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ZINC OXIDE NANORODS AS ELECTRON TRANSPORT LAYER IN MEH-PPV/ZnO ORGANIC LIGHT EMITTING DIODES

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ABSTRACT

This thesis discusses on the development of zinc oxide (ZnO) nanorods for the application as electron transport layer in MEH-PPV/ZnO Organic Light Emitting Diode (OLED). In general, the mobility of holes is higher than electrons in most semiconducting organic material. Therefore, it is essential to develop an efficient electron transport layer in order to balance out the number of carriers, hence increases the efficiency of the device. Furthermore, combining inorganic material with organic material in a device can take advantages of both materials. The thesis work involved three main parts for the fabrication of MEH-PPV/ZnO OLEDs. The first part was the deposition of novel layer-by-layer ZnO seeded catalyst. High (0 0 2) *c*-axis ZnO seed catalyst was prepared using simple and low cost method of sol-gel spin coating technique. Layer-by-layer method was applied in the deposition of the ZnO seed catalyst layer, which is defined by annealing of every layer of the thin film. The second part involved the growth of ZnO nanorods using thermal chemical vapour deposition (TCVD) method by employing vapour-solid (VS) mechanism, without using pump vacuum to control the pressure in the tube. Using single furnace TCVD, substrate positions with a distance of 3 cm from the zinc powder, at an oxygen flow rate of 5 sccm and temperature of 825^{o}C were found to be the optimum conditions for the growth of the ZnO nanorods in this study. The characterization revealed that the nanorods had low resistivity of 5 x 10^{-2} Ω-cm at highest (0 0 2) crystalline structure. This strongly indicates that the ZnO nanorods had good electrical behaviour which can transport electrons more efficiently in the device. Third part involved the study of MEH-PPV thin films dissolved in non-aromatic solvent such as 1,2 dichlorobenzene and toluene to produce p-type conducting emissive layer. With an optimum solution concentration of 5 mg/ml, highest photoluminescence (PL) spectrum was produced with an emission centred at 590 nm. From the optimized thin films, OLEDs were fabricated. As a conclusion, by combining the ZnO nanorods with MEH-PPV in the OLEDs had improved the electrical characteristics of the device compared to single layer MEH-PPV based device. The fabricated device worked as a diode; which showed a rectifying current. The lowest turn on voltage was found to be at 0.4V using the ZnO nanorods grown at temperature of 825^{o}C. At this deposition temperature, the Schottky barrier height was 0.59 eV, with an ideality factor of 12.91. The OLEDs were also tested using electroluminescence (EL) spectroscopy to prove the devices' functionality. The EL emission spectra were found to match with the PL emission for both ZnO and MEH-PPV thin films.