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Rapid growth of Sb_2S_3 thin films by chemical bath deposition with ethylenediamine tetraacetic acid additive

U. Chalapathi, B. Poornaprakash, Chang-Hoi Ahn, and Si-Hyun Park*

Department of Electronic Engineering, Yeungnam University, Gyeongsan 38541, South Korea

** Tel: 82-053-810-3096, Fax: 82-053-810-4770, E-mail: sihyun_park@ynu.ac.kr*

Abstract

Sb_2S_3 is a suitable photovoltaic material because of its favorable optoelectronic properties as well as being comprised of earth-abundant and nontoxic precursor elements. The chemical bath deposition method has been widely used to deposit Sb_2S_3 thin films. However, longer deposition times as well as multiple depositions have been reported to prepare thicker Sb_2S_3 films. In order to produce good quality Sb_2S_3 films with a thickness greater than $1\ \mu\text{m}$ within a short deposition time, we have added a small amount of ethylenediamine tetraacetic acid (EDTA) to the conventional chemical proportions used for the deposition of Sb_2S_3 films. The effect of EDTA, $\text{Na}_2\text{S}_2\text{O}_3$, bath temperature, and the deposition time were studied. By optimizing these conditions, uniform good quality Sb_2S_3 thin films with a thickness greater than $1\ \mu\text{m}$ could be obtained in a short deposition time of 3 h. The films prepared at the optimized conditions were annealed to improve the crystallinity. The films exhibited orthorhombic crystal structure with lattice parameters $a = 11.42\ \text{nm}$, $b = 3.81\ \text{nm}$, and $c = 11.24\ \text{nm}$, and a direct optical band gap of 1.66 eV. This approach is beneficial for obtaining good quality Sb_2S_3 films which is ideal for solar cell applications.

Keywords: Sb_2S_3 thin films, Chemical bath deposition, Annealing, EDTA, Raman spectroscopy, Microstructure.

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