Organic Solar Cells Using Single Wall Nanotubes

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INTRODUCTION

Organic Solar Cells (?)

A solar (or a photovoltaic) cell is a device that converts sunlight light into electrical energy. Organic photovoltaics (OPVs) are a promising low cost alternative to silicon solar cells, thus a great deal of effort is being devoted, in both academic and industrial laboratories, to increase the quantum efficiency, and scale-up the production processes. An attractive feature of the OPVs based on conjugated polymers is that they can be fabricated by a coating processes (e.g., spin coating or inkjet printing) to cover large areas, and may be formed on flexible plastic substrates. This was made possible by the discovery of photoinduced electron transfer from the excited state of a conjugated polymer (as the donor) onto fullerene C_{60} (as the acceptor).

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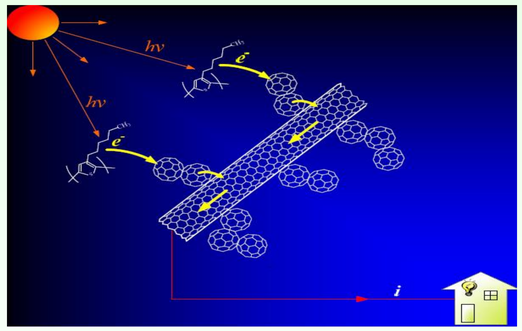


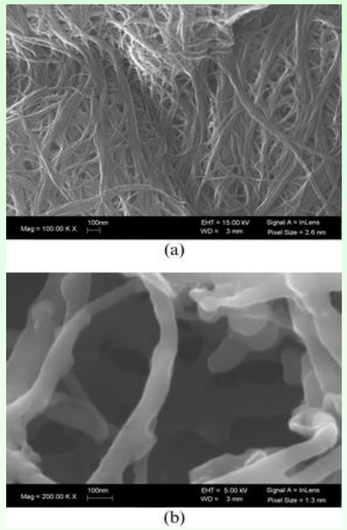
Microwave Induced Synthesis C_{60}-SWCNTs Photoactive Layer (?)

The active film is made from a polymer that when mass produced will be inexpensive enough that and one can envision even a wall painted with a solar cell. We demonstrated efficiency improvement of poly(3-hexylthiophene) (P3HT)-fullerene (C_{60}) bulk heterojunction photovoltaic cells by the introduction of single wall carbon nanotubes (SWCNTs) into the photoactive layer. A novel covalently bonded SWCNT composite was synthesized via a microwave induced functionalization approach. As compared to control devices with only C_{60}, the addition of SWCNTs resulted in improvement of both the short circuit current density Jsc and the fill factor (FF). Such a device takes advantages of both C_{60} for electron accepting and SWCNTs for efficient electron transport. The results indicate that this a promising approach for the development of inexpensive polymer based solar cells.

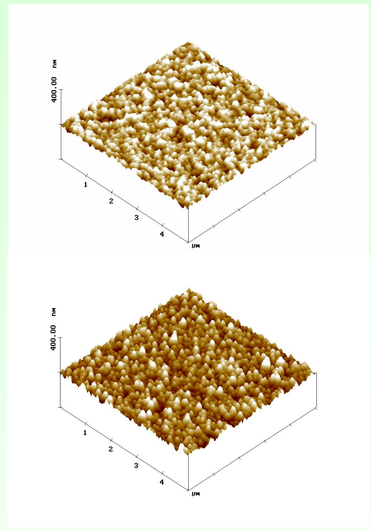
Fullerene–Single wall carbon nanotube Complex (?)

A fullerene–single wall carbon nanotube complex has been developed by

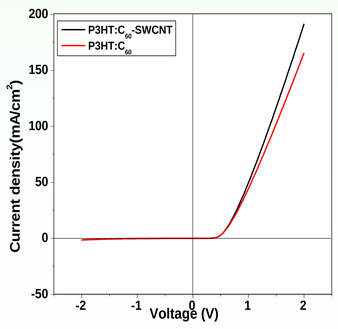
CHARACTERIZATION



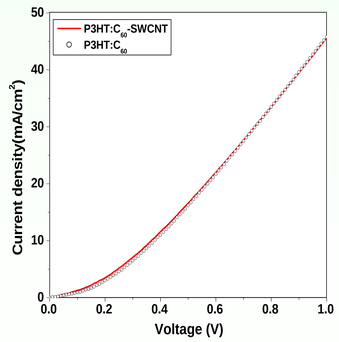
SEM images of (a) original SWCNTs from aqueous solution,and (b) C_{60}–SWCNT complex prepared by microwave irradiation.



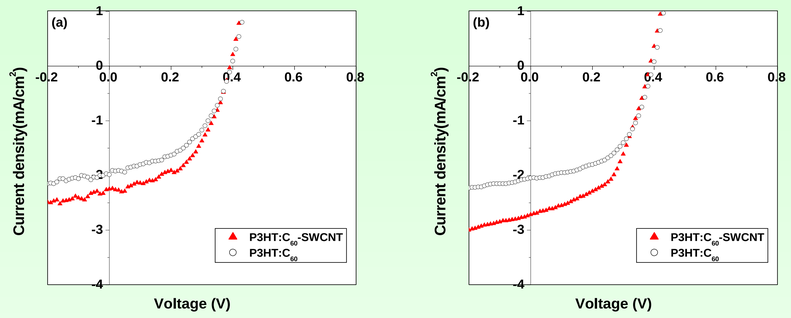
AFM images showing a 5 mm 6 5 mm surface scan area of (a) P3HT : C_{60} film (Ra = 5.78 nm), and (b) P3HT : C_{60}–SWCNT film (Ra = 8.33 nm).



I–V characteristics in the dark of photovoltaic cells with P3HT : C_{60}–SWCNT composite (solid line) or P3HT : C_{60} composite (open circle) as the active layer annealed at 120 °C for 10 min.



I–V characteristics in the dark of hole-only devices with a gold cathode. Incorporation of SWCNTs had no apparent effect on hole transport in the active films.



I–V characteristics under simulated solar irradiation at 95 mW cm^{-2} for photovoltaic cells with P3HT : C_{60}-SWCNT composite (solid triangle) or P3HT : C_{60} composite (open circle) as the active layer annealed at (a) 135 °C, and (b) 120 °C for 10 min.

SUMMARY

In conclusion, we have successfully fabricated polymer photovoltaic devices based on C60-modified SWCNTs and a conjugated polymer P3HT. The best power conversion efficiency of 0.57% under simulated solar irradiation (95 mW cm22) was achieved on a cell annealed at 120 uC for 10 min. Introduction of SWCNTs into the composite not only enhanced the short circuit current, JSC, because of faster electron transport via the network of SWCNTs, but also improved the fill factor due to the morphology change. These results clearly indicate that the polymer : C60–SWCNT composite is an excellent candidate for the fabrication of low cost polymer photovoltaic cells.

Reference

1. C. Li, Y. Chen, Y. Wang, Z. Iqbal and S. Mitra, J. Mater. Chem; 2007, 17, 1-7

2. Y. Wang, Z. Iqbal and S. Mitra, J. Am. Chem. Soc.; 2006; 128(1):95-99.

Acknowledgement

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