

CHAPTER 9

CONCLUSIONS AND SUGGESTION FOR FURTHER WORKS

The most amorphous PVA-chitosan blend has been determined from the XRD and SEM analysis and the film C4P6 was chosen to become the host for the polymer blend electrolytes. Solid polymer electrolyte based on PVA-chitosan-NH₄NO₃ (salted system) and PVA-chitosan-NH₄NO₃-EC (plasticized system) were successfully prepared. The electrolytes were mixed in appropriate concentrations to form films via the solution casting method. From the FTIR studies, the interaction between the PVA-chitosan blend with NH₄NO₃ salt was observed by the shifting at the amine (NH₂), carboxamide and hydroxyl (-OH) bands from 1558 to 1518 cm⁻¹, 1647 to 1636 cm⁻¹ and 3337 to 3318 cm⁻¹ respectively and proved that complexation has occurred. Interaction between salt and plasticizer was observed when the C=O bending band of EC has shifted from 715 to 719 cm⁻¹. C=O stretching band of EC also shifted from 1771 and 1797 cm⁻¹ to 1773 and 1803 cm⁻¹ respectively hence proven that EC-NH₄NO₃ experienced an interaction.

From the present work, the conductivity has increased due to several factors such as;

- ❖ The number density of charge carriers has increased due to that of NH₄NO₃ doping salt. Pure PVA-chitosan polymer blend film conductivity has increased from 4.48 x 10⁻¹¹ S cm⁻¹ to 2.07 x 10⁻⁵ S cm⁻¹ with the incorporation of 40 wt. % of NH₄NO₃ salt concentration. This

has been proven by employing the Rice and Roth model equation and from the dielectric constant plots.

- ❖ Plasticization has also helped to increase the conductivity. EC has helped to dissociate the salt hence allowing more salt to becoming ions. The highest conducting sample in the plasticized system was obtained to be $1.60 \times 10^{-3} \text{ S cm}^{-1}$.

- ❖ Temperature has increased the conductivity where from the plot of conductivity at various temperatures, the relationship is Arrhenian. On heating the polymer electrolytes, the ions tend to vibrate faster and posses enough energy to dissociate. The dielectric constant ϵ_r plot versus frequency at different temperatures is another proof that conductivity is influenced by temperature. As the temperature increases the dielectric constant also increases resulting in conductivity enhancement since the number of mobile ions has increased. For both systems studied, the highest conducting sample possesses the lowest activation energy.

- ❖ Amorphousness and crytallinity of the sample can affect the conductivity where the more amorphous and lower crytallinity sample has the higher conductivity and this can be illustrated by the SEM micrograph and XRD studies.

EC as plasticizer in this work has contributed by;

- ❖ Dissociating the NH_4NO_3 salt into more mobile ions. The Rice and Roth model has shown that the number density of ions has increased.
- ❖ Increasing the dielectric constant of the samples as depicted from ϵ_r versus frequency plot that shows increasing values.
- ❖ Reducing the crystallinity and increasing the amorphousness of the samples hence promoting more ions to enhance the conductivity.
- ❖ Promoting new pathways and shortening distance between transit sites for ions to travel. Lower activation energy is required.

Fabrication of primary and secondary proton batteries in this present work has been successfully carried out using the highest conducting sample in the plasticized system as electrolyte. The polymer electrolyte used (sample 30[60C4P6-40AN]-70EC) in the batteries has a breakdown voltage detected at 1.70 V thus supporting the OCPs of the fabricated batteries and at the same time strengthening the viability of the proposed battery chemistry. Primary proton batteries were discharged at 2 mA current having a higher discharge capacity of (38.86 ± 4.12) mAh. Maximum power density of primary battery was obtained at (9.47 ± 0.26) mW cm⁻². Rechargeable proton battery in this work performed for 9 cycles with almost 90 hours of charge-discharge period before the potential of the battery dropped to lower than 20 % of the initial potential value with charge discharge current of 0.3 mA.

Fabrication of electric double layer capacitor (EDLC) has been successfully carried out. The EDLC can perform for 100 cycles at 0.095 and 0.381 mA cm⁻² current density at room temperature. The capacitance of the EDLC was obtained to be 27.1 and 16.7 F g⁻¹ for the current density applied at 0.095 and 0.381 mA cm⁻² respectively.

For future work, the conductivity of the polymer electrolyte should be enhanced as high as 10⁻² to 10⁻¹ S cm⁻¹. In order to make it possible, there are few ways to follow;

- ❖ By introducing a suitable filler to the electrolyte
- ❖ Introducing a second or a third plasticizer
- ❖ Double salt effect

The performance of the batteries and EDLC could be improved by alteration of the electrodes used. Besides that, the steps of preparing the electrodes could also be one of the challenges.