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Synthesis and Characterisation of PVA-Naoh Based Polymer Electrolyte

Amit Sachdeva
School of Electronics and Electrical Engineering, Lovely Professional University, Jalandhar-144411
Email: amit.sachdeva087@gmail.com

Abstract: Polymer electrolyte is a combination of a polymer and salt leading to the synthesis of highly conducting composite. In the present research a polymer electrolyte is synthesised using a low cost polymer Polyvinyl alcohol and salt Sodium hydroxide. Conductivity measurement of the prepared composite is done using Complex Impedence Spectroscopy and maximum conductivity is calculated as 3.6x10-5 S/cm. Confirmation of perfect complexation of the polymer and salt in the prepared polymer electrolyte is done using XRD measurement.

Keyword: Zinc Oxide, nanoparticle, SEM, XRD

1.INTRODUCTION:

The term polymer electrolytes know days is studied extensively by scientists around the globe. This is on account of large number of applications of this composite in almost every field thus serving the soceity, Polymer electrolytes are used in the fabrication of modern day technologies/devices like as dielectric material for supercapacitor, or in the form of electrolytes for rechargeable batteries and many other electrochemical applications[1-3]. For its use in these devices one o the most important properties of polymer electrolyte is its ionic conductivity. For use in electrochemical applications ionic conductivity values of the synthesised material should be high. Based on values of ionic conductivity there are three types of polymer electrolytes: solid polymer electrolyte, liquid electrolyte and her based polymer electrolyte. Liquid electrolytes are the traditionally used electrolytes and has maximum value of ionic conductivity as compared to other types of polymer electrolyte. But liquid electrolytes suffer from a setback that it has a leakage problem that limits its use various types of devices like Dye Sensistised Solar Cell (DSSC). Solid electrolytes suffer from low values of ionic conductivity as they are packed tightly and no space is available for , movement of ions in such a tightly packed structure.Gel based polymer electrolyte removes all the drawback and forms a good electrolyte contact with the electrodes. Although the ionic conductivity value is less as compared to liquid electrolyte but it forms better contact leading to electrochemical applications.

Polyvinyl alcohol (PVA) is known for its hydrophilic nature due to which it is very easy to cast it in the form of film. All it can form poymer complexes via hydrogen bonding. It also has high value of dielectric constant apart from being non toxic and low cost polymer. It can dissolve in water at around 50oC and forms a clear transparent film whenever casted in a petri plate. Main function of salt in a polymer is that it should get ionised quickly and completely [4-7]. PVA offers advantage in this context as the presence of O-H group which is polar tends yo ionise the added salt.Apart from this alt is free to move in the matrix on account of highly flexible nature of the polymer [8-10].

The present investigation deals with synthesis of high ionic conducting polymer electorate based on polymer Polyvinyl alcohol and salt Sodium Hydroxide (NaOH).

2. MATERIALS AND METHODS:

Polyvinyl alcohol having molecular weight of 72000 gm/mol was purchased from Aladin Reagent Company, China. Sodium hydroxide was obtained from Zhejiang Wanglin, China.

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Vol-22-Issue-17-September-2019

Solution casting method was used in the synthesis of polymer electrolyte based on Polyvinyl alcohol and Sodium Hydroxide. It is a low cost and easy method to prepare composite films. In this method both the polymer and salt are first of all dissolved in a common solvent and are casted in the form of a film on a petrplate. Common solvent used in the present research work is water. Both PVA and salt NaOH are soluble in water.In the process itially water us heated at 50oC and 0.5gm of Polyvinyl alcohol is added to it and mixed homogenously using a magnetic stirrer. After this varying concentration of salt NaOH (10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%) was added to the in tally prepared solution. This fixture was stirred overnight so as to form a viscous solution. In the morning this viscous solution was poured in a petruiplate for around 12 hours in order to gather the composite in the form of film.

3. RESULT AND DISCUSSION:

3.1. CONDUCTIVITY MEASUREMENT:

The synthesised polymer electrolytes in the form of a film was tested in the frequency range of 100Hz to 100 kHz using HIOKI 3522-50 LCR Hi TESTER, USA. Ionic conductivity of the prepared samples was measured by placing them within spring loaded stainless steel electrodes. Various Cole Cole lot were prepared at varying concentration of salt in polymer electrolyte. Cole Cole plotprovdied the value of bulk resistance (Rb) and corresponding conductivity values can be calculated using relation ;

$$\text{Conductivity} = R_b \times l/A;$$

Here ‘Rb’ defines the value of bulk resistance, ‘l’depicts the thickness of the film and ‘A’ area defines cross sectional area of the sample.

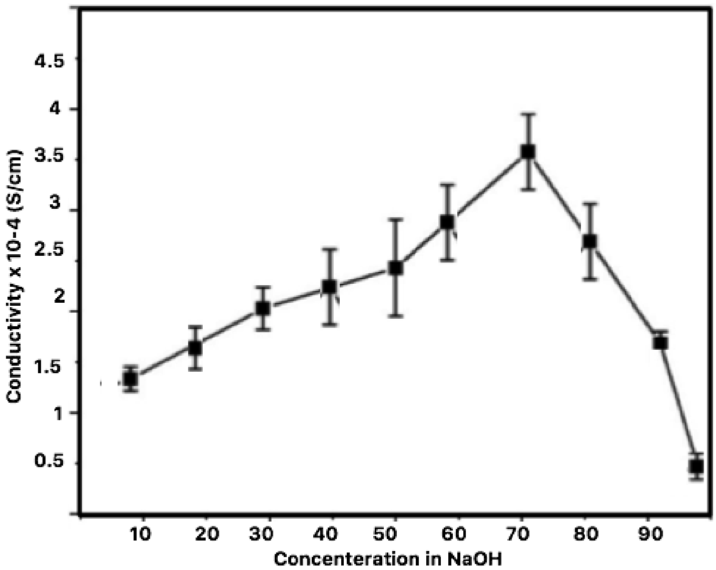

Fig 1: Variation in ionic conductivity with respect to concentration of NaOH.

