Controlled Growth of Vertically Aligned ZnO Nanorod Array Via Polymer Assisted Hydrothermal Method

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Abstract

Hydrothermally synthesized vertically aligned Zinc Oxide (ZnO) Nano rod array are widely used in semiconductor device applications including LEDs, transducers, sensors and solar cells. It is an interesting material for third and fourth generation solar cells due to its thin and aligned morphology which increases the effective surface area and improve charge transport. The aspect ratio of the nanorods found to be a critical parameter for most of the device application particularly towards solar cell applications.

In this work, we report a simple solution process method to control the aspect ratio of the nanorods by a modified hydrothermal synthesis. ZnO nanorods were fabricated on a 100 nm ZnO thin film coated glass substrate. The growth solutions were prepared by mixing 100 ml of 50 mM Zinc acetate ($Zn(CH_3COO)_2{\cdot}2H_2O$) and 100 ml of 50 mM hexamethylenetetramine ($(CH_2)_6N_4$) (HMT). Polyethylenimine (PEI) with molecular weight of 600 was used as a controlling agent. Growth were carried out different times. Resulting Nano rods were characterized using Scanning electron microscopy (SEM), X-ray diffraction (XRD) and UV-vis spectroscopy (UV-vis). Resulting Nano rods exhibited vertical orientation and uniform distribution on the substrate with a hexagonal cross section. XRD confirmed that these nanorods grown with and without PEI show highly crystalline hexagonal wurtzite phase. We found that the aspect ratio of the nanorods increased when PEI is added to the growth solution. The average diameter and length of ZnO Nanorods were determined as 60 nm and 125 nm with and without PEI in to the growth solution. The length of the Nanorods was determined as ≈1 µm to ≈5 µm with and without PEI respectively. The variation of aspect ratio with and without PEI with growth time will be discussed in the presentation