CHAPTER 5

Conclusions and Possible Future Works

5.1 Conclusions

ZnO films are successfully modified using chemical texturing processes including one-step texturing process, two-step texturing process, two-step coating-texturing process and acid vapor texturing process. All the processes exhibit that textured films change in characteristics including physical property, optical property, electrochemical property.

For dye-sensitized solar cells application, the films textured by one-step texturing process with base and acid solution exhibit maximum power conversion efficiency of 2.00% and 2.02%, respectively. The enhanced power conversion efficiency is due to a formation of porous structure which is achieved better dye adsorption. Moreover, an enhanced power conversion efficiency of 2.26% is obtained for the DSSCs fabricated on the two-step texturing process with base and acid solution at texturing time of 2 min and 10 s, respectively. The enhancement is due to a better high-ordered fine porous formation which is observed from a significant increase of small pore size in range of 5-10 nm and confirmed by maximum specific surface area. Thus, the fine porous formation is considerate an important factor for achieving dye adsorption and enhancing power conversion efficiency. For a two-step coating texturing process, it is found that short-circuit current density is successfully increased using two-step coating to increase dye adsorption. Furthermore, fill factor is effectively improved using two-step texturing to create porous films. Thus, the power conversion efficiency and fill factor are 2.28% and 0.51 for the ZnO(acid 10 s)/ZnO(base 1 min) films based DSSC. Moreover, the acid-acid texturing give the maximum PCE of 2.35% with FF of 0.54 for the ZnO(acid 10 s)/ZnO(acid 10 s) films.

A vapor texturing process is demonstrated an effective method for improving dye adsorption and reducing electron recombination which is provided an enhanced power conversion efficiency of dye-sensitized solar cells. Power conversion efficiency is enhanced related to increased short-circuit current density. The short-circuit current density is increased due to an increased dye adsorption which is agreed with the change in pore density. Besides, the short-circuit current density is also increased due to a reduced charge recombination.

Among the texturing processes, the two-step coating-texturing films show the best enhanced power conversion efficiency of 2.35%. It can be described by two improving factors; (i) the thicker films support more dye adsorption which is resulted in higher J_{sc}, and (ii) the texturing films support interfacial contact between ZnO/dye/electrolyte which is resulted in better J_{sc}.

This work demonstrates that texturing processes have ability to create fine porous films for enhancing power conversion efficiency of ZnO dye-sensitized solar cells. The major role of porous films is an achievement of dye adsorption which is observed a significant correlation to power conversion efficiency. While minor roles are increase of light scattering and reduce electron recombination.

5.2 Possible Future Works

5.2.1 Variation of parameters for chemical texturing process such as concentration, temperature and addition of oxidizer to optimize texturing factors.

5.2.2 A shape control of ZnO photoelectrodes by patterning morphology such as pyramid and cone structure via texturing process to achieve light scattering.

5.2.3 Surface modification of ZnO photoelectrodes using physical process such as plasma jet and ions beam for controlling fine surface formation.