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Photovoltaic Performance of Vertically Aligned ZnO Nanowire Based Dye Sensitized Solar Cells

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1. Introduction

Harvesting solar energy with inexpensive materials and manufacturing methods has become an important challenge. The most promising one amongst the alternative approaches has been the TiO_2 nanoparticle-based dye sensitized solar cells (DSSCs) with efficiencies exceeding 10%. ZnO has a similar band gap and an electron affinity to TiO_2, and ZnO based DSSCs have shown the second highest efficiencies (ca. 5%) after TiO_2. Also, ZnO wurtzite structure can form ZnO nanowires and nanostructures with a large variety of morphologies that are accessible many kinds of growth methods.

2. Experimental

ZnO nanostructures were synthesized on FTO substrates using a simple waterbath procedure. The seed solution was made by mixing 5 mM zinc acetate in 20 ml acetone under vigorous stirring for 15 min. The FTO substrates were dipped into the solution to form a thin seed layer. Post annealing of the seed layer was done at 200°C for 2 hours. The ZnO nanowire were grown in a sealed waterbath containing 5 mM zinc acetate and 5 mM hexamethylenetetramine at 90 ^{o}C. This process synthesized ZnO films with a thickness around 1-2 μm. The post-treatment using $TiCl_4$ will be applied to modify the nanostructures.

3. Results and Discussion

One of the disadvantages of ZnO in the application for DSSCs is a high recombination rate. The purposes of this research are to reduce the recombination rate and to improve the electron transportation. From the previous study of nano-arrays structures, the post-treatment could improve the cell's performance from 1.9% to 2.5% in the energy conversion efficiency. Figure 1 shows the morphology difference in film microstructure between nano arrays and vertically aligned ZnO nanostructure.

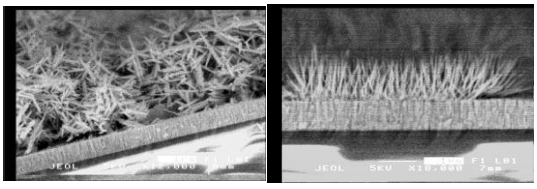

Fig.1 nano arrays (left) and vertically align ZnO (right).

Effects of synthesis parameters, post-treatment on the surface morphology and structural property of the ZnO film will be discussed to improve the photovoltaic performance of ZnO based DSSCs.