CHAPTER 8

SUMMARY AND CONCLUSIONS

In the present work, we have successfully synthesized nanchitosan from prawn shells by ionotropic gelation method. Chitin nanofiber was synthesized from shrimp shell waste using acid hydrolysis method by our collaborator’s lab in Thailand. In addition, nano hydroxyapatite was purchased commercially from Sigma Aldrich. These three biopolymers were used as nanofillers in the polymer matrix.

Four different classes of polymer electrolyte systems were prepared by hot-press method using acetone and THF as solvents. In all the four systems, PEO was employed as polymer host. Two different lithium salts, namely lithium triflate and lithium bisoxalatoborate were employed as salts. The effect of nanofillers (NC/CNF/nHAp) on structural, thermal, electrical, electrochemical and interfacial properties of polymer electrolytes was studied. In addition, succinonitrile (SN) was used as a plasticizer in the polymer electrolytes and effect of its addition on the electrical and electrochemical properties of polymer electrolytes were studied.

X-ray diffraction studies revealed that the incorporation of nanofillers in the polymer matrix enhances the amorphous phase of the polymer electrolytes as evidenced by reduction in the intensity of crystalline characteristic peaks. The peak shifts, intensity changes and new peaks
formation noted in the FT-IR studies confirmed the complexation of materials in the prepared polymer electrolytes. The DSC analysis indicated that the melting temperature and degree of crystallinity was reduced upon incorporation of nanofillers and SN.

In all the nanocomposite and plasticized nanocomposite polymer electrolytes (NCPEs and PNCPEs), ionic conductivity increases with increase in temperature. The temperature dependence behavior of these electrolytes obeyed VTF equation instead of the Arrhenius equation which confirmed their amorphous characteristics. It showed that the ionic transport depended on the segmental motion of polymer chain. Among the prepared electrolytes, NC incorporated NCPEs showed better electrical, electrochemical and interfacial properties. The highest ionic conductivity obtained was $10^{-3}$ S/cm at 60 °C. Maximum ionic conductivity of $10^{-3}$ S/cm was achieved with incorporation of 10 wt% of NC. Plasticizer was added in these NCPEs to improve the ionic conductivity. The ionic conductivity of PNCPEs was found to have a maximum of $10^{-2.6}$ S/cm upon 2 wt% addition of SN and 8 wt% incorporation of NC. The addition of plasticizer in PNCPEs increased the conductivity upon one order of magnitude compared to NCPEs.

The dielectric behavior was analyzed using dielectric permittivity and dielectric modulus of the electrolytes. Non-Debye characteristic was divulged in dielectric relaxation study. In order to determine the bulk dielectric response of NCPEs and PNCPEs, the dielectric modulus which masks the polarization effect was investigated.

The electrochemical stability of NCPEs and PNCPEs were analyzed by subjecting the symmetric Li/NCPEs or PNCPEs/Li cells to CV
analysis at ambient temperature. All the electrolytes possessed well defined redox peaks which indicated the cathodic deposition and anodic stripping was favored in electrolyte system. Further the ESW of NCPEs and PNCPEs were considerably enhanced.

The interfacial stability of polymer electrolytes was analyzed by subjecting the symmetric Li/NCPEs or PNCPEs/Li cells to compatibility analysis at 60 °C for ten days continuously. The NC incorporated NCPEs and PNCPEs possessed better interfacial resistance ($R_i$) value compared to other electrolytes.