Single-Walled Carbon Nanotubes and Graphene for Solar Cells

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We proposed a water vapor treatment to build up SWNTs to a self-assembled micro-honeycomb network for the application of solar cells [1]. The micro-honeycomb network consists of vertically aggregated SWNT walls and a buckypaper bottom. This hierarchical structure is very efficient to collect holes from the interface of Si. The heterojunction solar cell was fabricated by dry depositing the SWNT film to the 3 mm by 3 mm n-type silicon substrate. The pristine SWNT-Si heterojunction solar cell shows a record-high fill factor of 72 % as well as a power conversion efficiency (PCE) of 6 % without tuning the diameter or height of original vertically aligned SWNTs. A recent record of highest PCE was about 8.9 % without doping. The PCE remains stable for months in ambient condition. A PCE exceeding 10 % is achieved in the dry state after dilute nitric acid treatment. Coating with PMMA also is found to be efficient to increase the PCE up to 11%.

On the other hand, heterojunction solar cells using highly transparent-conductive SWNT films from controlled bundle-diameter and long bundle length are also promising [2]. Here, SWNTs were synthesized by the thermal decomposition of ferrocene vapor in a carbon monoxide atmosphere, with the average diameter of approx. 2 nm. Our preliminary test result shows the highest PCE of 11 % among such CNT-Si design without chemical doping. These solar cells are stable after 10 months [2]. Finally, millimeter scale single crystal graphene is probed to be a very useful hole collector in the same configuration as SWNT film. The preliminary test of 5 mm graphene with PMMA exhibits more than 11% PCE. Growth control of graphene by alcohol CVD [3] is also discussed.

References:

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