4° SIMPOSIO INTERDISCIPLINARIO EN MATERIALES

THIN-FILM SOLAR CELLS BASED ON ANTIMONY CHALCOGENIDES THROUGH CHEMICAL BATH DEPOSITION

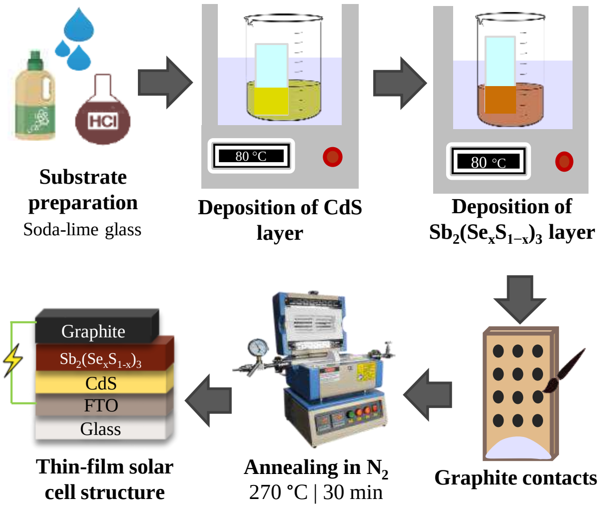
A. Nuñez-Rodríguez[1], J. Escorcia-García[2]

[1] *CINVESTAV Unidad Saltillo, Ingeniería Cerámica, México.*
[2] *CONACYT-CINVESTAV Unidad Saltillo, Ingeniería Cerámica, México.*

INTRODUCTION

The search of new semiconductor materials for electrical energy generation constituted by non-toxic and abundant elements using inexpensive processes has been investigated in recent years. Antimony chalcogenides like antimony sulfide (Sb_2S_3) and antimony selenide (Sb_2Se_3) have been positioned as novel and attractive materials for the absorber layer in solar cells due to their interesting optoelectronic properties. Sb_2S_3 has high optical bandgap (E_g=1.5-1.8 eV) but low electrical photoconductivity (10^{-8}-10^{-6} Ω^{-1} cm^{-1}). On the contrary, Sb_2Se_3 possesses E_g of 1.3-1.7 eV and higher photoconductivity than Sb_2S_3 (>10^{-6} Ω^{-1} cm^{-1}). For this reason, the evaluation of Sb_2S_3 in solar cells gives high open-circuit voltage (V_{oc}) with low short-circuit current densities (J_{sc}), while Sb_2Se_3 produces low V_{oc} and high J_{sc} values. Therefore, the implementation of a solid solution constituted by antimony sulfide-selenide, $Sb_2(Se_xS_{1-x})_3$, will optimize the chemical composition of the absorber to obtain both high V_{oc} and J_{sc} values in the resulting solar cells.

EXPERIMENTAL DETAILS



Substrate preparation
Soda-lime glass

Deposition of CdS layer

Deposition of $Sb_2(Se_xS_{1-x})_3$ layer

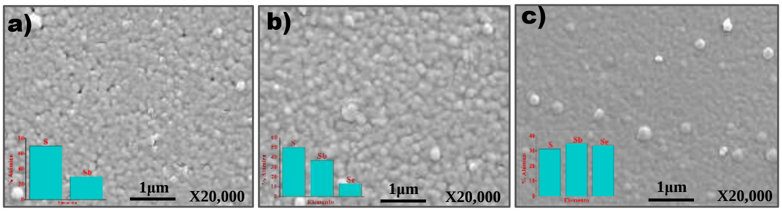
Graphite contacts

Annealing in N_2
270 °C | 30 min

Thin-film solar cell structure

RESULTS

Morphology



Sb_2S_3
150 ± 29 nm

Sb_2SeS_2
210 ± 30 nm

Sb_2Se_2S
130 ± 20 nm

Fig. 1. Surface micrographs of annealed $Sb_2(Se_xS_{1-x})_3$ thin films in N_2 atmosphere

Optical analysis

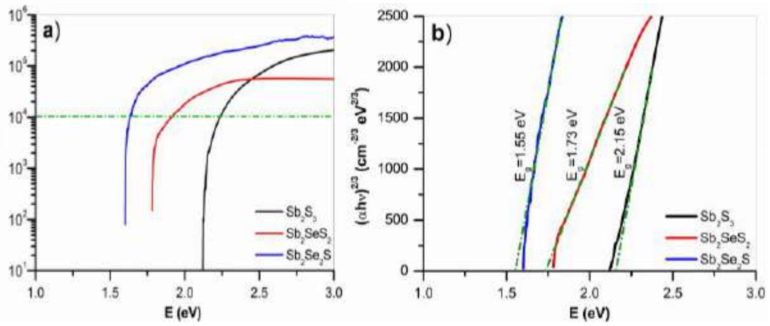


Fig. 3. a) Optical absorption coefficient and b) bandgap of the films

Structural characterization

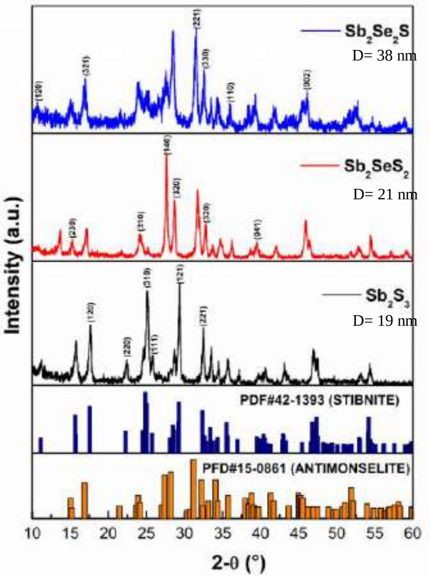
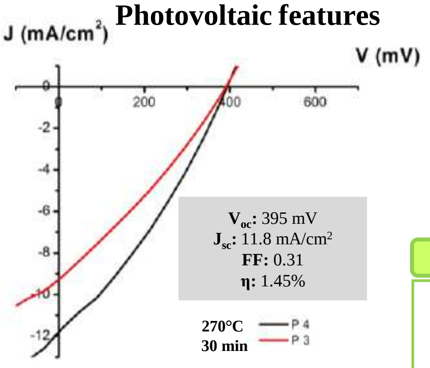


Fig. 4. XRD patterns of $Sb_2(Se_xS_{1-x})_3$ $_3$ films

Fig. 2. Thin-films obtained through chemical bath deposition (80 °C, 2 h)

Photovoltaic features



V_{oc}: 395 mV
J_{sc}: 11.8 mA/cm^2
FF: 0.31
η: 1.45%

270°C
30 min

Fig. 5. JV curves of solar cells under AM1.5G

CONCLUSIONS

The results demonstrated that Se incorporation into solid solution increased the crystallite size and decreased the bandgap. Then, photovoltaic parameters improved with the increase of Se content, reaching a power conversion efficiency (PCE) of 1.45%. Further experiments would be implemented to improve film thickness and crystallinity in $Sb_2(Se_xS_{1-x})_3$ films to obtain better PCE values.

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CONTACT

aylin.rodriguez@cinvestav.mx

jose.escorcia@cinvestav.edu.mx