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Study of ion Transport Property of Ag^+ ion Conducting Polymeric Nanocomposite Electrolyte Thin Film (1-x) [70PEO:30AgCl]: $xTiO_2$ Prepared by Hot Press Technique

Arti Verma

Department of Applied Physics, Rungta College of Engineering & Technology Bhilai, Chhattisgarh, India

E-mail ID- arti.verma577@gmail.com

Abstract:

Study of ion transport property of nanocomposite polymeric membrane of composition (1-x) [PEO: AgCl]: $xTiO_2$ where x = 3 wt % to 10 wt % is the main objective of this study. The maximum conduction is obtained for this composition is for the value of x=7 wt % of filler concentration of TiO_2. The nanocomposite polymer electrolyte (NCPE) membrane is casted by dispersing nano size filler particles of TiO_2 treated as 2^{nd} phase in 1st phase solid polymer electrolyte (SPE) consists of polymer PEO & salt AgCl in appropriate weight % ratio. The maximum conduction of Ag^+ ion in NCPE is obtained for x = 7 wt%.

Key words: nanocomposite polymeric membrane, hot press technique, optimum conducting composition.

Introduction:

A nanocomposite polymer electrolyte is a solid material made of a polymer matrix with nanofillers dispersed in it. The nanofillers are usually less than 100 nanometres in size. These materials are used in batteries, fuel cells, solar cells, and more. Polymer electrolytes act as a medium for conducting ions between two electrodes. Conducting polymer electrolytes are used in energy storage and conversion devices like batteries and fuel cells, capacitors etc. They are also used in microelectronics, photovoltaic devices, and electrochromic displays. Nanocomposite polymer electrolytes have high ionic conductivity, they are chemically stable in aqueous solutions, they are environmentally stable, they have rapid electrode kinetics. Nanocomposite polymers can be synthesized using methods like sol-gel, in situ polymerization, intercalation, green synthesis, and electro spinning, hot press technique etc. Hot-press casting is one of the most efficient, low-cost, completely dry/solution-free methods of casting polymer thin films [1]. This process is less expensive, comparatively takes less time, completely solvent free dry method for casting polymeric membrane [2-3]. However, pure polymers have low electrical as well as ionic conductivity. They are modified into polymer electrolytes by combining the polymers with various dopants, nanofillers, and plasticizers to

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enhance the conductivity [4]. These have good stability and flexibility. Nanofiller dispersion improves polymer electrolyte thermal characteristics [5-7]. Nowadays, solid polymer electrolytes based on poly (ethylene oxide) (PEO) are more popular.

Material preparation:

Present paper reports preparation of Ag^+ ion conducting nanocomposite polymer electrolyte membrane of composition (1-x) [70PEO:30AgCl]: $xTiO_2$ where x=3 wt% to10 wt% and finding of optimum conducting composition (OCC) of the prepared membrane. The solid polymer electrolyte of composition [70PEO:30AgCl] is found as highest conducting film at room temperature is used as 1st phase polymer electrolyte host and nanosize TiO_2 filler particles as 2nd phase dispersoid. The powders of the chemicals in appropriate wt% ratio was homogeneously mixed for 30 min in an agate pestle mortar at room temperature then heated separately to temperature nearly 70°C for nearly 20 min by mixing continuously. The resulted slurry was then pressed between ~1.25 tons/cm^3 between two SS blocks giving rise to a film of uniform thickness 0.032cm.

conductivity (σ) measurement:

The conductivity (σ) measurement was done with the help of (ESCORT, ELC-131D,TAIWAN) by keeping different sample between two non-blocking electrodes at fixed frequency (1kHz).

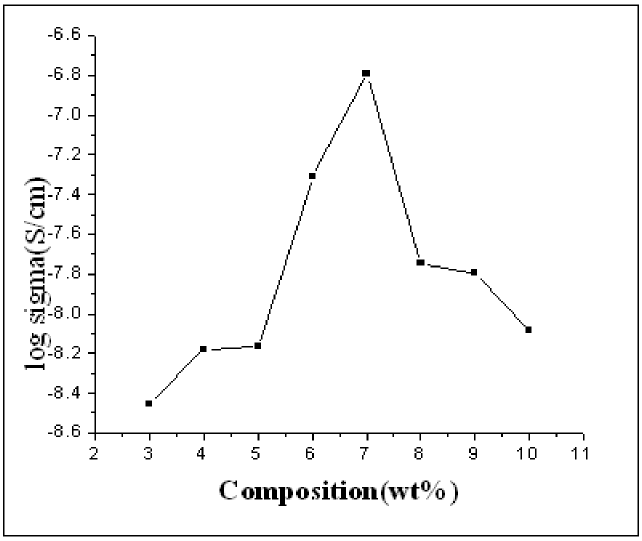

Figure1: room temperature conductivity log σ as a function of filler particle TiO_2 concentration (x) for NCPE membrane.

Figure1 shows filler particle TiO_2 concentration dependent conductivity of the nanocomposite polymer electrolyte. membrane (1-x) [70PEO:30AgCl]: xTiO2 the conductivity measurement for the various composition x=3 wt% to10 wt % was done by dispersing nanosize filler particles

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of TiO_2. The maximum conduction is obtained for x = 7% wt % is ~1.6×10^{-7}S/cm. It has been observed that by adding nanoscopic filler particles of TiO_2 the conductivity of membrane enhances by two orders as compare to pure PEO [8-9].

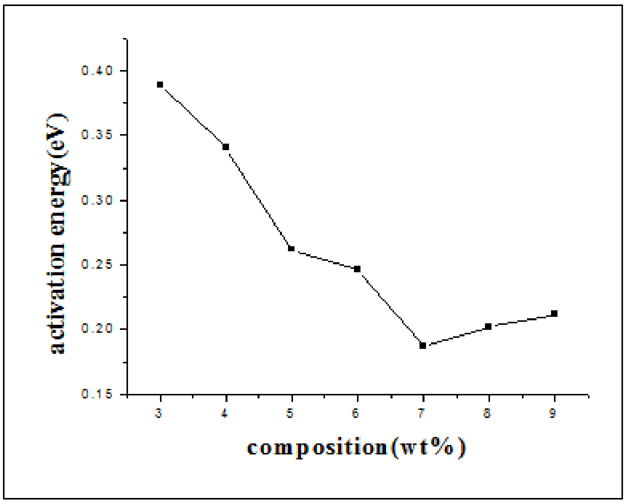

Figure2: activation energy (E_a) as a function of composition x (wt %) for NCPE membrane.

NCPE OCC membrane: σ (T) = 0.468×10-4 exp (-0.187/kT)

Where activation energy E_a=0.187eV for NCPE (OCC). Figure 2 depicts the graph of activation energy (E_a) and composition x (in wt %) of NCPE membrane of different composition. From the figure it is clear that the activation energy E_a is minimum for the NCPE (OCC) composition.

Conclusion:

The membrane of solid polymer electrolyte of composition [70PEO:30AgCl] and nanocomposite membrane of composition 93[70PEO:30AgCl]:7TiO2 is prepared by using hot press technique. For the transport property study conductivity (σ) at room temperature, filler particle TiO_2 concentration dependent conductivity of the nanocomposite polymer electrolyte is plotted. The maximum conduction is obtained for x = 7% wt % is ~1.6×10^{-7}S/cm. From the Experiment it has been observe that the conductivity of NCPE (OCC) membrane enhances by one order as compare to SPE (OCC) and of two orders as compare to pure PEO.

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