Impedance study of PVAc-Glycerin based Polymeric Gel at different Temperatures

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Summary: Proton conducting polyelectrolyte gel was prepared by mixing different ratios of Poly vinyl acetate (PVAc) : Zirconyl Oxychloride Octahydrate ($ZrOCl_2.8H_2O$) : Glycerin. The gel was yellowish in color; its conductivity was determined by standard AC impedance method at a temperature range of 20 °C to 80 °C. The conductivity showed increase with temperature and followed Arrhenius behavior. The polyelectrolyte was found to be showing no morphological transitions and stable thermally.

Introduction

Polymer electrolytes are the newest area in ionic conductors to receive much attention. They are important from their application point in electro-chemical devices such as batteries and electro-chemical devices [1]. Polymer electrolytes are mixtures of salts with polymers like PEO, PMMA, and PVC or others etc. [2]. Within the field of polymer electrolytes, proton conducting polymer electrolytes have become the materials of growing interest. Various types of proton conducting electro-lytes have been studied [3]. The polymeric electro-lytes in this category are numerous but mostly they are either strong inorganic complexes [3] or ammonium salts [4] with commercially available electrodonar polyvinyl alcohol PVA, polyethylene oxide (PEO), polyacrylic acid (PAA) and so on [5]. It was found that these polymeric electrolytes have conductance much higher than their alkali metal analogues. The work on such systems has been hotly pursued in order to search new systems along with development of modified systems [6-10].

The main goal of the present work was to prepare and study the conductance of conducting polymer gel based on commercially available PVAc with Glycerin and Zirconyl Chloride mixed Composite. The conductivity response as a function of temperature was studied to understand transport behavior of this system.

Results and Discussion

The polyelectrolyte gel prepared by the procedure as described in experimental section was yellowish in color. The conductivity of this was determined through standard impedance method at each temperature and is given in Table-1.

Table-1: Conductivity values of polyelectrolyte

Temperature °C	Log. Conductivity μS/cm
20	-2.900
40	-2.722
50	-2.675
60	-2.610
70	-2.536
80	-2.453

The conductivity range at different temperature is in Micro Siemen, which shows that this system is very low conductor but a thin film configuration and processing can compensate for such low conductance. The conductivity does not show drastic variations in the temperature range under study, which suggests that these electrolytes are suitable for electro chromic device applications. The increase in conductivity with temperature can be explained to be due to decrease in viscosity and hence increased chain flexibility. The conductivities are presented as Arrhenius plot in Fig. 1. It can be seen that the conductivity follows the Arrhenius behavior throughout the range of temperature under study and there is only one Arrhenius region. Two Arrhenius regions were found by Shukla *et al.*, [11] in their composite of PVA_x : NH_4SCN: PVAc and they attributed these different regions to be due to morphological transitions; but in our case with this system there is only one Arrhenius region and hence we can say that there is no morphological transition occurring here, there is no phase change occurring and they are thermally stable.

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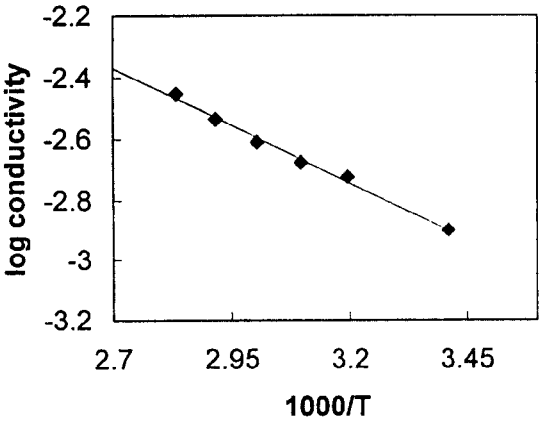

Fig. 1: Arrhenius Plot

Experimental

Proton conducting gel was prepared by mixing two gels; one from Zirconyl chloride octahydrate ($ZrOCl_2.8H_2O$) (Merck), dissolved in 2M HCl and hydrolyzed with 4M H_3PO_4 + 2M HCl . The gel was homogenized after 20 hours by stirring with magnetic stirrer and the washed first with 0.2 H_3PO_4 and subsequently with distilled water. The second gel was that of polyvinyl acetate dispersed in Glycerin. The ratio of mixing was varied ($ZrOCl_2.8H_2O$): Glycerin: PVAc (0.72 g: 1.21ml: 0.75 g). Then the two gels were mixed together and dried to remove water. The resulting gel was a viscous substance respectively.

AC impedance measurements were done using Hioki (Japan) 3522-50 LCR Hitester at a frequency range of 1Hz to 10KHz at 5 mV voltage. Gel sample was pressed between two stainless steel discs inside a plastic sample holder. Measurements were made in the temperature range 20 °C to 80 °C.

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