Preparation and characterization of TiO_2 coated carbon nanotube carpets as photoanode in dye sensitized solar cell

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One of the biggest challenges in the twenty-first century is undoubtedly the energy conversion and its storage. Dye-sensitized solar cells (DSSC) have been developed since 70s and are highly promising and cost-effective alternative to silicon photovoltaic.

Dye-sensitized solar cells (DSSC) are complex systems and contain several different components: optical transparent electrodes, semiconductor nanoparticles, coordination compounds, inorganic salts and metallic catalysts. Each component has its own function within the solar system. Nevertheless, the main goal is to transfer solar energy into electricity in the most efficient way. To enhance electron transfer in the most productive way in the DSSCs system, a photoanode using TiO_2 coated multiwall carbon nanotube carpet (TiO_2-CNTs) was prepared.

Carbon nanotubes (CNTs) within the solar system provide a promising alternative to commonly used materials due to their high electrical conductivity, corrosion resistance, excellent electrocatalytic activity and lower production costs. It is expected that increase of the specific surface area by adding CNTs to the systems combined with organic dye will enhance several parameters (power conversion efficiency (η), photocurrent density (J_{sc}), open-circuit voltage (V_{oc}), and fill factor (FF)).

Large thickness of the photoanode determines an increase of recombination processes and, thus, a lower charge transfer resistance. The optimal 10μm thick photoanode was used within the DSSC system. Thereupon thin carpet of CNTs was prepared using focused ion beam (Fig. 1a).

Thin films of amorphous TiO_2 were homogenously coated onto the surface of CNTs carpet using atomic layer deposition (ALD). The structure and the surface morphology of the samples were characterized using scanning electron microscopy and transmission electron microscopy (Fig. 1b, 1c). The obtained results prove illustrate that ALD can provide a useful method to deposit electrode materials on high surface area substrates for dye sensitized solar cell.

The electrochemical impedance spectroscopy (EIS) is employed to investigate the electron transport properties such as effective electron lifetime (τ_{eff}), effective electron chemical diffusion coefficient (D_{eff}), and effective electron diffusion length (L_n).

The development of the TiO_2-CNTs and organic dyes hybrids with satisfactory parameters like stability, durability, non – corrosive and cheap DSSC is being developed in our studies.

First model of DSSC was designed and fabricated and first results was achieved and are very promising.

References

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Figures

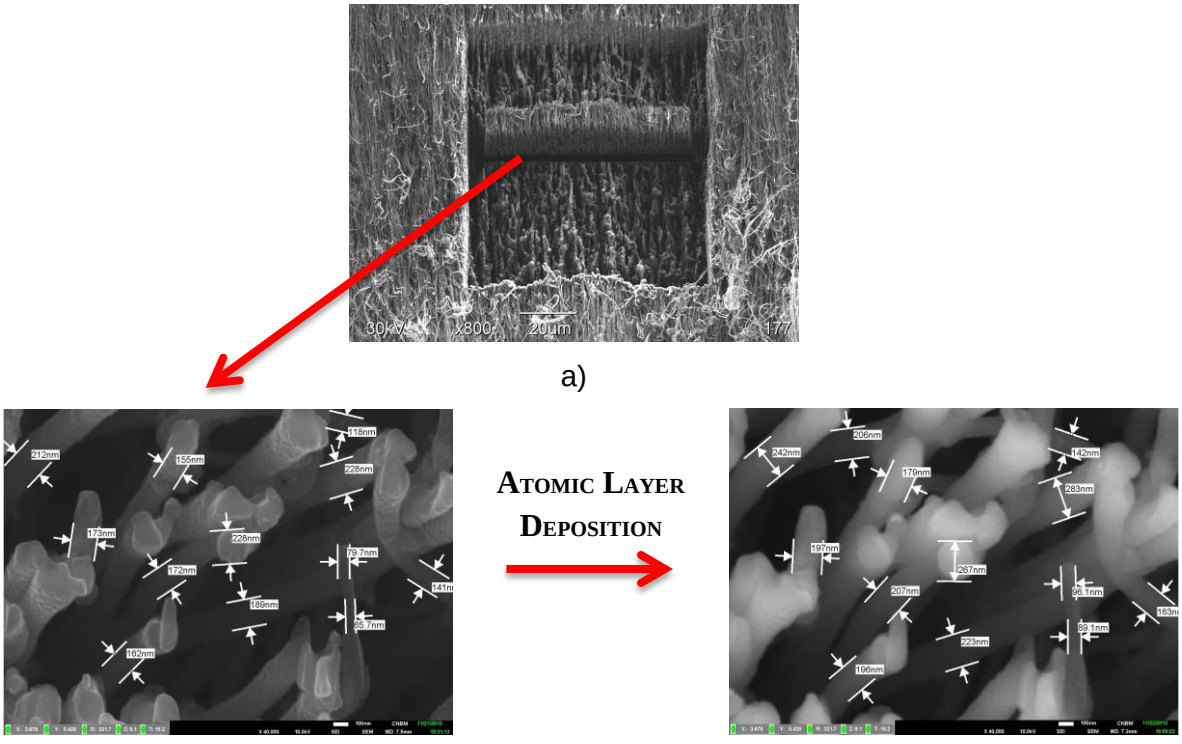

Fig. 1 SEM micrograph for MWNTs carpet a), b) before and c) after Atomic Layer Deposition of TiO_2