Fabrication of 3D Nanostructured Cadmium Telluride Solar Cells Based on Electrodeposition

Huiying Fu, Kwong-Hoi Tsui, Siu-Fung Leung, Zhiyong Fan*

Department of Electronic and Computer Engineering, the Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

*email: eezfan@ust.hk

Highly ordered three dimensional (3-D) nanostructured aluminum (Al) nanopillar arrays have been synthesized via a typical high voltage anodization of thin Al foil. Following a low voltage anodization of Al nanopillar arrays to form a buffering layer of alumina and a deposition of a thin layer of metallic materials onto alumina nanopillar arrays by sputtering, photovoltaic active materials cadmium telluride (CdTe) and cadmium sulfide (CdS) can be efficiently electrodeposited onto the nanopillar arrays. The growth rate of CdTe and CdS can be easily controlled by tuning the pH values of the electrodeposition solution, the concentration of the precursors, and the temperature applied for the electrodeposition. By carefully tuning the deposition potential, electrodeposited CdTe and CdS can both show Cd-rich properties, which are beneficial factors for the fabrication of photovoltaic devices. The obtained CdTe and CdS layers were found to be dense with a sub-micron grain size and a uniform thickness. The enhanced optical absorption of the CdTe nanpillar arrays have been characterized with measurements and simulations. More importantly, the heterojunction photovoltaic devices based on electrodeposition showed improved power conversion efficiency as compared to the planar samples fabricated with the same deposition condition. Further optimization for the devices, including deploying other metallic materials as the bottom contact and the introduction of highly ordered Al nanopillar arrays with different pitch and height fabricated using nano-imprinting process as the substrate, is needed to enable the fabrication of highly efficient CdTe photovoltaic devices based on 3D nanostructure and electrodeposition.

Reference

1. Fan, Z.Y.; Ravazi, H.; Do, J.W.; Moriwaki, A.; Ergen, O.; Chueh, Y.L.; Leu, P.W.; Ho, J.C.; Takahashi, T.; Reichertz, L.A.; Neale, S.; Yu, Y.; Wu, M.; Ager, J.W.; Javey, A. Three-dimensional Nanopillar-array Photovoltaics on Low-cost and Flexible Substrates. *Nat. Mater.* **2009**, *8*, 648-653.

2. Leung, S. F.; Yu, M.; Lin, Q.; Kwon, K.; Ching, K. L.; Gu, L.; Yu, K.; Fan, Z. Efficient Photon Capturing with Ordered Three-Dimensional Nanowell Arrays. *Nano Lett.* **2012**, *12*, 3682-3689.