CHAPTER 1

INTRODUCTION TO THE THESIS

For almost 35 years, solid polymer electrolytes (SPE) have been extensively studied since Wright discovered ionic conduction in polymers in 1975. After the discovery that polymers doped with salt can conduct charge, Armand announced that these novel materials can be potential electrolytes in batteries. The tradition of fabricating the electrochemical devices using solid polymer electrolyte in research has been carried out until today in the effort to produce cheap and sustainable energy.

Pollution and emission of hazardous waste products from conventional energy sources have become a big issue. The solution to overcoming these problems will be to produce greener and smarter energy resources. Batteries are one of the ideal choices [Jiang and Rahimi, 2009]. Solid-state energy devices have been suggested to be one of the future global green energy converters [Singh *et al.,* 2008]. To realize this suggestion, researchers all over the world are working on alternative energy devices such as batteries and electric double layer capacitors. The key ingredient towards building up the alternative energy technologies is the choice of suitable advanced materials such as proton or ionic conductors that can also play the role of a separator.

Solid polymer electrolyte based on blending poly(vinyl alcohol) (PVA) and chitosan have been studied in this thesis. Polymer blending has been proposed by many researchers worldwide in order to get an electrolyte with better conductivity and good mechanical properties. The blend of PVA and chitosan has been extensively applied in

the biomedical field [Chuang *et al.,* 1999; Chandy and Sharma, 1992; Nakatsuka and Andrady, 1992; Minoura *et al.,* 1998]. There are few reports on PVA-chitosan blend based polymer electrolytes [Razak *et al.,* 2009] and also few reports on the application of PVA-chitosan blend electrolytes in electrochemical devices [Jiang *et al.,* 2008]. An overview of the current state of polymer electrolytes, ion conduction mechanism, polymer blend based polymer electrolytes, plasticized polymer electrolytes and the electrochemical devices based on proton conducting polymer electrolytes are given in Chapter Two.

The polymer electrolytes in this work have been prepared using the solution cast method. The effect of ammonium nitrate as the doping salt is investigated. To the highest conducting sample in the polymer blend-salt system, ethylene carbonate (EC) will be added and the effect of plasticizer investigated. Chapter Three in this thesis will not only cover the method of sample preparation, but will also cover the techniques of material characterization and method of fabrication and characterization of the solid-state proton batteries and electric double layer capacitor (EDLC).

Amorphousness of polymer electrolytes is one of the crucial factors for the choice of the polymer host. This is because conductivity depends on amorphousness of the material. Besides that, the surface morphology of polymer electrolytes can also shed some light towards the increment and the decrement of conductivity. X-ray diffraction (XRD) and scanning electron microscopy (SEM) studies have been carried out and the data will be presented in Chapters Four and Six.

Polymer-polymer, polymer-salt, polymer-plasticizer, polymer-salt-plasticizer and salt-plasticizer interactions have been verified using Fourier transform infrared

(FTIR) spectroscopy. Results from these studies are presented in Chapter Five. FTIR results may offer some understanding on the conduction mechanism of the ions.

Chapter Six in this thesis deals with electrochemical impedance studies of the polymer electrolytes. From electrochemical impedance studies, conductivity of the samples can be determined. Conductivity behavior at various temperatures will also be determined in order to understand the ion conduction mechanism. The dielectric constant of the polymer electrolyte will be calculated from the impedance data in order to obtain a deeper understanding on the conducting behavior of the electrolytes. Transport parameters such as mobility and number density of ions have been calculated using the Rice and Roth model.

The highest conducting sample in the plasticized system will be chosen as the electrolyte in the electrochemical devices fabricated. Results are presented in Chapter Seven. From device characterizations, their performance will be known. Chapter Eight discusses results presented in the thesis and Chapter Nine concludes the thesis with some suggestions for future work. From the brief contents of the thesis, it is clear that the objectives of the present investigation can be summarized as:

- To prepare a polymer electrolyte based on chitosan/PVA blend doped with NH_4NO_3 salt.
- To improve the conductivity of the salted system by adding ethylene carbonate as a plasticizer.
- To understand the conduction mechanism.

- To fabricate solid state proton batteries and to evaluate performance of the cells fabricated.
- To fabricate EDLC and to evaluate performance of the EDLC fabricated.