CHAPTER 1

INTRODUCTION TO THE PRESENT WORK

1.1 Background

In recent years much attention has been focused on the development of electric vehicles, fuel cells and portable power sources largely due to the growing interest in finding substitutions for petroleum based products. Among the many electrochemical device options, lithium ion batteries constitute an important component in the growth and development of energy storage devices [Lindley, 2010; Kang and Cender, 2009]. The development of new solid electrolyte materials is creating opportunities for few types of electrical power generation and storage systems. The development of alternative energy technologies require the search of suitable materials that can also play the role of an electrolyte. Solid state devices would be the future global green energy converters if they can be successfully commercialized [Singh et al., 2008].

Although in current commercial electrochemical devices, liquid electrolytes are being used, they are not without problems. The use of liquid electrolytes tend to make some device bulky and heavy, thus lowering the specific energy and specific power entities of these devices. The liquid electrolytes may consist of volatile solvents making their storage difficult and their use unfriendly to the environment. These problems have led to the development of solid electrolytes in particular polymer electrolytes in solid state. The first report on solid electrolytes was by

Wright in the seventies and later on by Armand showed the technological importance of such materials. Solid polymer electrolytes are also not without problems. Their room temperature ionic conductivity is still low for the usage. This, among other factors led to the study on solid polymer electrolytes added with inorganic fillers and organic macro molecules. The objective of this work are given in the following section.

1.2 Objective of the present work

- To expand knowledge on the ionic conductivity of solid polymer electrolytes based on PEO that has been added with LiI salt, inorganic filler, Al_2O_3 and organic fillers Calix4 and Calix6.
- To expand knowledge on spectroscopy there by complexation in the aspects of PEO –LiI with inorganic and organic fillers using Fourier Transform Infrared spectroscopy.
- To understand complexation of PEO-LiI, PEO-LiI with Al_2O_3, PEO-LiI with Calix4 and PEO-LiI with Calix6 using X-ray diffraction.
- To understand the ionic conductivity variations due to the anion trapping using impedance spectroscopy studies in PEO-LiI and PEO-LiI-Al_2O_3, PEO-LiI-Calix4 and PEO-LiI -Calix6 systems.

With these objectives in mind, the scope of the thesis has been set and explained in the following section.

1.3 Scope of the present thesis

Solid polymer electrolytes (SPEs) based on PEO with different weight percentage of LiI have been studied. Similar type system has been studied by many researchers worldwide in order to get a better ionic conductivity with good mechanical and transport properties [Lee et al.,2011, Kalia et, al., 2007]. However, there are few research had done on PEO-LiI with Calix arenes. Therefore, a general introduction, literature review on different components of Li based polymer electrolytes such as salts, solvent, polymers and types and kinds of different polymer electrolytes i.e. solid and gel polymer electrolytes will be discussed in Chapter Two.

Chapter Three in this thesis will not only outline the experiments carried out to prepare samples, but will also cover the techniques involved to study the characteristics of the samples. All the polymer electrolyte samples in this work have been prepared using solution casting technique. PEO with different weight percentage of LiI system is prepared. To the high conducting PEO : LiI [90wt.% :10 wt.%] system inorganic filler, Al_2O_3, organic fillers Calix4 and Calix6 arenes were incorporated.

Chapter Four describes interactions between PEO-LiI and PEO-LiI-Al_2O_3, PEO-LiI-calix4 and PEO-LiI-calix6 using Fourier transform infrared (FTIR) spectroscopy. FTIR studies have been performed to verify the occurrence of complexation between the lithium ion and the polymer. These are necessary as these interactions can affect the ionic conductivity and conductivity mechanism of the ions.

Chapter Five describes X-ray diffraction (XRD), that have been carried out to examine the effect of adding LiI, Al_2O_3, calix4 and calix6 arenes to PEO. The nature of samples whether crystalline, amorphous or semi crystalline will be determined. This work demonstrates that amorphous nature of polymer electrolytes can also shed some indication towards the decrement and increment of the conductivity.

Chapter Six deals with electrochemical impedance spectroscopy, to study the electrical properties of polymer electrolytes. Conductivity behaviour at various temperatures of the samples can be determined from the impedance studies. Conductivity is an important parameter for all electrolytes. From the literature the conductivity obtained is of the order of 10^{-5} S cm^{-1} at room temperature. Other admittance responses such as complex permittivity electrical modulus will be analysed from impedance data in order to obtain a deeper understanding on the conducting behaviour of the samples, which is explained in Chapter Seven.

All the results presented in this thesis will be discussed in Chapter Eight and Chapter Nine concludes the thesis with some suggestions of future work.