EFFECT OF ETHYLENE GLYCOL ON MORPHOLOGY, CRYSTALLINITY, AND OPTICAL PROPERTIES OF WO_3 NANOWIRES

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Abstract

Dye-sensitized solar cells (DSSC) are at the forefront of research on photovoltaic devices with advantages such as the requirement of mostly abundant materials from earth, respectable efficiencies, low level requirement of high-temperature material processing, and the simplicity of cell assembly [1]. To the best knowledge of the authors, to date the most efficient n-type DSCs are based on TiO_2 with efficiency approaching 12% [2]. As an n-semiconductor and a kind of transition metal-oxide, tungsten trioxide (WO_3) is known as a multi-functional material with perfect performances of gas-sensitivity, catalysis, electrochemical capacity and DSSC [3]. WO_3 itself is an extremely stable material that can survive most harsh environments such as exposure to strong acids. The carrier mobility of WO_3 is also reported to be within the range of TiO_2. Furthermore, WO_3 can be obtained in a number of nanostructured forms such as nanoporous nanoplatelets, nanoparticles, and nanowires to increase the surface to volume-to-ratio for maximum dye loading.

Aims

- ***The aim of this work is to report a facile technique for the synthesis of WO_3 using hydrothermal method with various volume ratios of ethylene glycol to water, and the effects of EG on the morphology, crystallinity, and optical properties of WO_3 were investigated.***

Experimental

1. Synthesis of WO_3 powder

The WO_3 were prepared using 0.2 g of ammonium paratungstate ($(NH_4)_{10}(H_2W_{12}O_{42})\cdot xH_2O$) in 18 mL of of distilled water. Ethylene glycol was introduced in various quantities from 2mL to 12 mL. The pH was ajusted at 2 with 100 µL of nitric acid. The obtained solution was transferred into Teflon-line autoclave with a volume of 45 mL. The autoclave was placed on a magnetic stirrer to stir for 2 hours. Finally, the teflon-bomb autoclave was kept at 250 °C using a reaction time 3h. The autoclave was cooled down to room temperature naturally. The precipitate was filtered and washed with deionized water and then, the product was dried at 80 °C for 1h.

2. Characterization of WO_3 powder

The structure of products was determined by powder X-ray diffraction (XRD) PW 3040/60 X'Pert PRO using Cu-Kα radiation with (λ=1.5418Å), in the range 2θ = 10 - 80°. **The morphology** of WO_3 nanocrystals was observed using a Scanning Electron Microscope Inspect S (SEM/EDAX) and a Transmission Electron Microscope (TEM, Titan G2 80-200).

The diffuse reflectance spectra (DSR) was obtained using a Lambda 950 UV-Vis-NIR Spectrophotometer with 150 mm integrating sphere in the wavelength range of 400–800 nm.

Results and discussion

X-Ray Diffraction

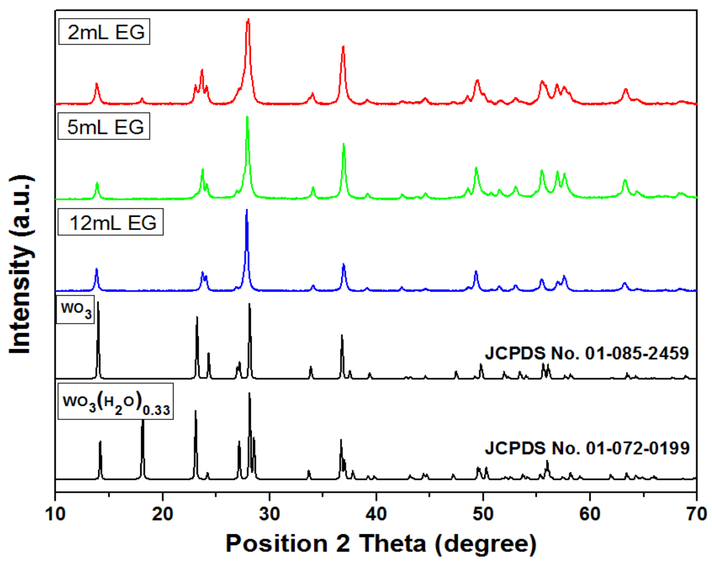

Figure 1. *Room temperature X-ray diffraction patterns of WO_3 with different concetration of EG*