Initially the value of ionic conductivity is increased as the concentration of NaOH increases within the polymer matrix. This is because more number of free ions are available for movement in the

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Vol-22-Issue-17-September-2019

polymer matrix. Maximum conductivity is found when 70% NaOH is added to polymer sample and the value of ionic conductivity is 3.6x10-5 S/cm as in fig 1. As he concentration of salt in the polymer matrix increases further, the value of ionic conductivity begins to decline. This is on account of filling up of free space that may be available in the matrix along with agglomeration of salt particles preventing the movement of ions [11-12].

3.2. X-RAY DIFFRACTION

XRD measurement of the samples was done using Shimadzu diffractometer XRD-6000. XRD pattern was recorded for pure salt NaOH (fig 2a), polymer PVA (fig 2a) and the maximum conducting composite sample i.e PVA+70% NaOH (fig 2c) using a copper target at wavelength of X-Rays equal to 1.45.X-Ray diffraction is used to study about the crystallinity and amorphicity of the sample. Ionic conductivity is highly related with these two properties.

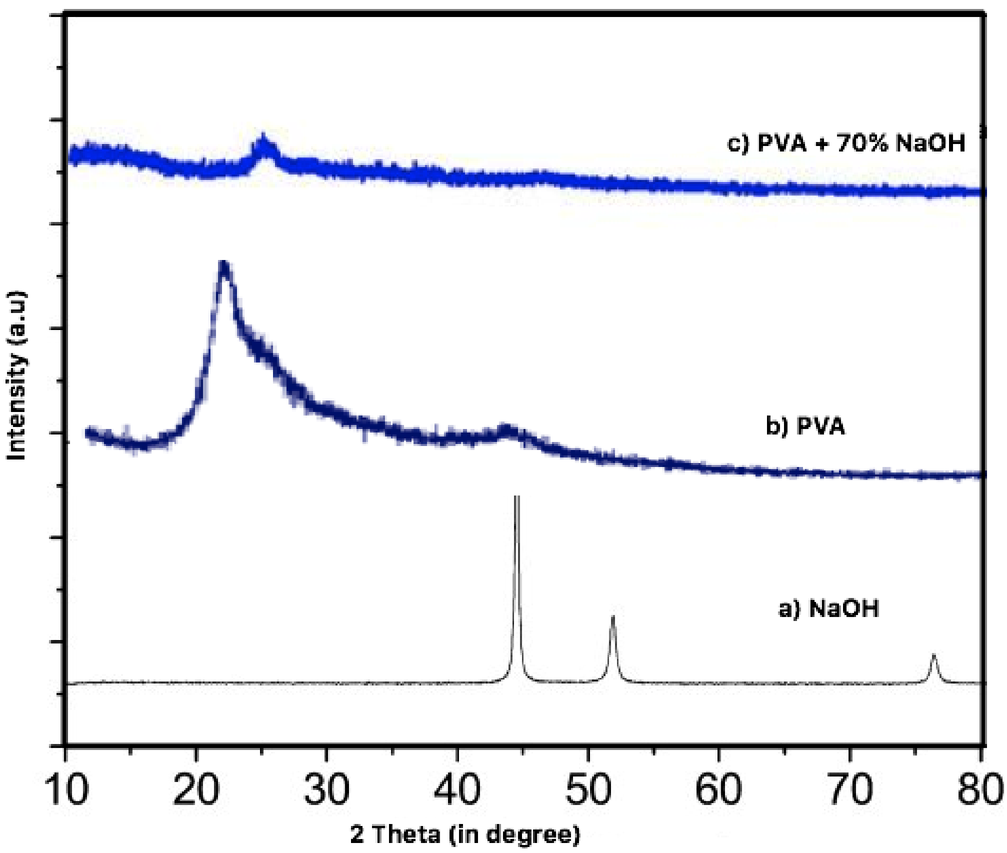

Fig 2: XRD pattern of a) Pure NaOH b) pure PVA. c) PVA-NaOH composite

Movement of ions in a polymer matrix takes place in the amorphous region [13-14]. So in order to enhance the conductivity amorphous region f the matrix has to be increased. As clearly visible in fig 2c when 70% salat is added to the polymer matrix the intensity of peak in the composite has reduced. This clearly indicated the existence of amorphous region in the matrix. This result also

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validates the result obtained in complex impedance spectroscopy.Aper from the fig2a and 2b clearly shows characteristic peak of pure salt at 45o and polymer at 26o.

4. CONCLUSION

The present investigation deals with formation of polymer electrolyte based on polymer PVA and salt NaOH. Conductivity measurement of the sample was done using complex impedance spectroscopy and structural arrangement was studied using X-Ray diffraction. Maximum conducting sample was prepared by adding 70% NaOH in polymer matrix. The value of maximum conductivity is 3.6x10-5S/cm. The conductivity results run in synchronisation with the result obtained by XRD measurement as the sample at 70% NaOH was found to be extremely amorphous.

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