International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
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# Temperature Dependent Conductivity of Solid Polymer Electrolyte Based On Polyvinyl Alcohol

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## ABSTRACT

Solid polymer electrolytes have number of advantage over the conventional liquid electrolyte such as longer life, easily fabricate in desirable shape and leakage free and so on. The attempt has been made in this study with polyvinyl alcohols (PVA) doped with different percentage of Ammonium Iodide ($NH_4I$) were prepared by solution casting technique. It is reveal that electrical conductivity of polyvinyl alcohol doped with ammonium iodide increases with increasing salt concentration as well as temperature. The temperature dependent conductivity shows Arrhenius behavior.

**Keyword -** Solid polymer electrolyte, Electrical conductivity, Polyvinyl alcohol.

## I. INTRODUCTION

An electrolyte is a substance that produces an electrically conducting solution when dissolved in a polar solvent, such as water. The dissolved electrolyte separates into cations and anions, which disperse uniformly through the solvent. To overcome the leakage problem in liquid electrolyte, it is replaced by solid polymer electrolyte [1]. Also solid electrolyte has a several advantages such as ease of handling, low cost, high environment stability. Polymer electrolytes (PEs) are ironically conducting material that may be used in the fabrication of solid-state electrochemical devices such as rechargeable batteries, supper capacitor, fuel cells, gas sensors [2-5]. The role of polymer electrolyte in these application are provide good electrode-electrolyte interface, provide good electrolyte insulation and allow a fast and selective transport of the ions. It is extremely important to understand the charge transport mechanism of polymer electrolyte for practical application. Electrical properties of polymer can be suitability modified by adding of salt. In present study, PVA has been chosen as polymer host due to their mechanical strength, excellent film-forming ability, dopant-depenent electrical and optical properties, low cost and high tensile strength (6-7). PVA is semicrystalline material and it contain hydroxyl group attach to methane carbon which can be source of hydrogen bounding. As per literature survey ammonium salt are very good proton donor (8-9)

## II. METHODS AND MATERIAL

In the present study, polyvinyl alcohol, ammonium Iodide, and double distilled water were used to prepare solid polymer electrolyte. The film of pure

and different composition of PVA-NH4I has been prepared by solution cast technique. In this technique, appropriate amount of PVA and NH4I have been dissolved individually in double distilled water .These solution have been mixed together in different molar ratio (95:05) (90:10) (85:15) (80:20) (75:25) and stirred well by using magnetic stirred for 10-12 hr to obtained homogenous mixture. The obtained mixture is casted in petri dish. The whole assembly was placed in dust free chamber. The solvent was allowed to evaporate slowly at room temperature for 3-4 days. The thicknesses of the film were in the range of 0.032-0.024 mm.

## III. RESULTS AND DISCUSSION

### Electrical properties

The variation of conductivity of polymer electrolytes as a function of temperature at different voltage for 75PVA -25AI in the temperature range 310-350Kas shown in the fig1.

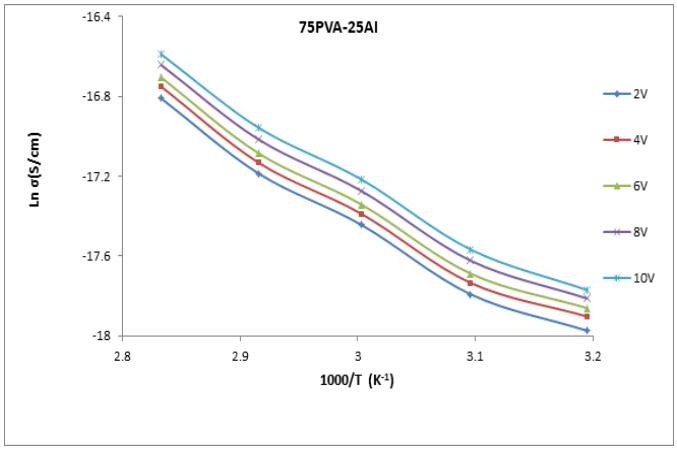


**Fig 1**

It was found that proton conductivity of the electrolytes increases with increasing temperature. The conductivity (σ) varies with temperature (T) according to the equation

$\sigma T = \sigma 0 \exp(-Ea/KT)$

Where σ0 is the pre exponential factor, Ea is activation energy, T is absolute temperature,

K is Boltzman constant.

The variation of conductivity of polyvinyl alcohol with ammonium iodide with different concentration as a function of temperature in the temperature range 310-350K as shown in the Fig 2. It was found that conductivity of the electrolytes increases with increasing temperature in pure PVA as well as all composition of polymer electrolyte.

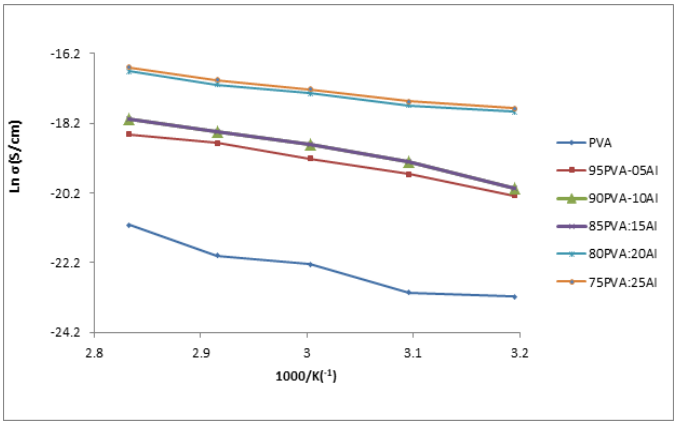


**Fig 2**

The increase in conductivity with temperature may be attributed to the transition from semi-crystalline phase to amorphous phase due to hoping mechanism between coordinating site and segmental motion (i.e. polymer chain) of polymer electrolyte [10]. As the amorphous region increases the polymer chain acquires faster internal modes in which bond rotations produce segmental motion to favor inter and intra-chain ion hopping, and thus the degree of conductivity becomes high. [11-12].

The activation energy, Ea is calculated for prepared polymer electrolyte by linear fit of the Arrhenius plot. It is found that the activation energy decreases with increase of salt concentration in all polymer electrolytes. Increase in the electrical conductivity and decrease in the activation energy value of polymer electrolytes can be explain on the basis that the polymer films are known to be a mixture of amorphous and crystalline region and the conductivity behavior of such films may be dominated by the properties of amorphous region[13]. The amorphous nature provides a bigger free volume in

polymer electrolytes system with increase in temperature [14].

## IV. CONCLUSION

Polyvinyl alcohols (PVA) doped with different percentage of Ammonium Iodide ($NH_4I$) were prepared by solution casting technique. It is reveal that electrical conductivity of polyvinyl alcohol doped with ammonium iodide increases with increasing salt concentration as well as temperature. The activation energy decreases with increase of salt concentration in prepared polymer electrolytes

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