CHAPTER 9

CONCLUSIONS AND SUGGESTION FOR FURTHER WORK

Polymer electrolytes based on chitosan-NH_4I, (chitosan-PVA)-NH_4I, (chitosan-PEO)-NH_4I and chitosan-NH_4I-ionic liquid (IL) were successfully prepared by the solution cast technique. The shifting of wavenumber in FTIR studies proved the complexation has occurred between salt and polymer host. Interaction between NH_4I and chitosan was observed by the shifting of amine band from 1561 cm^{-1} to 1513 cm^{-1}, carboxamide band from 1652 cm^{-1} to 1619 cm^{-1} and hydroxyl band from 3346 cm^{-1} to 3351 cm^{-1}. In the (chitosan-PVA)-NH_4I system, the interaction was observed by shifting of carbonyl band from 1734 cm^{-1} to 1713 cm^{-1} other than amine, carboxamide and hydroxyl bands. Apart of amine and carboxamide band, the interaction also occurred at the oxygen atom of the C-O-C band in the (chitosan-PEO)-NH_4I system when the band is found to shifting from 1107 cm^{-1} to 1069 cm^{-1}. The miscibility of the polymer blend was inferred from the hydrogen bonding between chitosan and both PVA and PEO in the respective FTIR spectrum. In the chitosan-NH_4I-IL system, the shifting due to interaction of NH_4I or IL to the chitosan was observed at amine, carboxamide and hydroxyl bands from 1561 cm^{-1} to 1513 cm^{-1}, 1652 cm^{-1} to 1620 cm^{-1} and 3346 cm^{-1} to 3360 cm^{-1}, respectively.

The degree crystallinity of 19.8% is obtained for pure chitosan film and become complete amorphous with addition of 45 wt.% NH_4I. The films obtained by blending chitosan with PVA and PEO are more amorphous compared to the pure PVA and PEO film. The addition of NH_4I makes the blend films more amorphous.

The conductivity of the electrolyte was observed to increase with increasing NH_4I concentration, blending of two kinds of polymer and the addition of ionic liquid. The increase in conductivity can be due to several factors such as:

- Increase in the number density of charge carriers due to the increase in NH_4I concentration and incorporation of ionic liquid.
- The number of transit or complexation sites for ion to conduct has increased due to blending of the two polymer hosts.
- Increase in mobility of charge carriers due to increase in temperature and flexibility of polymer host.

The highest room temperature conductivity for each polymer electrolyte systems follow the order Ch9 < CV5 < CEO7 < CIL5. Transference number measurement confirms that the polymer and polymer blend electrolytes with the addition of NH_4I are ionic conductors.

Fabrication of dye-sensitized solar cells (DSSCs) has been carried out using different type of dyes and electrolyte systems. DSSC using dyes extracted from black rice and Ch9 electrolyte exhibits J_{sc} of 0.006 mA cm^{-2}, V_{oc} of 0.16 V, fill factor of 0.16 and efficiency of 0.0002 %. The efficiency of DSSC increased to 0.001 % using CIL5 electrolyte with the same dye. The performance of DSSC is further increased with efficiency of 0.14 % using CIL5 electrolyte in gel form and dyes of black rice. DSSC using dyes extracted from red cabbage exhibit better performance compared to dyes from blueberry and black rice with highest efficiency of 0.2 %. Using ruthenizer as sensitizer and CIL5 gel electrolyte, the efficiency of 0.74 % was obtained. The efficiency of DSSC is further increase up to 1.2 % with the addition of 80 wt.% of IL into chitosan-NH_4I electrolyte in gel form. The low performance of the DSSCs in this work is probably due to the insufficient ionic conductivity of the electrolyte, ~10^{-4} S cm^{-1}. The performance of the DSSCs in this work is clearly improved with the increase in conductivity of the electrolytes (3.04×10^{-4} S cm^{-1}).

To improve the performance of DSSC in future work, some suggestions are forwarded:

- Improve the conductivity of the electrolyte up to 10^{-3} to 10^{-1} S cm^{-1}.
- Using different techniques of TiO_2 electrode preparation such as printing method. The thickness of the TiO_2 film is one of the parameters in the cell. In this work, the thickness of the TiO_2 film is determined by thickness of the tape. The difficulty of this method is not only the concentration of TiO_2 paste but also the speed of rod can be affected to obtain the required film thickness. A screen printing machine is very suitable to optimize the film thickness.
- Improve the sealing technique of DSSC fabrication. By using suitable sealing material and technique, it should be impermeable to moisture.