

Graphene and SWNT film as Hole Transport Layer and Electrode for Solar Cells

Shigeo Maruyama

Department of Mechanical Engineering, The University of Tokyo
Energy NanoEngineering Lab., National Institute of Advanced Industrial Science and Technology
(AIST)

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

<http://www.photon.t.u-tokyo.ac.jp/>

Abstract:

By using ethanol as carbon source [1], single crystal graphene flake of 5 mm size can be grown. The single crystal A-B stacked bi-layer graphene as large as 200 micron-meters is also realized. The application of graphene and SWNTs as hole-transport-layer and transport electrode in various kinds of solar cells are also discussed. Solar cell systems tested are honeycomb-structured SWNTs-Si solar cell [3], dry-deposited SWNTs-Si solar cell [4], graphene-Si solar cells, organic solar cell (OSC) and perovskite-type solar cells. 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. Higher PCE of 14 % is achieved by Cu-based doping, For organic solar cells, the SWNT/MoOx/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 double-sided perovskite solar cells with over 9% PCE. The dual functional behavior of SWNT and graphene will be discussed.

References

- [1] P. Zhao, S. Kim, X. Chen, E. Einarsson, M. Wang, Y. Song, H. Wang, S. Chiashi, R. Xiang, S. Maruyama, *ACS Nano*, 8 (2014) 11631.
- [2] P. Zhao, A. Kumamoto, S. Kim, X. Chen, B. Hou, S. Chiashi, E. Einarsson, Y. Ikuhara, S. Maruyama, *J. Phys. Chem. C*, 17 (2013) 10755.
- [3] K. Cui, T. Chiba, S. Omiya, T. Thurakitserree, P. Zhao, S. Fujii, H. Kataura, E. Einarsson, S. Chiashi, S. Maruyama, *J. Phys. Chem. Lett.*, 4 (2013), 2571.
- [4] 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.



Ph.D. in School of Engineering from the University of Tokyo in 1988. Research associate until 1991, Lecturer for a year, an associate professor from 1993, Full professor from 2004, and distinguished professor from 2014 at the University of Tokyo. From April 2015, Cross-appointment fellow for Advanced Industrial science and technology (AIST). During 1989 through 1991: Visiting fellow at Professor Richard Smalley group at Rice University. 2009-2012: Program officer of Japan Society for the Promotion of Science (JSPS). Since 2011: President of “The Fullerenes, Nanotubes and Graphene Research Society,” Since 2014: Director of The Japan Society of Applied Physics.