Zinc Oxide Nanorod Arrays Based Dye-Sensitized Solar Cells and Its Photovoltaic Performance in Indoline Dye System

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Dye-sensitized solar cell (DSSC) is one of the most successful devices that takes advantage of nanostructures to accomplish efficient solar-to-electric power conversion[1]. The key component of a DSSC is a photoanode comprised of a film of sintered oxide semiconductor nanoparticles (TiO_2) coated onto a transparent conducting oxide (TCO) substrate. Nano-sized TiO_2 particles, however, have many traps hindering electron mobility[2].

Among the various semiconductor materials, Zinc oxide (ZnO), a presentative II-VI group compound semiconductor with a direct wide bandgap of 3.37eV and large exciton binding energy of 60 meV, is an important electronic and photonic material and has attracted considerable attention[3].

1D nanostructures, such as nano-wires and nanotubes have been extensively used, as the aim is expected to significantly improve the electron transport efficiency in the photoelectrode films by providing a direct conduction pathway for the rapid collection of photogenerated electrons and, therefore, reduce the number of interparticle hops[4].

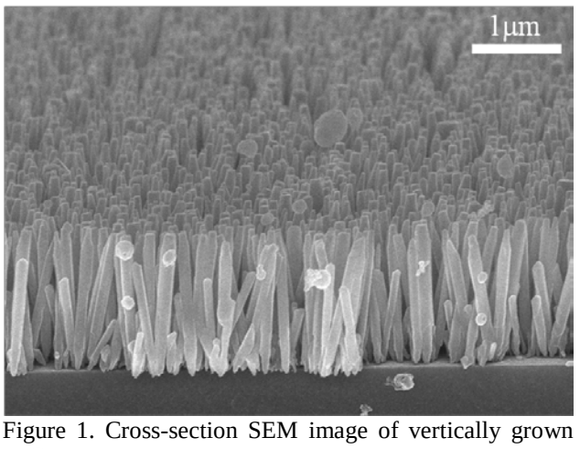

Figure 1. Cross-section SEM image of vertically grown ZnO

In this study, the arrays of ZnO nanorods were synthesized on seeded FTO substrates by immersing the seeded substrates in aqueous solution. Then, synthesized samples were immersed into prepared solution for 60min. Sandwich type of DSSC were fabricated by covering counter electrode on the dye-adsorbed ZnO based photoelectrode and two electrodes were held with a clip. Then the gap of the two electrodes was filled with the electrolyte consisting of 0.5mol LiI, 0.05mol I2, 0.5mol tert-butylpyridine and acetonitrile/propylene carbonate with 1:4 [v/v%].

The morphologies of synthesized samples were characterized by FE-SEM and TEM. The photovoltaic performance of DSSC was carried out by measuring the J-V characteristic curves under a simulated solar illumination of 100 mW/cm2. The electrochemical impedance spectroscopy (EIS) was carried out by Iviumstat. The EIS was obtained at open circuit potential at frequencies ranging from 10^{-1}Hz to 10^5 Hz. Electron transport time, diffusion coefficient and recombination rate were measured by intensity modulated photocurrent spectroscopy (IMPS) and intensity moduylated photovoltage spectroscopy (IMVS).

References

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