The Effect of Carbon Nanotubes in Thin Film Polymer Photovoltaic Cells

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Objective

Our goal is to fabricate polymer solar cells with a carbon nanotube embedded active layer to increase solar cell charge collection and open circuit voltage. This may improve the overall cell efficiency.

PPC Technology

Polymer photovoltaic cell (PPC) technology has the potential to:
• Be used for unique application use utilizing its lightweight and flexible properties
• Offer low fabrication costs due to its low processing temperature requirement and its printable characteristic
• Be price-to-performance competitive with silicon solar cells in the future

Fabrication Procedure

Fabrication steps are as follows:
• Carbon nanotube (CNT)/poly3-hexylthiophene (P3HT) solutions were ultra-sonicated and centrifuged
• The CNT/P3HT solution, Poly3,4-ethylenedioxythiophene (PEDOT), and TiO2 were spin coated on a fluoride tin oxide (FTO) slide,
• Slides were baked after the PEDOT layer and TiO2 layer in a vacuum oven
• A silver or copper electrode was deposited on top

Testing

Testing was done using a lamp to illuminate the bottom of the cell, electrodes facing the top. The voltmeter’s source probe was connected to the FTO and sense to the copper wire connected to the electrode. The open circuit voltage and short circuit current were measured in both a dark and illuminated setting.

Results

Performance of Added CNTs

Our PPC samples created with CNTs demonstrated increased photo-response compared to our control cells. Figure 3a shows the absorption spectra over the IR and visible light range. The absorption increases as the wt% CNTs increases. Figure 3b shows how voltage changes with the wt% CNTs.

Characterization of PV Response

Most of our solar cells either behaved as resistors or short circuited, as opposed to having the desired diode behavior. Figure 4a shows a typical current density versus voltage curve of our samples generated using a voltmeter and LabView software. The symmetry about the 0V axis implies there is no bias in electron/hole travel. Figure 4b shows a manually made IV curve of our round 3 samples indicating P3HT/SWNT cell is a photodiode.

Conclusions & Future Research

As the wt% CNT increases, the UV absorption increases. Additionally the open circuit voltage increases. Because we were unable to create working diodes, we cannot determine the correlation between higher efficiency and CNT concentration. In order to perform such a test, we need working diodes. Possible explanations are degradation of materials via short life times and oxidation as well as penetration of layers.

Future work needs to investigate the differences with TiO2 layer and without TiO2 layer, as well as the engineering parameters to fabricate this type of P3HT/SWNT cells. Alternative materials to replace the P3HT should be considered. It also entails selecting a different blend of materials, having a shorter time period between fabrication and testing, and working entirely under vacuum.

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References