Single-walled carbon nanotube film as dual-functional electron-blocking-layer and transparent electrode for solar cells

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Abstract:
It was found that a film of single-walled carbon nanotubes (SWNTs) can be a dual-functional layer as electron-blocking-layer (hole-transport-layer) and transparent conductive electrode for nanotube/silicon heterojunction solar cells, organic solar cells, and perovskite solar cells. We have demonstrated efficient SWNT/Si solar cells using dry-deposited high-quality SWNTs [1] and honeycomb-structured SWNTs [2]. The SWNT/Si solar cells using the dry deposited SWNT film demonstrated the air-stable power conversion efficiency (PCE) of 11.6% before any intentional doping process. With the stable copper oxide based doping the PCE can be more than 13.5 %. Here the SWNTs film acts as the efficient hole-collection-layer and transparent electrode at the same time. For organic solar cells, the SWNT/MoOx/PEDOT:PSS layer was demonstrated as a dual functional layer replacing ITO and organic hole-transport-layer. Using PTB7/PC71BM mixture as active materials, the PCE of 6% was obtained for glass substrate and 3.89% on flexible PET substrate [3]. This dual-functional layer was also demonstrated in double-sided illumination perovskite solar cells using SWNT film instead of electron-blocking-layer and gold electrode with over 9% PCE [4]. Another perovskite solar cell structure using SWNTs instead of ITO is also proposed [5].

References

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Brief CV:

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.