Optical band gap

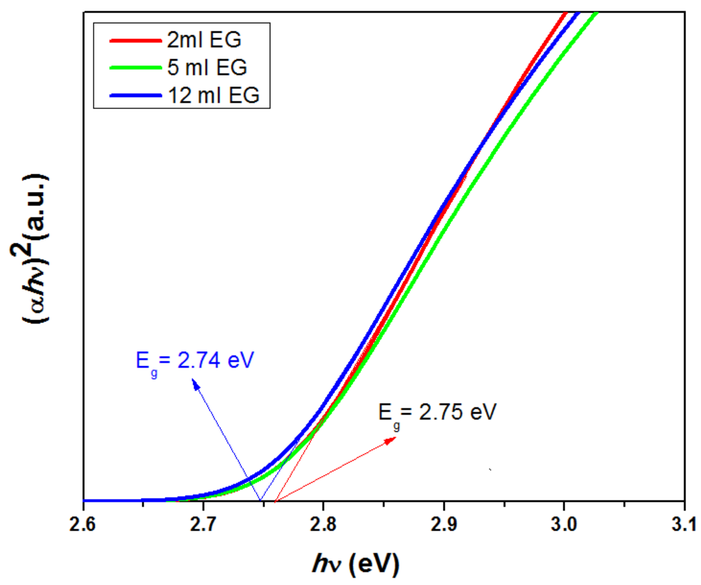

Figure 2. *Band gap of WO_3 with different concetration of EG*

SEM images

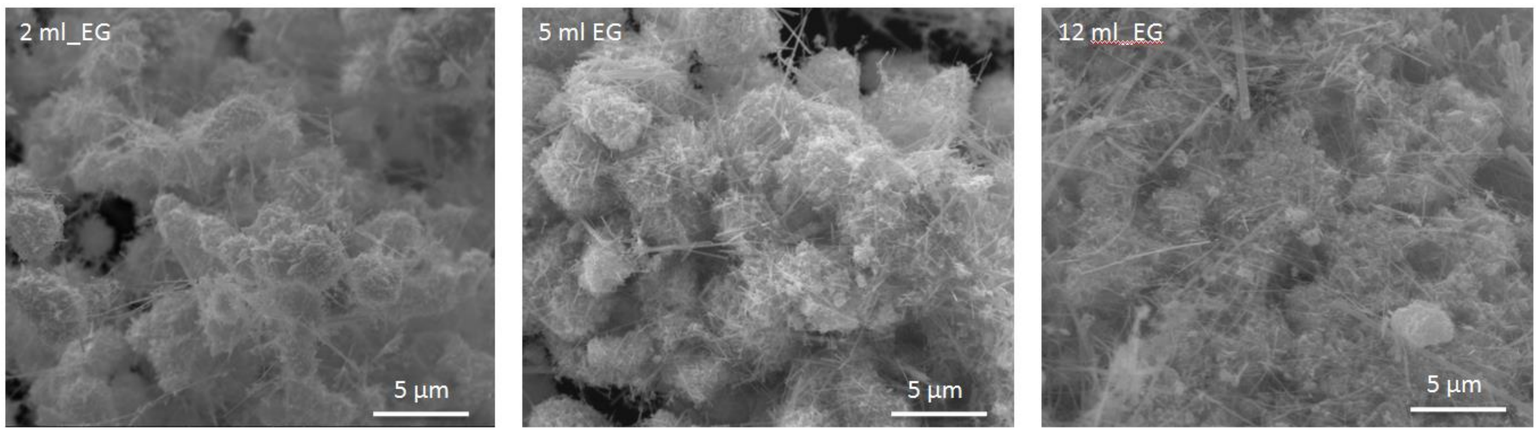

Figure 3. *SEM image of WO_3 with different concetration of EG*

Conclusions

- ***In summary, WO_3 nanostructure (nanowires), has been successfully synthesized via a facile one-step hydrothermal methods using various quantities of EG.***
- ***From XRD patterns the crystallinity of WO_3 nanowires was improved by increasing the quantities of EG***
- ***SEM images shows that with increasing quantities of EG, increase the length of the nanowires. Thus, the pure phase of the compound WO_3 is formed without impurity of $WO_3(H_2O)_{0.33}$***
- ***The band gap of the WO_3 nanowires decreases, with increasing quantities of EG from 2.75 eV for 2 ml EG, to 2.74 eV for and 12 ml EG.***

Acknowledgment

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References

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