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Investigation of ZnO nanotetrapods at different evaporation temperature prepared by thermal-CVD method for OLED applications

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ABSTRACT – An organic semiconductor have been discovered for various applications such as in organic light-emitting diodes (OLEDs). The metal oxides such as zinc oxide (ZnO) provide an interesting alternative for conventional low work function metals as electron injection layer in OLEDs. This study focuses the preparation of ZnO nanotetrapods at different evaporation temperature using thermal chemical vapor deposition (CVD). These will provide better performance and suitable for optoelectronic device.

1. INTRODUCTION

The developments of optoelectronic are widely used until today due to environment-friendly and good performance device. Organic light emitting diodes (OLEDs) was showed a good potential as solid state lighting source. OLED have been intensively investigating for the last decade, because it have many potential applications such as optoelectronics [1]. The inorganic material has been introduced in organic light emitting diodes (OLEDs) because of LED emission in the UV and visible region due to its extrinsic and intrinsic defect [2]. The shape and dimensionality is important role in properties and application of nanomaterial.

The fabrication of ZnO nanotetrapods was done by thermal-CVD. The thermal-CVD has preferred used in this work due to simple preparation, simpler crystal growth technology and give high performance solid material. The objective of this paper is to investigate the optical properties of various evaporation temperatures of ZnO nanotetrapods using thermal-CVD.

2. METHODOLOGY

2.1 Synthesization of ZnO Nanotetrapods

ZnO nanotetrapods were synthesized and grown using thermal-CVD in a horizontal quartz tube. 1g of zinc powder (99.9% purity; Sigma-Aldrich) was placed in an alumina boat at the centre of the tube of furnace 1 and furnace 2. The zinc powder was spread in the boat at furnace 1 as indicate in Fig. 1. The temperature of furnace 1 was set at 750°C while furnace 2 was increased to 500°C in order to control growth temperature of ZnO nanotetrapods. The oxygen gas was supplied into the tube at flow 5 sccm. The growth time was 30 minutes under a constant flow of 100 sccm of argon gas with pressure of 1bars. The furnace cooled down to room temperature.

2.2 Characterization Technique

The surface morphology has been characterized using field emission scanning electron microscope (JEOL JSM-J600F). The photoluminescence (PL) for ZnO nanotetrapod was characterized by using FlouroMax3 Horiba Jobin Vyon. The crystalline structure of ZnO nanotetrapod was analyzed by X-ray diffraction (XRD, Broker AXS D8 Advance with Cu Kα radiation).

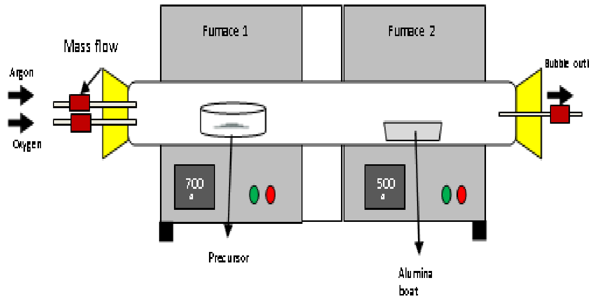

Figure 1 Thermal-CVD process.

3. RESULTS AND DISCUSSION

The (0 0 2) diffraction peak was most dominant at temperature 750°C. It can be seen that the higher intensity were high purity and crystallinity of the obtained product [3]. There are no diffraction peaks corresponding to other impurities are detected. The crystalline quality of the sample is depending on evaporation temperature of ZnO.

Surface morphology of synthesis of ZnO nanotetrapods by thermal chemical vapor deposition was obtained using field emission scanning electron microscopy (FE-SEM). The nanotetrapods become bigger as the evaporation temperature increased. When zinc reacted with oxygen, it can attribute to the thermodynamic equilibrium and kinetically controlled progress. The morphology of ZnO nanotetrapod depends on the evaporation temperature, substrate temperature and evaporation time [4]. When it appears to 750ºC, the vapors were depleted of reacting species to form the hexagonal arms and needles of ZnO nanotetrapods [8].

Table 1 Length and diameter of ZnO nanotetrapods.

ZnO nanotetrapods at different evaporation temperature (ºC)	**Length of ZnO nanotetrapods (nm)**	**Diameter of ZnO nanotetrapods (nm)**
700	342	34.4
725	356	37.3
750	481	68.4

Photoluminescence (PL) spectra of ZnO nanotetrapods were measured at room temperature in the wavelength range of 325 nm to 700 nm. There are two emission peaks of a narrow peak at 384 nm as UV emission and a broad peak at 529 nm as green emission. The UV emission is related to near band edge emission of the wide bandgap where the recombination of free exciton through an exciton-exciton collision process [3, 5]. The UV emission efficiency of ZnO is dependent on the crystalline quality. The visible emission occurs due to defect of oxygen vacancy and crystallization of ZnO.

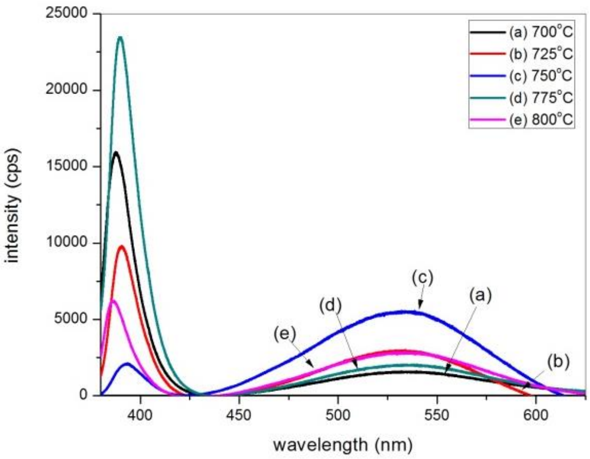

Figure 2 Photoluminescence of ZnO nanotetrapods at different evaporate temperature.

4. CONCLUSION

In this paper, the ZnO nanotetrapods were successfully prepared using thermal-CVD at different evaporation temperature. This study focuses the optimum of ZnO nanotetrapods with temperature 750ºC to obtain the high intensity and conductivity as well. This parameter will be implied for the fabrication of MEH-PPV: ZnO nanocomposite for OLED device.

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