CHAPTER-VI

CONCLUSION AND SCOPE FOR FUTURE WORK

In this chapter, summary of the research work carried out in the area of natural polymer based electrolytes using natural polymers is provided. Various conclusions withdrawn from the analysis of experimental results are recapitulated here. It also explores the possible extension in the proposed work and methodology for the synthesis of natural polymer based electrolytes and scope for future work.

The demand of energy around the world is increasing exponentially using fossil fuels which has posed enormous pressure not only on Government but also to researchers. Therefore, researchers are focusing their interest in developing some alternative sources for energy by using polymer electrolytes for electrochemical devices which are flexible, movable, biodegradable and economical. In this regard, the growth of solid-state electrolytes are the becoming more promising area for the development of all types of electrochemical devices. These electrolytes can be prepared by using ionic salts, plasticizers, polymers and ceramics both in complex as well as in hybrid form.

Polymer electrolytes is one of the most important part for any electrochemical device. It acts as a separator and provide ionic conduction between the electrodes. They provide high performance, good ionic conduction, optically transparent and opens the opportunities for the researchers to construct these polymer cells with different combinations for commercial purposes. Nowadays, in most of the electrochemical devices, synthetic polymer based electrolytes are frequently used. They have shown good results but found to be non–ecofriendly, health hazardous and non- economical. In order to overcome the mentioned problems, different types of natural polymer based electrolytes have been explored.

The following section summarizes the chapter-wise concluding remarks of all the preceding chapters. The scope for future work in this area at the end of this chapter concludes the research work.
Chapter I describes the need for polymer based electrolytes and its uses in various electrochemical devices. It also discusses about the benefits and drawbacks of conventional electrolytes and development of polymer electrolytes with their pros and cons. It also states the main objectives of the research work and how the complete thesis has been organized.

Chapter II gives a brief background on synthetic as well as natural polymers which were used in the synthesis of polymer electrolytes and show the conductivity obtained by the researchers using these polymers with different salts and acids at ambient temperature. This chapter also presents the problems related to existing polymer electrolytes and their uses. Information obtained from this literature review helped in selecting the suitable natural polymer, salt/acid.

In chapter III, all the materials and methods used in the research work for the synthesis of natural polymer based electrolytes are mentioned. This chapter also discusses about the basic parameters, principles and instrumentation techniques used for the characterization of these samples.

Chapter IV gives the details of experimental work carried out to meet the objectives of the research work. It gives the details for optimizing the parameters for the preparation of polymer electrolytes by using natural polymers. Two types of polymer electrolytes were prepared i.e. solid polymer electrolytes by using cellulose derivatives and gel polymer electrolytes by using polysaccharides which are polyelectrolytes in nature by doping them with different salts and acids.

Results of various characterization used for the analysis of samples are discussed in chapter V. Various conclusions withdrawn from these characterization techniques are as follows:

- With the addition of salt/acid in polymer increases the conductivity but after a certain amount of these dopants conductivity start decreasing due to the more number of charge carriers which produces the hindrance in conduction pathway.
- The addition of plasticizer in these polymer electrolytes further increases the conductivity because of the high dielectric constant of the plasticizer which
reduces the cohesive force and increases the solvation of salt/ acid and also breaks the intrahydrogen bonding in these natural polymer electrolytes. The best conductivity at room temperature was obtained in hydroxyethyl cellulose based solid polymer electrolyte i.e. 4.6 x 10^{-3} S/cm when doped with Li salt and plasticized by 20 wt. % of plasticizer.

- Temperature dependence conductivity shows the Arrhenius behavior confirmed by regression value which is near to unity of the samples i.e. with the increase in temperature there is increase in conductivity in a linear pattern.
- The calculated activation energy of the samples were very low due to the amorphous nature of the polymer electrolytes. We obtained lowest activation energy of 0.11eV in HEC based polymer electrolyte.
- The bulk resistance of the electrolytes decreases with the increase in temperature due to the reduction in viscosity and increasing flexibility of polymer chain with temperature.
- Cyclic voltammetry confirms the ionic conduction in polymer electrolyte by showing cathodic and anodic peaks separately and also confirms the redox reaction in the cell.
- Results from linear sweep voltammetry shows the working range of the synthesized polymer electrolytes up to 1.75 V in case of solid polymer electrolytes.
- FTIR results confirmed the interaction of the salts and plasticizer in polymer matrix by shifting and broadening of the bands.
- XRD results confirms the increase in amorphous nature by doping of salt and plasticizer in polymer electrolyte.
- Glass transition temperature (T_g) of the synthesized polymer electrolytes were recorded through DSC technique and found thermal stability for solid polymer electrolytes in the range of 57°C – 87°C and for gel polymer electrolytes 95°C- 110°C. The most thermal stable electrolyte was gum arabica based gel polymer electrolyte i.e. 110°C.
SCOPE FOR FUTURE WORK
Increasing demand for safe and ecofriendly energy devices has led the researchers in the development of green electrolytes, which not only has the ability to replace the synthetic electrolytes but also reduce the harmful effects and cost of the electrolytes. After concluding our work on natural polymer based electrolytes, we found that there is need to explore more natural polymer based electrolytes which are alternative to synthetic based system with higher ionic conductivity at room temperature as well as at high temperature, good thermal and electrochemical stability, cost effective, and non-volatile nature, to use them in different energy storage and conversion devices.