PREPARATION OF ZnO NANOWIRES FOR SOLAR CELLS APPLICATION

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ABSTRACT

In this work we have synthetized ZnO nanowires and composite ZnO-carbon nanotubes (ZnO-CNT) films for application as photoanode in solar cells. The films were synthetized in two steps. In the first one, a seed layer was deposited on FTO coated glass wafer using a Pechini solution. In the second step ZnO nanowires and ZnO-CNT (0.1%wt) was grown by microwave assisted hydrothermal on these tin layer. The results show incorporation of CNT in ZnO nanowires films and it is a promisor material for solar cells.

Key worlds: solar cells, zinc oxide, carbon nanotubes

INTRODUCTION

So far, the most successful dye-sensitized solar cells have been produced using TiO_2 nanoparticles combined with ruthenium polypyridine complex dyes. However, ZnO has emerged as a promising alternative to replace TiO_2, with marked improvements in performance of the cells produced based on ZnO. The band gap and electron affinity of the ZnO and TiO_2, are very similar, however, the ZnO has higher electron mobility. ZnO also has a lower density of states in the conduction band, which promotes the rate of injected electrons as compared to the TiO_2. Thus, the potential use of the ZnO solar cell includes good electron transport and rapid transfer of load due to high electron mobility, 2-3 orders of magnitude higher compared with anatase TiO_2 (1-3). Carbon nanotubes are promising materials of their exceptional electrical properties, thermal stability, high surface area, and tubular structure. The introduction of CNT, single-walled (SWCNT) or multi-walled (MWCNT) tubes, as electrodes in organic solar cells and DSSC has already been carried out. There is a general agreement that CNT can efficiently enhance the transport of electrons and holes, besides providing a higher surface area and electronic conductivity, which confers higher photoconversion efficiency for these solar cells (4). Thus, this paper presents the synthesis and characterization of ZnO nanowires and composite ZnO-CNT films for application in solar cells.

OBJECTIVE

The aim of this present study is to incorporate carbon nanotubes in ZnO films in order to obtain good photo electrodes to solar cells, enhancing the transport of electrons and holes and consequently the efficiency of these devices.

EXPERIMENTAL

Firstly, a precursor solution of ZnO was prepared by Pechini method using zinc nitrate, citric acid and ethylene glycol. This solution was deposited by sin coating, 3000rpm for 30s on FTO coated glass wafer. After that, these films were treated in oven at 500°C for 1h.

ZnO nanowires were synthetized by microwave assisted-hydrothermal synthesis on ZnO thin layer. We used zinc acetate and hexamethylenetetramine at 160°C and 1h to obtain ZnO nanowires.

Furthermore, 0,1%wt of CNT (provided by collaborators) was added in hydrothermal synthesis of ZnO nanowires and we used the same conditions reported above.

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The characterizations of the films were performed by thermogravimetric analysis, X-ray diffraction and high resolution scanning electron microscopy (FE-SEM).

RESULTS

The termogravimetric (TG/DTA) analyses of precursor polimeric solutions were realized. The results of TG showed the temperature of ZnO phase crystallization and DTA shows the mass loss about the endothermic and exothermic processes.

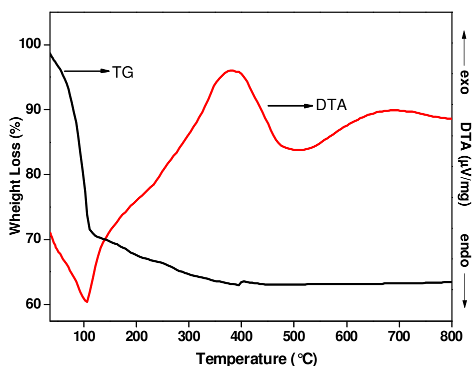

Fig. 1- TG and DTA curves of Zinc precursor

X-rays patterns of ZnO nanowires showed the peaks relating to the crystallization of zinc oxide. It was not possible to observe patterns relations with carbon nanotubes.

