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Randomly Casted Single-Wall Carbon Nanotubes Films for High Performance Hybrid Photovoltaic Devices

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Abstract : Single-wall Carbon nanotubes (SWCNTs) possess an unprecedented combination of unique properties that make them highly promising for suitable for a new generation of photovoltaic (PV) devices. Prior to discussing the integration of SWCNTs films into effective PV devices, we will briefly highlight our work on the synthesis of SWCNTs by means of the KrF pulsed laser deposition technique, their purification and transfer onto n-silicon substrates to form p-n junctions. Some of the structural and optoelectronic properties of SWCNTs relevant to PV applications will be emphasized. By varying the SWCNTs film density (µg/cm2), we were able to point out the existence of an optimum value that yields the highest photoconversion efficiency (PCE) of ~10%. Further control of the doping of the p-SWCNTs films, through their exposure to nitric acid vapors, along with the insertion of an optimized hole-extraction-layer in the p-SWCNTs/n-Si hybrid devices permitted to achieve a PCE value as high as 14.2%. Such a high PCE value demonstrates the full potential of these p-SWCNTs/n-Si devices for sunlight photoconversion. On the other hand, by examining both the optical transmission and electrical conductance of the SWCNTs' films, we established a figure of merit (FOM) that was shown to correlate well with the PCE performance. Such a direct relationship between the FOM and the PCE can be used as a guide for further PCE enhancement of these novel p-SWCNTs/n-Si PV devices.

Keywords : carbon nanotubes (CNTs), CNTs-silicon hybrid devices, photoconversion, photovoltaic devices, pulsed laser deposition
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