

# The Photoelectrochemical Performances of Silver-Tin-Sulfide Thin Films Created Using Chemical Bath Deposition

Kong-Wei Cheng<sup>\*</sup>, Lin-Ya Yeh<sup>\*</sup>

Department of Chemical and Materials Engineering, Chang Gung University, Taoyuan, Taiwan  
Address: 259 Wen-Hwa 1<sup>st</sup> Rd., Kwei-Shan, Taoyuan, 333, Taiwan.

\*Email: kwcheng@mail.cgu.edu.tw

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In this study, the silver-tin-sulfide ( $\text{Ag}_8\text{SnS}_6$ ) thin films were deposited onto the surfaces of glass substrates and indium-tin-oxide (ITO)-coated glass substrates using the chemical bath deposition. The effect of Ag/Sn molar ratio in solution bath on the structural, morphological, optical, photoelectrochemical (PEC) properties of samples was investigated. The X-ray diffraction patterns (XRD) and energy dispersive analysis of X-ray (EDAX) of samples revealed that the samples are the  $\text{Ag}_8\text{SnS}_6$  phase (JCPDS no.38-434) with impurities such as  $\text{Ag}_2\text{S}$  and  $\text{SnS}$  phase in the samples at high Sn content in samples. With an increase in the content of Ag in the samples, pure ATS phase in samples was observed. Field-emission scanning electron microscope (FE-SEM) showed that island-like microstructures can be observed on the surface of samples and those in samples became larger with a decrease of Ag/Sn molar ratio in samples. The direct band gaps of the samples were range of 1.26 to 1.61 eV, respectively, depending on the Ag/Sn molar ratio in samples. From the Hall measurement, the carrier densities and mobilities of samples are in the ranges of  $3 \times 10^{14}$ - $2.5 \times 10^{12} \text{ cm}^{-3}$  and  $14.02 \sim 23.05 \text{ cm}^2/\text{V-s}$  respectively. The carrier concentrations of samples decreased with a decrease in Ag/Sn molar ratios in samples. The conduction types of all samples are n-type semiconductors. The maximum photoelectrochemical response of sample (e) in 0.35M  $\text{Na}_2\text{S}$  and 0.25M  $\text{K}_2\text{SO}_3$  aqueous solution reached  $1.13 \text{ mA/cm}^2$  at an external potential of + 0.25 V vs. an Ag/AgCl reference electrode under illumination using a 300 W Xe lamp.

Keywords: Photoelectrodes, thin films, semiconductors, crystal growth

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