

DC Conductivity and XRD of Solid Polymer Electrolytes

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ABSTRACT

A solid polymer electrolytes of polyvinyl alcohol with ammonium bromide having different composition have been prepared by solution cast technique. We have measured the DC electrical conductivity of solid polymer electrolyte at different temperature. The dc conductivity was obtained from current-voltage characteristics by using two probe technique in the different temperature range. The addition of salt in the polymer PVA increase the ionic conductivity. XRD analysis reveals the complex formation between the polymer and salt.

Keywords: Polyvinyl alcohol, Ammonium bromide, XRD, DC electrical conductivity.

I. INTRODUCTION

Polymer have been used as a insulating material and very low ionic conductivity. To increase the ionic conductivity depend on the addition of some dopant (ammonium salts) in polymer. [1]. Polyvinyl alcohol was choosen as a polymer host because it has been attractive due to dielectric strength, good charge storage capacity, good film forming ability, and dopant dependant electrical and optical properties. [2-3]Ammonium salts have been a very good proton doner to the polymer matrix system and to increase the conductivity [4-5]. So in present work, to study DC electrical conductivity of solid polymer electrolyte.

and deionized distilled water as a solvent have been used to prepare solid polymer electrolyte by solution cast technique. In this method PVA and ammonium bromide have been dissolved separately in deionized distilled water by mole percent. Then different molar ratio of NH₄Br in PVA and the solution is stirred well using magnetic stirred, untiled homogenous solution was formed. These homogeneous solution was casted in petri dish and evaporated slowly at room temperature. The flim have been formed with uniformed thickness. The variation between current and voltage measured by using Kiteley 6487 picoammeter/voltage source meter instruments at various constant temperature.

II. METHODS AND MATERIAL

Polyvinyl alcohol with molecular weight 125,000 (AR grade Sd fine), ammonium bromide (AR grade merck),

III. RESULTS AND DISCUSSION

XRD analysis

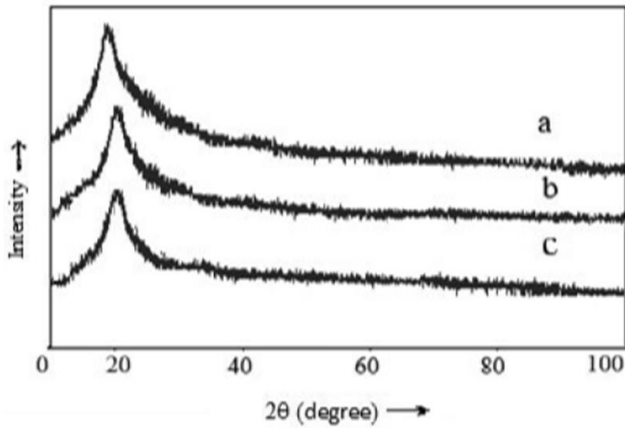


Figure 1: XRD spectra of (a) Pure PVA, (b) PVA:NH₄Br(90:10), (c) PVA: NH₄Br(75:25)

The fig1 shows that the X-ray diffraction (XRD) pattern of pure PVA and PVA with 10 and 25 mole % of ammonium bromide added in PVA . The broad peak is observed for pure PVA and has been shifted in the complex. In salt added system has been found to increase in broadness and decrease in intensity [6]. The broadening of the peak due to addition of ammonium bromide is attributed to an increased amorphous of polymer complex electrolyte [7]. Thus the XRD analysis reveals the complex formation between the polymer and salt [8]. The Polyvinyl alcohol dissolves completely.

DC conductivity

I-V Characteristic of solid polymer electrolytes

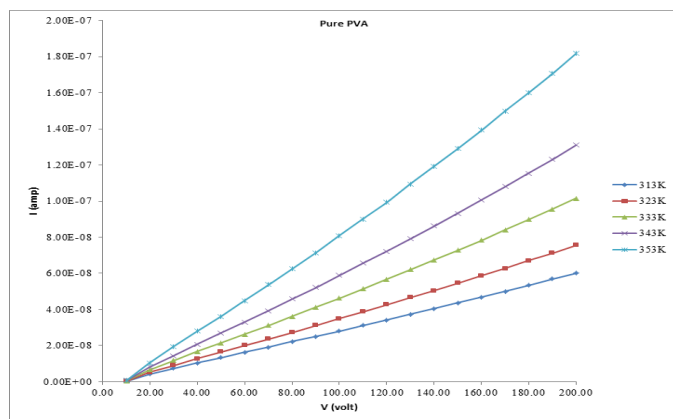


Figure 2: Variation of current (I) with Voltage (V) of Pure PVA

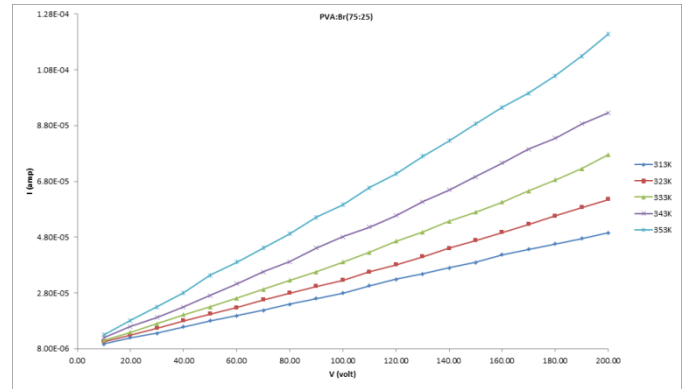


Figure 3: Variation of current (I) with Voltage (V) of PVA with 25 mole % of ammonium bromide (75:25).

