Abstract #2046, 224th ECS Meeting, © 2013 The Electrochemical Society

Electrodeposition of Lead Sulfide Thin Film and Application as Counter Electrode for Quantum Dot Solar Cells

Le Van Nghiem[1], Ha Thanh Tung[2], Nguyen Thai Hoang[1,3], Nguyen Thi Phuong Thoa[1]

[1]University of Science, Vietnam National University – Ho Chi Minh City, 227 Nguyen Van Cu Street, District 5, Ho Chi Minh City, Vietnam

[2]Dong Thap University, 783 Pham Huu Lau Street, Ward 6, Cao Lanh City, Dong Thap Province, Vietnam

[3]Center for Molecular and Nanoarchitecture, Vietnam National University – Ho Chi Minh City, Linh Trung, Thu Duc District, Ho Chi Minh City, Vietnam

Email: lvnghiem@hcmus.edu.vn

Abstract

Semiconducting lead sulfide films (PbS) was deposited on fluorine doped tin oxide (FTO) conductive glass electrode by cyclic voltammetry (CV) from the solution of $Pb(NO_3)_2$ 1.5 mM and $Na_2S_2O_3$ 1.5 mM. CV experiments were carried out at various potential scan rates in a potential range 0.0 to –1.0 V versus Ag/AgCl/KCl(sat) electrode, pH from 2.40 to 2.70 and ambien temperature. The structure of deposited thin film was determined by X-ray diffraction (XRD). The surface morphology and crystallite size were characterized by scanning electron microscopy (SEM). Electrochemical impedance spectroscopy (EIS) and CV measurement were used to investigate the electrochemical behavior of PbS thin film in the polysulfide solution. The results showed good adherence of PbS thin films, prepared at pH 2.65 and 100 $mV.s^{-1}$ potential scan rate, to the glass substrate. These conditions also support the formation of 100–300 nm sized cubic crystals.

The obtained PbS/FTO system was used as a counter electrode for fabrication of quantum dot solar cells (QDSCs) with total active area of 0.385 cm^2. The photoanodes of cells were made by three-layer CdSe-CdS-ZnS adsorption on a mesoporous TiO_2 film. The polysulfide solution was used as an electrolyte. At the full-sun (1000 W/cm^2) simulated light, the primary results of fabricated QDSCs were: energy conversion efficiency of around 0.63%, short circuit current 6.14 $mA.cm^{-2}$, open-circuit potential 0,43 V.

Keywords: cyclic voltammetry, electrodeposition, lead sulfide, quantum dot, solar cell, thin film.

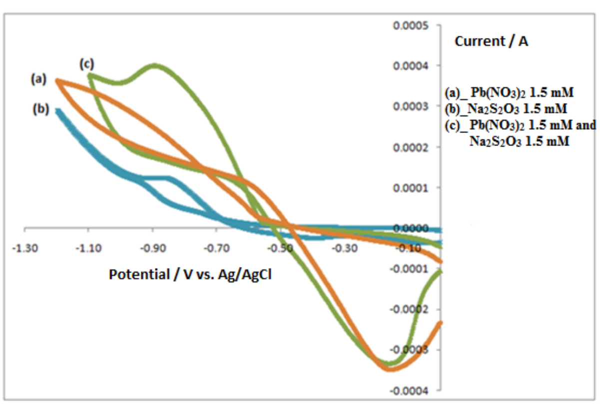

Figure 1. Cyclic voltammograms measured at 100 $mV.s^{-1}$ in 2.65 pH solutions containing: (a) 1.5 mM $Pb(NO_3)_2$; (b) 1.5 mM $Na_2S_2O_3$ and (c) 1.5 mM $Pb(NO_3)_2$ + 1.5 mM $Na_2S_2O_3$.

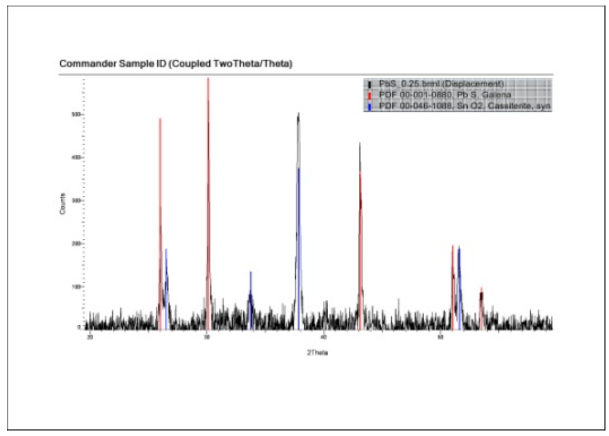

Figure 2. XRD pattern of the PbS layer prepared at 100 $mV.s^{-1}$ potential scan rate.

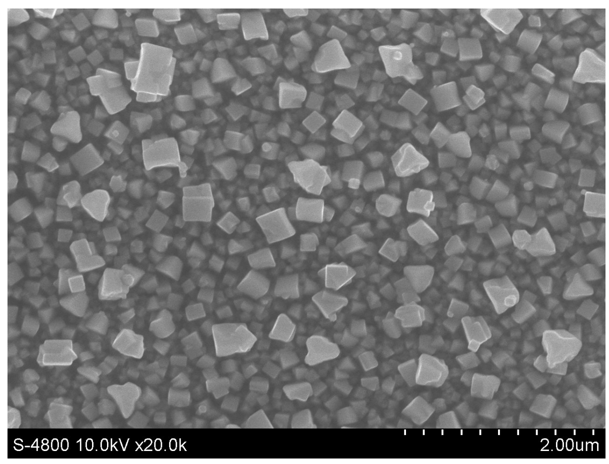

Figure 3. SEM image of PbS thin film prepared at 100 $mV.s^{-1}$ potential scan rate.

References

1. A. Aghassi, M. Jafarian, I. Danaee, F. Gobal, and M. G. Mahjani, *Journal of Electroanalytical Chemistry*, **661**, 265 (2011).
2. Z. Tachan, M. Shalom, I. Hod, S. Rühle, S. Tirosh, and A. Zaban, *The Journal of Physical Chemistry C*, **115**, 6162 (2011).
3. S. Seghaier, N. Kamoun, R. Brini, and A.B. Amara, *Materials Chemistry and Physics*, **97**, 71 (2006).
4. M. A. Barote, A. A. Yadav, T. V. Chanvan, and E. U. Masumdar, *Digest Journal of Nanomaterials and Biostructures*, **6**, 979 (2011).
5. J. Yuechao, G. Xiaoyong, L. Jingxiao, C. Yongsheng, Z. Jianpeng, and L. Xinli, *Materials Letters*, **72**, 116 (2012).