# Dye Sensitized Solar Cell Based on Polyaniline - Carbon Nanotubes Composite

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The advantages of the sensitized solar cells are high optical absorption coefficients, compatibility with plastic substrate, low-temperature production, and low cost. A typical dye sensitized solar cell (DSSC) makes use of a photoanode based on a porous layer of semiconducting titanium dioxide ($TiO_2$) nanoparticles, photosensitized by a dye (e.g. a ruthenium polypyridyl complex), and deposited on a conductive glass substrate. After sunlight absorption, the photo-generated electron in the dye is transferred to the conduction band of the $TiO_2$ where it moves toward the back contact to finally enter the circuit. The dye is then regenerated from its oxidized form by electron transfer from iodide ions ($I^-$) dissolved in the electrolyte that permeates the porous $TiO_2$ nanoparticles structure. The tri-iodide ions ($I_3^-$) formed in the dye regeneration process diffuse through the liquid electrolyte to the cathode, where they are reduced back to $I^-$, to complete the cycle [1].

It is well known that polyaniline (PANI) is one of the most promising conducting polymers. Due to its high electrochemical activity, environmental stability and low cost, PANI materials have been employed to fabricate efficient counter electrode in DSSCs [2].

Carbon nanotubes (CNTs) are a novel carbon allotrope that possesses structural and electronic properties that are unique from other carbon allotropes, such as graphite, fullerene, and diamond [3]. Carbon nanotubes (CNTs) have shown significant potential to be used in a wide variety of many applications on the basis of their remarkable mechanical and electronic properties [4-8]. CNTs have highly $\pi$-conjunctive and hydrophobic sidewalls consisting of $sp^2$ carbons [9], which enable them to be incorporated in organic solar cells.

Recently, there is a large interest to incorporate carbon nanotubes (CNTs) into organic solar cells because of the unique electrical properties of CNTs. For example, CNTs were used as electron acceptors in the photoactive layer of the solar cells [10]. Also, CNTs were used as transparent anodes in order to replace the prevailed wildly used indium tin oxide (ITO) [11].

The CNTs blended PANI base counter electrode and ruthenium dye sensitized $TiO_2$, prepared using hydrothermal method, photoelectrode were assembled to form DSSC. Different compositions of counter electrodes, such as (ITO/PANI, ITO/PANI/CNT and ITO/PAN-CNT/graphite), were fabricated and evaluated. The electrical properties of the fabricated solar cells were investigated by measuring the current density–voltage (*J–V*) under both darkness and illumination conditions. It is found that there is improvement in the performance of DSSC which has PANI-CNTs compared with that fabricated without CNTs. In addition, presence of graphite layer onto the PAN-CNT enhanced open circuit voltage, current density short circuit and energy efficiency to be Voc 0.52 V, 8.2 mA/cm$^2$ and 1.8%, respectively.

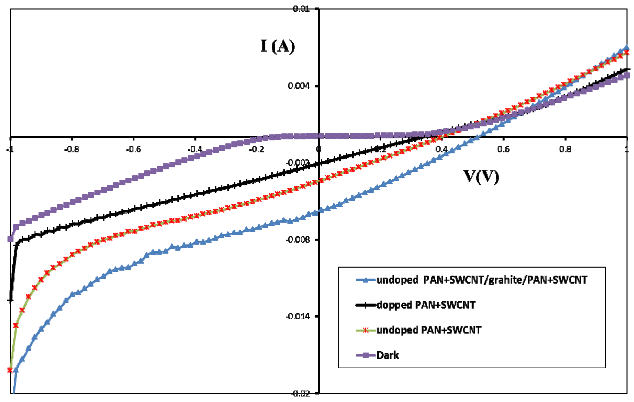


**Figure 1**: (I-V) curves for nanocomposite solar cells

## References

1. K.T. Dembele, R. Nechache, L. Nikolova, A. Vomiero, C. Santato, S. Licoccia, F. Rosei, Effect of multi-walled carbon nanotubes on the stability of dye sensitized solar cells, Journal of Power Sources 233 (2013) 93-97.

2. Guiqiang Wang, Wei Xing, Shuping Zhuo, Electrochimica Acta 66 (2012) 151– 157.

3. Iijima S. *Nature* 354 (1991) 56–8

4. Dai H., Hafner J. H., Rinzler A. G., Colbert D. J. and Smalley R. E. *Nature* 384 (1996) 147–50

5. Choi W. B. *et al Appl. Phys. Lett.* 75 (1999) 3129–3131

6. Liu C., Fan Y. Y., Liu M., Cong H. T., Cheng H. M. and Dresselhaus M. S. *Science* 286 (1999) 1127–1129

7. De Pablo P. J., Graugnard E., Walsh B., Andres R. P., Datta S. and Reifenberger R. *Appl. Phys. Lett.* 74 (1999) 323–325

8. Wei Y. Y. and Gyula E. *Appl. Phys. Lett.* 76 (2000) 3759–3761.

9. Abdel-Fattah T., Siochi E. and Crooks R., *Fullerenes Nanotubes Carbon Nanostruct.* 14 (2006) 585–594.

10. Berson S., De Bettignies R., Bailly S., Guillerez S., Jousselme B., *Adv. Funct. Mater.* 17 (2007) 3363–3370.

11. Kyamakis E., Stratakis E., Koudoumas E., *Thin Solid Films* 515 (2007) 8598–8600.