Fig. 2 shows the pure PVA and fig. 3 shows PVA with 25 mole % of ammonium bromide I-V relation on five different temperatures 313 K to 353 K. The result shows ohmic behavior. In the ohmic region, the electrical conduction is governed only by the resistance of the polymeric material and controlled by thermally activated carriers. Again, it is observed that the current increases with increasing temperature in ohmic region for all samples. As the temperature increases, the probability of thermal ionization of the trapping centers increases too, hence a shift in the fermi quasi fermi level occurs and this cause the lowering of barrier across which the electrons are transported and conduction becomes ohmic [9-10].

Arrhenius plot

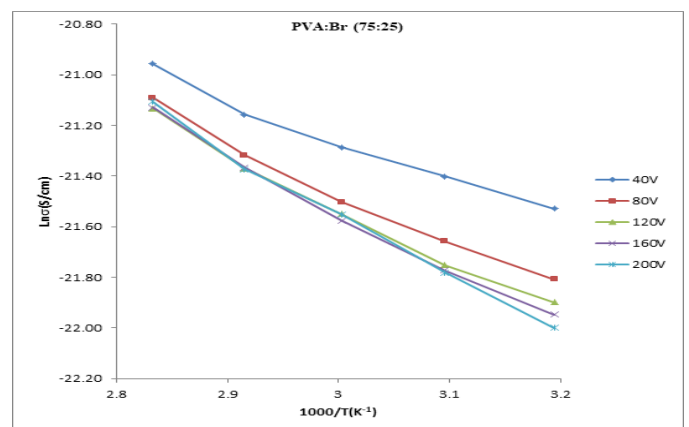


Figure 4: Variation of conductivity $\ln(\sigma)$ with temperature at different voltages (Arrhenius plots) for PVA with 25 mole % of ammonium bromide.

The temperature dependence of DC conductivity $\ln\sigma$ versus $1/T$ as shown in fig 4. The conductivity solid polymer electrolyte PVA-NH₄BR (25mole%) is mostly depend on temperature. The temperature increases conductivity also increases in accordance with Arrhenius equation is given by -

$$\sigma_T = \sigma_0 \exp(-E_a/KT)$$

Where σ_0 is the pre exponential factor, E_a is the activation energy and K is the Boltzmann constant [11-12]. The ionic conductivity is enhanced with increase of temperature and added with mole percent of ammonium bromide which suggest that the free volume around the polymer chain system increases causes the mobility of ions and polymer segments [13]. The segmental motion either allows the ions to hop from one side to another side. Hence ionic motion in polymer electrolyte is due to hopping of ions from one side to another site and the dynamic segmental motion of polymer, and accordingly the conductivity of polymer electrolyte becomes high.

IV. CONCLUSION

A solid polymer electrolytes of pure PVA and PVA with NH₄Br at different mole percent shows Ohmic behavior The XRD analysis reveals the complex formation between the polymer PVA and salt ammonium. The temperature dependence ionic conductivity of these composite polymer electrolyte exhibited Arrhenius behavior. The ionic conductivity has been found to be increase depend on the concentration of the ammonium salts.

V. REFERENCES

- [1]. Jr. F. Billmeyer, Text book of polymer Science, Wiley Singapore, (1984).
- [2]. N. Vassal E. Salmon, J. F. Fauvarque, J. Electrochem Soc 146, 20-26, (1999).
- [3]. A. Lawandowski, K. Shorupska, J. Malinska, solid state ionic 133, 265-271, (2000).
- [4]. M. Kumar, S. S. Sekhon Eur polymer J 38, (2002) 1297-1304.
- [5]. M. Hema, S. Svasekarapandian, A. 403, Sakunthala, D. Arunkumar, H. Nithiya, Physica, (2008), 2740-2747.
- [6]. L. H. S. Perling, "Introduction to Physical Polymer Science", John Wiley, Sons, (2001).
- [7]. Hasoon Salah Abdulla, Abdullah Ibrahim Abbo., Int. Electrochem. Sci. 7, 10666-10678, (2012).
- [8]. J. Luo, A. H. Jensen, N. R. Brooks, J. Sniekers, M. Knipper, D. Ali, Q. Li, B. Vanroy, M. Wubbenhorst, F. Yan, L. Van Meervelt, Z. Shao, J. Fang, Z-H Luo, DE D Vos, K. Binnemans, J. Fransaer, Energy environmental Science 8, 1276-1291, (2015).
- [9]. J. Luo, O. Conrad, IFJ. Vankelecom, J Matter chem 1, 2238-2247, (2013).
- [10]. T. Miyamoto, K. Shibayama, J Appl Phys 44, 5372-5376, (1973).
- [11]. S. D. Druger, A. Nitzam, M. A. Ratner, J Chem Physics 79, 3133-3142, (1983).
- [12]. S. D. Druger, A. Nitzam, M. A. Ratner, Phy Rev B 31, 3939-3947, (1985).
- [13]. Lord Raleigh, Phil. Mag. 34, 481 (1892).