TiO$_2$ Blocking Layer for Improving the ZnO-Nanowire Photovoltaic Properties as Dye Sensitized Solar Cells

R. Winantyo$^1$ and K. Murakami$^2$

$^1$Graduate School of Science and Technology, and $^2$Graduate School of Engineering, Shizuoka University

E-mail: rangga-ftui09@hotmail.com

1. Introduction

We are developing the high performance nanostructured ZnO-based DSSC. Our previous results reveal that the open circuit voltage, $V_{OC}$ is improved greatly through a modification of ZnO nanowire configuration, while the short circuit current, $J_{SC}$ remains the same. The improved $V_{OC}$ indicates the suppression of charge recombination at the ZnO surface, which also should increase $J_{SC}$. Our nanostructured ZnO-based photoelectrode consists of FTO substrate, ZnO seed layer and nanostructured ZnO layer. Therefore, the injected electrons from dye into nanostructured ZnO may leak to the electrolyte through the ZnO seed layer. In this study, we are trying to form a dense ZnO or TiO$_2$ layer at the bottom of nanostructured ZnO layer.

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 ethanol under vigorous stirring for 15 min. The FTO substrates were spin coated to form a thin blocking layer and seed layer. Post annealing of the blocking layer and seed layer was done at 400$^\circ$C for 2 hours. The ZnO nanowire were grown in a sealed waterbath containing 5 mM zinc acetate and 5 mM hexamethylenetetramine at 90 $^\circ$C. This process synthesized ZnO films with a thickness around 1-2 μm. The blocking layer should be thin enough, for the electron to tunnel to conductive FTO layer.

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. From the previous study of nano-arrays structures, vertical alignment could improve the cell’s performance. Figure 1 shows the schematic diagram vertically aligned ZnO nanostructure.

Effects of synthesis parameters and structural property of the ZnO film will be discussed to improve the photovoltaic performance of ZnO based DSSCs.