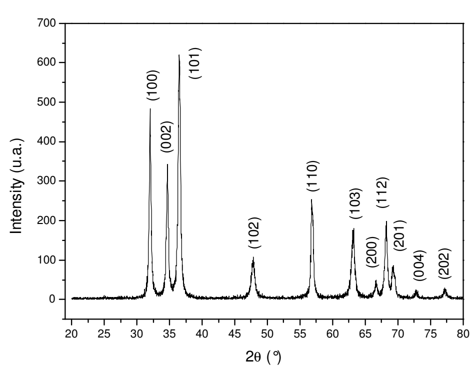

Fig. 2- XRD patterns of ZnO nanowires powders.

FE-SEM images of ZnO catalyst layer showed the precursor layer composed of uniform nanoparticles and was possible to observe the homogenous covering.

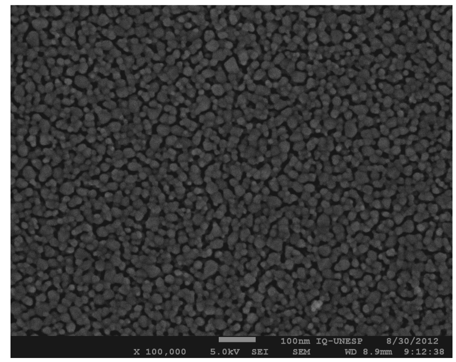

Fig. 3- FE-SEM images of ZnO catalyst layer

Figure 4 shows the ZnO morphology grown by microwave assisted hydrothermal synthesis. The wires were obtained using 1 hour synthesis time at 160ºC.

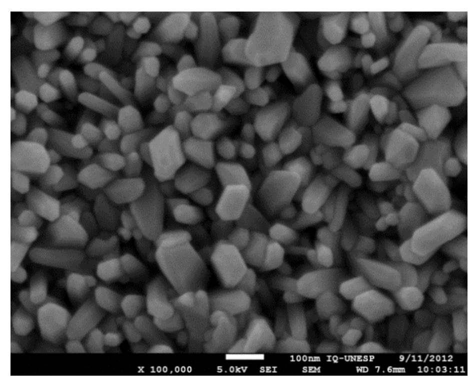

Fig. 4- FE-SEM images of ZnO nanowires.

The films composite ZnO-CNT were characterized by FE-SEM. The image shown the presence of carbon nanotubes incorporated on Zno wires.

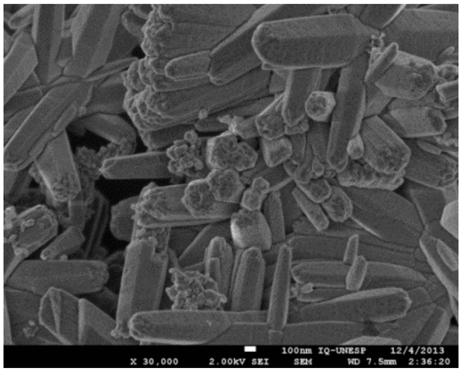

Fig. 6 FE-SEM images of ZnO nanowires-CNT

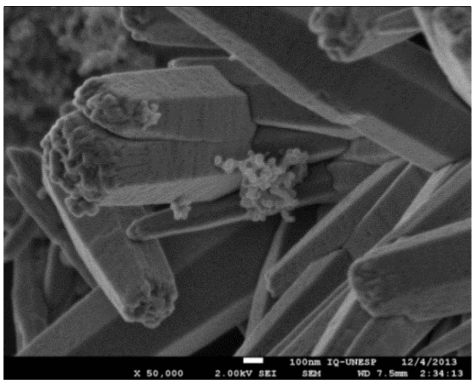

Fig. 7- FE-SEM images of ZnO nanowires-CNT

CONCLUSIONS

In this work we have synthesized a composite ZnO-CNT and this interesting photoelectrode is a promisor material to be used in solar cells.

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