Single-Walled Carbon Nanotubes/Silicon Based Solar Cells

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As the demand for more efficient and cheaper solar cells increased, the integration of carbon nanotubes and solar cells has become the center of discussion. The purpose of this research was to achieve photovoltaic conversion from high-density p-n junctions formed between single-walled carbon nanotubes (SWNTs) and n-type silicon (n-Si). It was hypothesized that the use of a nitric acid treatment would improve the power conversion efficiency of the devices, due to the formation of new functional groups on the CNTs. This was tested by forming silicon dioxide through dry oxidation and depositing titanium and gold via various techniques, upon which hydrofluoric acid and nitric acid-hydrochloric acid solutions were used for etching, respectively. Upon forming CNT films of various volumes, they were lifted onto the silicon substrate and current-voltage measurements were taken from a solar simulator. The results indicated that under dark conditions, the devices resembled p-n diodes, indicating that high density p-n junctions did form there. Device-1250 (1250 µL of CNT solution) achieved the highest power conversion efficiency before and after the nitric acid treatment due to a balance between conduction and transparency. The use of the nitric acid treatment increased the power conversion efficiency of Device-1250 by nearly 83% and by 113% for Device-500, the highest percentage increase for all of the devices. Thus, the hypothesis was supported as high density p-n junctions, decrease in series resistance, increase in shunt resistance, and formation of new functional carboxyl groups occurred as a result of the nitric acid treatment.

Awards Won:
Third Award of $1,000