Chalcogenide Advanced Manufacturing Partnership Open Day

CVD-grown Tin Sulphide for Thin Film Solar Cell Devices

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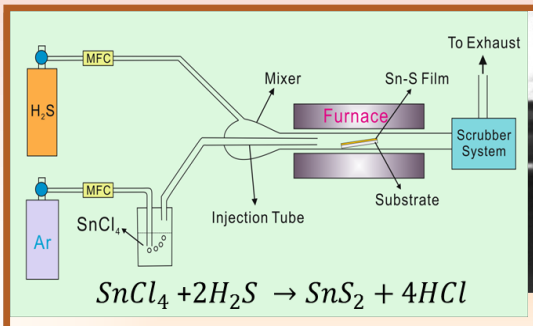
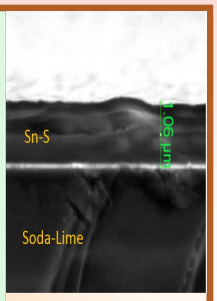
Abstract

Chalcogenide materials are proposed to be the leading in thin film photovoltaic (PV) technology. Tin mono-sulphide, a p-type semiconductor with the band gap of ~1.3 eV, has attracted great interest for the use as an absorber layer in chalcogenide thin film solar cells due to its desirable properties for making absorber layers in scalable, inexpensive, and non-toxic solar cells. In this work thin films of tin sulphide have been deposited by chemical vapour deposition (CVD) at room temperature onto soda lime substrates then annealed at four different temperatures 200,250,400 and 450° C with the aim of optimizing the properties of the thin films to achieve the required phase for use in solar cell device structures. These annealed CVD-grown thin sulphide thin films were further characterized with SEM, EDX, XRD, Raman and UV-VIS-NIR spectroscopy. The preliminary results of these tin sulphide thin films show great promise for PV applications.

Fabrication Technique

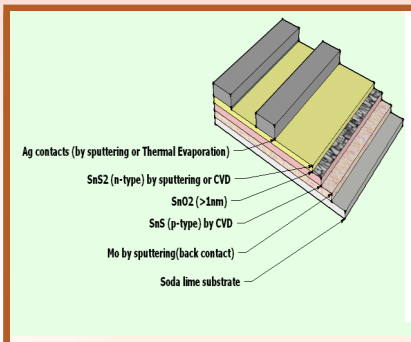


Deposition method of CVD reaction tin tetra chloride and hydrogen sulphide at room temperature on soda lime substrates.



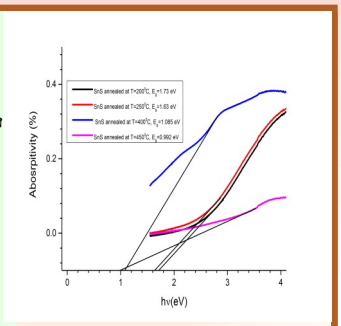
SEM image of deposited SnS thin film by CVD on SL substrate.

Solar Cell Structure



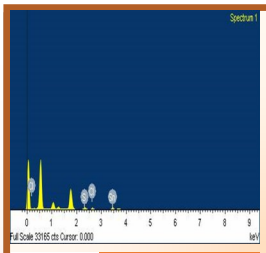
Configuration of SnS/SnS2 thin film solar

Optical Band Gap

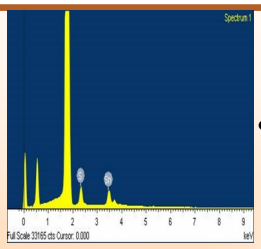


Energy Band gap estimated at various annealing temperatures.

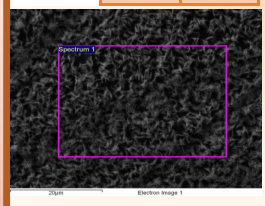
Film composition



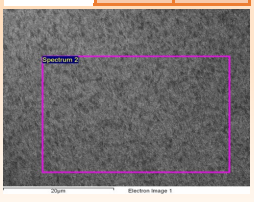
Element	Weight%	Atomic%
S K	35.82	67.38
Sn L	64.18	32.62
Cl K	16.00	29.33
Totals	100.00	



Element	Weight%	Atomic%
S K	18.09	44.98
Sn L	81.91	55.02
Totals	100.00	



As-Deposited SnS thin films at room temperature.

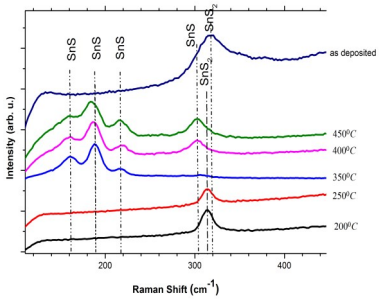


Annealed SnS thin films at 350°C.

EDX Measurements

- The tin to sulphur ratio varies with different annealing temperatures.
- A mono phase is observed at an annealing temperature of 350 C .
- EDX indicates the capability of obtaining a mono phase of SnS at 350C.

Phase Purity

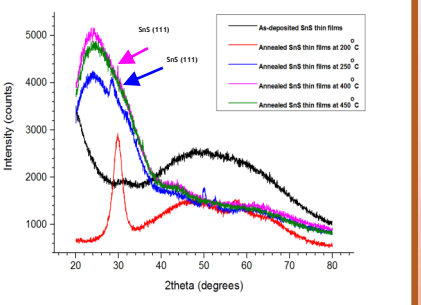


Raman Spectroscopy

To confirm the phase purity, Raman spectra were taken of SnS films annealed at different temperatures. The films annealed at 400°C show the Raman peaks of SnS at 160, 187,220 and 302 cm-1, which confirms that at this annealing temperature pure SnS without any contamination from SnS2 and Sn2S2.

X-ray Diffraction pattern of SnS films

Tin sulphide thin films deposited by CVD grow with a mixture of three phases SnS SnS2 and Sn2S3. however we found that by annealing the thin films to a temperature around 400°C it is possible to get thin films in the SnS mono phase (p-type).



Further Work

- Tailoring the optical band gap by controlling the deposition parameters.
- Incorporating with an n-type 2-D material such as MoS2.

Acknowledgements

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