

***Abstract***

*In this study a chitosan acetate (AC) film prepared from chitosan with a high molecular weight i.e.  $2 \times 10^6$  g/mol was found to exhibit the highest ionic conductivity of  $(2.14 \pm 0.14) \times 10^{-7}$  S/cm. The film was prepared by the solution cast technique. 1 g chitosan was dissolved in 100 ml of 1% v/v acetic acid solution. Ethylene carbonate (EC) was found to be a better plasticizer than propylene carbonate (PC). The film AC + 0.4g EC exhibits the highest electrical conductivity of  $(1.03 \pm 0.01) \times 10^{-5}$  S/cm. Finally, the film of (AC + 0.4g EC) to  $\text{LiCF}_3\text{SO}_3$  ratio of 80:20 was found to exhibit the highest conductivity of  $3.0 \times 10^{-4}$  S/cm at room temperature. The electrical conductivity of all samples were calculated using the bulk resistance value obtained from the complex impedance plot in the frequency range between 1 kHz to 5 MHz. Conductivity was also studied as function of temperature between 30 °C to 85 °C. The plot of  $\ln \sigma T$  versus  $10^3/T$  for each sample seems to obey Arrhenius rule. The regression value ( $r^2$ ) is between 98 % to 99 % indicating a good straight line fitting of the points obtained. The activation energy,  $B_1$  was calculated from the Arrhenius plots and the increase in  $\sigma$  can be explained in terms of the decrease in  $B_1$  and vice versa. The highest conducting polymer-plasticizer-salt complex has the lowest  $B_1$  of 0.28 eV. The modulus formalism shows that the samples are ionic conductors. X-ray diffraction (XRD) confirms the disruption of the crystalline phase of chitosan acetate upon the addition of plasticizers, complexation between the salt and chitosan and their transformation to the amorphous phase for samples that exhibit increasing electrical conductivity. Infrared spectroscopy (IR) shows the occurrence of chitosan-salt complexation, which involves an interaction between the cation of the salt and the lone pair electrons of amide groups in the chitosan. Complexation is confirmed by the shifting of the  $-\text{NH}_2$  bands at  $1590 \text{ cm}^{-1}$  to lower wavenumbers. Complexation is further confirmed by X-ray photoelectron spectroscopy (XPS) technique. The lithium signal can be deconvoluted into two peaks. The peak at  $\sim 54.0$  eV is attributed to Li-N interaction. The nitrogen signal can be deconvoluted into three peaks. The peak at 403.1 eV is attributed to Li-N interaction. Transference number measurements indicate that the anion of the salt,  $\text{CF}_3\text{SO}_3^-$  is the major ion conducting species in the complexed film exhibiting the highest electrical conductivity. The highest conducting film was used as an electrolyte in the fabrication of chitosan-based secondary polymer cells. However, the performance of these cells needs a lot of improvement as electrode-electrolyte contact poses serious problems, which magnifies the internal resistance of the cells.*