SYNTHESIS AND CHARACTERIZATION OF SOME COMPOSITE POLYMER ELECTROLYTES BASED ON POLY (ETHYLENE OXIDE) (PEO)

A THESIS PRESENTED BY

KANDASAMY VIGNAROOBAN

to the Board of study in Physics of the
POSTGRADUATE INSTITUTE OF SCIENCE

in partial fulfillment of the requirement
for the award of the degree of

MASTER OF PHILOSOPHY

of the

UNIVERSITY OF PERADENIYA
SRI LANKA
2007

SYNTHESIS AND CHARACTERIZATION OF SOME COMPOSITE POLYMER ELECTROLYTES BASED ON POLY (ETHYLENE OXIDE) (PEO)

KANDASAMY VIGNAROOBAN

Department of Physics
Faculty of Science
University of Peradeniya
Peradeniya
Sri Lanka

Due to the increasing demand for energy, development of materials for electrical power generation and storage systems are receiving much attention. An electrolyte is an essential component in batteries and in other electrochemical devices. Polymer based electrolytes have tremendous advantages compared to conventional liquid/solid electrolytes except their low ionic conductivity at ambient temperatures. Much research has been carried out to improve the ionic conductivity of polymer electrolytes in order to use them in practical applications. Poly (ethylene oxide) (PEO) is the commonly used host polymer in polymer electrolyte research.

In this work, several PEO based polymer electrolytes have been synthesized and characterized using Impedance Spectroscopy, Dielectric Spectroscopy, Differential Scanning Calorimetry (DSC) etc.

Several methods have been used to enhance the ionic conductivity of PEO_9 LiTf polymer electrolyte throughout this project such as incorporating various types of ceramic fillers to the PEO_9 LiTf, incorporating ceramic filler and a plasticizer to the PEO_9 LiTf, incorporating a second salt to the PEO_9 LiTf and incorporating two ceramic fillers together with PEO_9 LiTf polymer electrolyte.

Among the different types of ceramic filler incorporated PEO_9 LiTf electrolytes, the one incorporating the TiO_2 gave maximum enhancement and it would be due to the high Lewis acid character of TiO_2 compared to other fillers used.

Incorporating Ethylene Carbonate (EC) with PEO_9 LiTf : TiO_2 electrolyte resulted in further increase in conductivity due to the plasticizing effect of EC. DSC results also exhibit a reduction in T_g showing that the segmental flexibility of the polymer chains is increased and that could be the reason for conductivity enhancement. Mixed-filler incorporated samples did not show any enhancement in conductivity. It could be due to filler-filler interactions caused by the dielectric constant gradient between the filler particles.

Incorporation of $NiCl_2$ as a second complexing salt with PEO_9 LiTf and with PEO_9 CuSCN showed an enhancement in conductivity, possibly due to the increased amorphous phase produced by the second salt. DSC results obtained also correlate this assumption.