Self-Assembled Micro-Honeycomb Network of Single-Walled Carbon Nanotubes for Heterojunction Solar Cells

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Abstract: The gap between the outstanding electrical and optical properties of an individual single-walled carbon nanotube (SWNT) and inferior performance of macro-scale SWNT devices is hindering its widespread applications. The smart assembly is necessary to play SWNT to its full potential. Here, we propose a self-assembled micro-honeycomb network (μ-HN) of SWNTs obtained by water or ethanol vapor treatment of as-synthesized vertically aligned SWNTs (VA-SWNTs) for heterojunction solar cells with higher performance. The VA-SWNTs was synthesized by the standard alcohol-catalytic CVD method with Co/Mo dip-coated on Si/SiO_2 substrate [1]. The fabrication process of the micro-honeycomb structured film was obtained by exposing the as-synthesized VASWNT to water vapor and drying under ambient environment afterwards. Each micro-honeycomb cell consists of capillary-aggregated walls and randomly oriented bottom that contacts the Si substrate. The SWNT film was transferred on top of the substrate which has a 3 mm × 3 mm bare *n*-type silicon contact window in the center using hot water transfer technique. By the vapor treatment, collapsed spaghetti-like SWNTs contact to the substrate in the middle of each honeycomb cell. Cell walls consist of cross-linked heavily bundled SWNTs. The pristine SWNT-Si heterojunction solar cell fabricated with μ-HN shows a stable fill factor of 72%, which is the highest fill factor reported to date [2, 3]. The improvement is attributed to the hierarchical structure of micro-honeycomb network. A PCE (Power conversion efficiency) beyond 10% is achieved in the dry state after dilute nitric acid treatment.

References:

[1] Y. Murakami, S. Chiashi, Y. Miyauchi et al, Chem. Phys. Lett. Vol. 385 (2004), p. 298

[2] D. Tune, B. Flavel, R. Krupke, J. Shapter, Adv. Energy Mater. Vol. 2 (2012), p. 1043.

[3] Y. Jung, X. Li, N. K. Rajan, A. Taylor, A. D. Reed, Nano Lett. Vol. 13 (2013), P. 95.

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