PREFACE

Solid state ionics is a multidisciplinary scientific area that deals with ionic transport in a wide range of materials including glasses, polymers, composites, nano-scale materials, ceramics, and biomaterials. In a couple of decades, the field “solid state ionics” grew up to one of the most appealing scientific fields because of its advantageous technological applications such as Batteries, Fuel cells, Supercapacitors, Solar cells, Sensors, and Electrochromic displays. So far, all over the world, a large number of scientists are involved in the research of the field of solid state ionics. In the future, their missions will become extensively useful to fulfill social needs, to mitigate energy challenges, and to accomplish environmental sustainability. In the 1970s, a Japanese scientist, Takehiko Takahashi, originally introduced the term “solid state ionics”.The class of solid material having ionic conductivity of the order of 10^{-5} – 10^{-1} S cm^{-1} comparable to those liquid electrolytes are referred to as "Fast Ion Conductor" or "Superionic Solid".

Based on the microstructure and physical properties, the ion-conducting material is classified as (i) Framework crystalline / polycrystalline solid electrolyte (ii) Glassy/Amorphous solid electrolytes (iii) Composite solid electrolytes (iv) Polymer-based electrolyte. Among all, Polymer electrolyte is a class of material used in a broad variety of applications due to high ionic conductivity near to that of liquid electrolytes ease of fabrication in form of thin film, good electrode-electrolyte contacts, free from leakage as compared to traditional liquid electrolytes. The fundamental aspects of polymer-based solid electrolytes material using poly (ethylene oxide) (PEO) as host polymer were first introduced by P.V. Wright in 1975 and proposed as the material of interest for the development of electrochemical devices by M. Armand in 1978. By using polymer electrolytes, it is possible to design solid-state batteries and related devices. Polymer solid electrolytes are formed by adding alkali metal salt MX (M = Li, Na, Ag, Cu, etc.) and (X = I, F, Cl, etc.) having low lattice energy and bulky anion in host polar polymers like polyethylene oxide (PEO), polypropylene oxide (PPO), etc. The conventional solid polymer electrolytes (polymer-salt complexes) possess very low ionic conductivity because ion transportation through PE is governed by polymer chain segmental motion as well as local relaxation which is not possible in the partially crystalline PE. For that, a high degree of amorphicity in polymer electrolyte is required. Mobile ion transport in many types of ionic conductors is the cornerstone in a wide range of applications, including portable primary and secondary batteries, electrochemical sensors, electrochromic displays, fuel cells. Hence, the researchers have adopted a few methods to improve ionic conductivity and mechanical strength such as blending, adding nanoparticles, and crosslinking, etc. From a fundamental research perspective, the dynamics of mobile ions contributing to conductivity and diffusivity in different types of ionic conductors are vital and crucial. Alternative to solid polymer electrolyte, the gel polymer electrolyte system has been found as a potential candidate due to the possessor of high ionic conductivity of the order of 10^{-4} to 10^{-3} S cm^{-1}. In view of this, the present thesis deal with the fabrication of gel polymer electrolytes (GPEs) and focused on the investigation of electrical properties, ion transport properties, and electrochemical properties. The thesis is divided into seven chapters are as follows.

Chapter 1 presents the history and general overview of the classification of solid-state ionics materials or fast ionic conductors (FICs). A piece of detailed information regarding polymer electrolytes and its classifications are briefly discussed in this chapter. The possible applications of the polymer electrolyte in various electrochemical devices such as Electrochemical Capacitor or Supercapacitor, Fuel cell, Dye-sensitized solar cell (DSSC), Electrochromic display devices (ECDs), Sensors, Batteries have been presented also. In **Chapter 2**, various theoretical models have been explained to understand the ion conduction mechanism in the polymer electrolytes. **Chapter 3** gives details about used materials in the GPE system, techniques to fabricate the present gel polymer electrolyte system, and characterization techniques. **Chapter 4** emphasizes the characterization results obtained from the different characterization techniques. **Chapter 5** reports the electrical properties in which ionic conductivity, temperature-dependent ionic conductivity, AC conductivity, dielectric properties, and modulus properties have been discussed for all prepared GPE series. **Chapter 6** discusses the basic working principle of battery and discharge characteristics of the fabricated primary battery using optimized gel polymer electrolytes membranes as a separator sandwiched between the suitable anode and cathode materials. **Chapter 7** summarizes all the characterization results reported in the thesis and provides overall conclusions of the presented research work.