

# Single-Walled Carbon Nanotubes and Graphene as Hole Transport Layer & Electrode for Solar Cells

Shigeo Maruyama

Department of Mechanical Engineering, The University of Tokyo, Tokyo, Japan

maruyama@photon.t.u-tokyo.ac.jp

I will discuss the application of single-walled carbon nanotubes (SWNTs) and graphene as hole transport layer and transport electrode in various kinds of solar cells including honeycomb-structured SWNTs-Si solar cell [1], dry-deposited SWNTs-Si solar cell [2], graphene-Si solar cells, organic solar cell (OSC) [3] and perovskite-type solar cells [4]. Using millimeter-scale monocrystalline single-layer graphene and honeycomb-structured SWNT network, the nanocarbon-Si solar cell demonstrated the air-stable power conversion efficiency (PCE) of 11.6% before any intentional doping process. For organic solar cells, the SWNT/MoO<sub>x</sub>/PEDOT:PSS nanocomposite was proposed and developed as hole transport layer and electrode replacing ITO. Using PTB7/PC71BM mixture as active materials, the PCE of 6% was obtained for on glass substrate and 3.89% on flexible PET substrate. The hole transport and cathode function of SWNTs was also demonstrated in perovskite solar cells with over 9% PCE. The dual functional behavior of SWNT and graphene will be discussed.

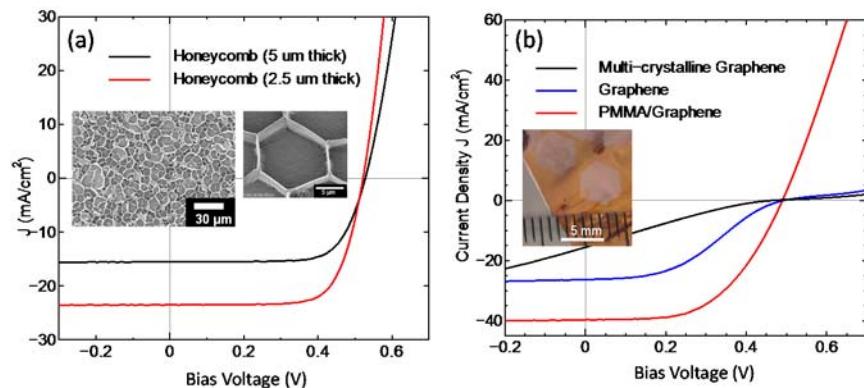


Figure 1. (a) Honeycomb structured SWNT/n-Si solar cell. (b) Graphene/n-Si solar cell.

## References:

- [1] K. Cui, T. Chiba, S. Omiya, T. Thurakitseree, P. Zhao, S. Fujii, H. Kataura, E. Einarsson, S. Chiashi, S. Maruyama, *J. Phys. Chem. Lett.*, 4 (2013), 2571.
- [2] K. Cui, A. S. Anisimov, T. Chiba, S. Fujii, H. Kataura, A. G. Nasibulin, S. Chiashi, E. I. Kauppinen, S. Maruyama, *J. Mater. Chem. A*, 2 (2014) 11311.
- [3] I. Jeon, K. Cui, T. Chiba, A. S. Anisimov, A. G. Nasibulin, E. I. Kauppinen, S. Maruyama, Y. Matsuo, submitted.
- [4] T. Chiba, T. Sakaguchi, A. G. Nasibulin, E. I. Kauppinen, R. Xiang, S. Chiashi, S. Maruyama, to be submitted.