N. Cioffi, A. Giaccherini, F.D. Benedetto, M.L. Foresti, G. Montegrossi, A. Lavacchi, F. Vizza, R.A. Picca, and M. Innocenti, *J. Electrochem. Soc.* 163, D3034 (2016).

Article Google Scholar

17. F.D. Benedetto, *ECS Trans.* 58, 59 (2013).

Article Google Scholar

18. M.A. Yildirim, A. Ateé, A. Astam, *Physica E Low Dimens. Syst. Nanostruct.* 41, 1365 (2009).

Article Google Scholar

19. X.J. Xu, J. Bullock, L.T. Schelhas, E.Z. Stutz, J.J. Fonseca, M. Hettick, V.L. Pool, K.F. Tai, M.F. Toney, X.S. Fang, A. Javey, L.H. Wong, J.W. Ager, *Nano Lett.* 16, 1925 (2016).

20. X.-H. Guan, P. Qu, X. Guan, and G.-S. Wang, *RSC Adv.* 4, 15579 (2014).

Article Google Scholar

21. R.S. Mane and C.D. Lokhande, *Mater. Chem. Phys.* 65, 1 (2000).

Article Google Scholar

22. R. Woods-Robinson, K. Cooper Jason, X. Xu, T. Schelhas Laura, L. Pool Vanessa, A. Faghaninia, S. Lo Cynthia, S. Lo Cynthia, F. Toney Michael, D. Sharp Ian, and W. Ager Joel, *Adv. Electron. Mater.* 2, 1500396 (2016).

Article Google Scholar

23. R. Sahraei, S. Noshadi, and A. Goudarzi, *RSC Adv.* 5, 77354 (2015).

Article Google Scholar

24. N.P. Huse, A.S. Dive, K.P. Gattu, and R. Sharma, *Mater. Sci. Semicond. Process.* 67, 62 (2017).

Article Google Scholar

25. L.A. Isac, A. Duta, A. Kriza, I.A. Enesca, and M. Nanu, *J. Phys. Conf. Ser.* 61, 477 (2007).

Article Google Scholar

26. M.S. Sreejith, D.R. Deepu, C.S. Kartha, K. Rajeevkumar, and K.P. Vijayakumar, Tuning the properties of sprayed CuZnS films for fabrication of solar cell. *Appl. Phys. Lett.* 105, 202107 (2014).

Article Google Scholar

27. H. Zhu, J. Iqbal, H. Xu, and D. Yu, *J. Chem. Phys.* 129, 124713 (2008).

Article Google Scholar

28. N. Li, L. Zhang, J. Zhou, D. Jing, and Y. Sun, *Dalton Trans.* 43, 11533 (2014).

Article Google Scholar

29. B. Guzeldir, M. Saglam, and A. Ates, *Acta Phys. Pol. A* 121, 33 (2012).

Article Google Scholar

30. S.V. Mahajan, D.S. Upadhye, S.U. Shaikh, R.B. Birajadar, F.Y. Siddiqui, S.B. Bagul, N.P. Huse, and R.B. Sharma, *AIP Conf. Proc.* 1665, 080063 (2015).

Article Google Scholar

31. A.S. Dive, N.P. Huse, K.P. Gattu, R.B. Birajdar, D.R. Upadhyay, and R. Sharma, *J. Mater. Sci. Mater. Electron.* 28, 15161 (2017).

Article Google Scholar

32. A.M. Diamond, L. Corbellini, K.R. Balasubramaniam, S. Chen, S. Wang, T.S. Matthews, L.W. Wang, R. Ramesh, and J.W. Ager, *Phys. Status Solidi A* 209, 2101 (2012).

Article Google Scholar

Acknowledgements

The authors are thankful to the head of the Department of Physics and Department of Nanotechnology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for providing necessary lab facilities.

Author information

Authors and Affiliations

Thin Film and Nanotechnology Laboratory, Department of Physics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, 431004, India

Ghamdan M. M. Gubari, Ibrahim Mohammed S. M., Nanasaheb P. Huse, Avinash S. Dive & Ramphal Sharma

Corresponding author

Correspondence to Ramphal Sharma.

Rights and permissions

About this article

Cite this article

Gubari, G.M.M., Ibrahim Mohammed, S.M., Huse, N.P. *et al.* An Experimental and Theoretical Study of $Cu_{0.2}Zn_{0.8}S$ Thin Film Grown by Facile Chemical Bath Deposition As an Efficient Photosensor. *J. Electron. Mater.* 47, 6128–6135 (2018). https://doi.org/10.1007/s11664-018-6491-3

Received	Accepted	Published
08 March 2018	28 June 2018	18 July 2018

Issue Date
October 2018

DOI
https://doi.org/10.1007/s11664-018-6491-3

Share this article

Keywords

$Cu_{0.2}Zn_{0.8}S$ thin film chemical bath deposition photosensitivity

DFT