

CNT-Si heterojunction solar cell with single-walled carbon nanotubes

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Single-walled carbon nanotubes (SWNTs) with outstanding electronic, optical, mechanical, and thermal properties are expected to be the most promising materials for next-generation energy devices as well as optical and electronic devices. However, the structure controlled assembly of SWNTs for various devices is still challenging. In this study, we discuss two different SWNT assemblies for SWNT-Si heterojunction solar cells.

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 vertical aggregated SWNT walls and a buckypaper bottom (quasi 2 dimensional random network). This hierarchical structure exhibits lower sheet resistance and higher optical transmittance compared with the buckypaper. 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 [2]. The PCE remains stable for months in ambient condition. A PCE exceeding 10 % is achieved in the dry state after dilute nitric acid treatment.

On the other hand, heterojunction solar cells using highly transparent-conductive SWNT films from controlled bundle-diameter and long bundle length [3] are also promising. Here, SWNTs were synthesized by the thermal decomposition of ferrocene vapor in a carbon monoxide atmosphere, with the average diameter of approx. 2 nm. The SWNT films showed a sheet resistance of 117 Ω /sq. at the transmittance of 91 % over the AM1.5G spectrum. Our preliminary test result shows the PCE of 10.12 %, with short-circuit current, open-circuit voltage and fill factor of 30.9 mA/cm², 540 mV and 60 %, respectively.

Both types of solar cells are stable after months, which is attributed to the high-purity pristine SWNTs. The updated performance of these solar cells and the detailed mechanism will be discussed.

References:

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