Photosensitive Schottky barrier diode based on Cu/p-SnSe Thin Film Fabricated by Thermal Evaporation

Hirenkumar Shantilal Jagani\textsuperscript{a,7}, Shubham Umeshkumar Gupta\textsuperscript{a}, Karan Bhoraniya\textsuperscript{a}, Mayuri Navapariya\textsuperscript{a}, Hetal Patel\textsuperscript{a}, Vivek M. Pathak\textsuperscript{a} and Gunvant K. Solanki\textsuperscript{a}

a) Thin Film Device Fabrication & Characterisation Laboratory, Department of Physics, Sardar Patel University, Vallabh Vidyanagar, Gujarat-388120, India.

*Corresponding Author: hirenjagani308@gmail.com (Hirenkumar Shantilal Jagani)

| h k l | 2θ (Deg) Observed | 2θ (Deg) Calculated | d (Å) Observed | d (Å) Calculated | FWHM | Crystallite Size (nm) | Micro-Strain E x 10\(^{-5}\) (ln^2 m^−1) | Dislocation density δ (ln m^−2) |
|-------|-------------------|-------------------|----------------|----------------|------|---------------------|--------------------------------|-------------------------------|
| 2 1 0 | 25.281            | 25.332            | 3.5200         | 3.5131         | 0.5010 | 28.3519            | 12.2214                         | 5.6E+08                        |
| 0 1 1 | 29.391            | 29.495            | 3.0365         | 3.0259         | 0.5010 | 28.6003            | 12.1152                         | 5.5E+08                        |
| 1 1 1 | 30.419            | 30.525            | 2.9361         | 2.9262         | 0.5010 | 28.6689            | 12.0862                         | 5.5E+08                        |
| 4 0 0 | 31.050            | 31.110            | 2.8779         | 2.8725         | 0.4008 | 35.8903            | 09.6544                         | 3.5E+08                        |
| 3 1 1 | 37.757            | 37.862            | 2.3807         | 2.3743         | 0.4509 | 32.4861            | 10.6661                         | 4.3E+08                        |
| 4 1 1 | 43.288            | 43.400            | 2.0884         | 2.0833         | 0.4509 | 33.0702            | 10.4777                         | 4.1E+08                        |
| 5 1 1 | 49.667            | 49.784            | 1.8341         | 1.8300         | 0.5010 | 30.4834            | 11.3668                         | 4.9E+08                        |
| 8 0 0 | 64.745            | 64.868            | 1.4386         | 1.4362         | 0.5010 | 32.7553            | 10.5784                         | 4.2E+08                        |

Table S1. Crystallographic parameter of SnSe thin film obtained from XRD.
Fig. S1. Optical image of Schottky diode by optical microscope having magnification of 10x.

Fig. S2. HR-TEM image of SnSe thin film deposited on Nacl crystal.

Fig. S3. Histogram of HR-TEM image of size distribution of nano-particles of SnSe thin film.
Table S2. Comparison of present work with previously reported data

| Materials | Optical property | Ref. |
|-----------|------------------|------|
|           | Bandgap (E_g) (eV) |      |
| SnSe      | 1.13             | (1)  |
| SnSe      | 0.87             |      |
| SnSe_2    | 2.04             | (2)  |
| SnS       | 1.14             | (3)  |
| SnS       | 1.24             | (4)  |
| SnS_2     | 2.53             | (5)  |
| SnTe      | 0.35             | (6)  |
| SnSe      | 1.75             | This work |

1. Li Z, Guo Y, Zhao F, Nie C, Li H, Shi J, et al. Effect of film thickness and evaporation rate on co-evaporated SnSe thin films for photovoltaic applications. RSC Advances. 2020 Apr 29;10(28):16749–55.
2. Mukhokosi EP, Krupanidhi SB, Nanda KK. Band gap engineering of hexagonal SnSe_2 nanostructured thin films for infra-red photodetection. Scientific Reports. 2017 Dec 1;7(1).
3. Zhao L, Di Y, Yan C, Liu F, Cheng Z, Jiang L, et al. In situ growth of SnS absorbing layer by reactive sputtering for thin film solar cells. RSC Advances. 2016;6(5):4108–15.
4. Reddy TS, Kumar MCS. Co-evaporated SnS thin films for visible light photodetector applications. RSC Advances. 2016;6(98):95680–92.
5. Kherkhachi IB, Attaf A, Saidi H, Bouhdjar A, Bendjdidi H, Benkhetta Y, et al. Structural, morphological, optical and electrical characterization of spray ultrasonic deposited SnS$_2$ thin film. Optik. 2016 Feb 1;127(4):2266–70.

6. Saini R, Singh M, Kumar R, Jain G. STRUCTURAL AND ELECTRICAL CHARACTERIZATION OF SINTERED SnTe FILMS. Vol. 7, Chalcogenide Letters. 2010.