

DEVELOPMENT OF PHOTOVOLTAIC TEXTILES (SOLAR TEXTILES) BASED ON CARBON NANOTUBE YARNS TO PRODUCE ELECTRICITY FROM SUN LIGHT

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The need for energy has been increasing with the increase of world population and consumption and this is one of the most difficult problems to be solved by mankind. The solutions should be environmentally friendly and without exhausting the limited resources. Therefore, many researchers have been working on this problem. As a result of these efforts, the 21st century will become the fossil fuels replaced with renewable clean energy resources.

This work aims at contributing to the solution of the problem by incorporating the two essential elements for mankind- the sun and textiles. There are some attempts to cover such a need but they are no further than basic application of solid solar panels on textile surfaces. This study presents the results of development of weavable Dye Sensitized Solar Cells (DSSC) produced by flexible yarns of conductive multiwalled carbon nanotubes (MWNTs) leading to the power conversion efficiency above 3%. This was achieved with a specific design and careful consideration of the yarn function in the DSSC so that a textile surface producing its own energy would become a reality.

The current available studies for such an aim are quite new and limited. In addition to that, mainly rigid wires or similar materials have been used and efficiency levels are low. Cai et al. obtained 1.9% efficiency with all-carbon electrode-based fiber-shaped dye-sensitized solar cells. Francis et al. managed to accomplish 1.76% efficiency with electro-spun rutile fibres. Hou et al. achieved as high as 5.5% efficiency by wrapping carbon fibre/PEDOT:PSS electrode along a Ti wire based photonode. Lv et al. designed a fiber-shaped DSSC by using TiO₂ coated Ti wire as electrode and Pt wire as counter electrode reaching efficiency of 5.05%. In another work, Lv et al. studied the effect of electrolyte refreshing effect on the photoelectrochemical performance of fibre-shaped DSSCs. Law et al. achieved 1.5% efficiency with their nanowire DSSCs. Chen et al. obtained 2.94% efficiency with their CNT fiber based DSSCs. These works show that there are just a few studies on real fiber DSSCs. The highest efficiency obtained with CNT fiber based DSSCs was 2.94% that showing the need for further studies on weavable solar cells which was the motivation of this work.

This work includes main stages of carbon nanotube yarn production, preparatory processes for electrodes, preparation of solar cells and testing by a solar simulator. By this presented MWNT based photovoltaics, 3.4% PCE value was obtained which is the highest level reached in literature. Also, new designs and improvements studies on the system have been explained.

Keywords: Flexible DSSCs, Photovoltaics, MWNTs

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