E1-15: A new polymeric Cu^+ ion conductor: (PEO)7-CuCNS

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Research on solid polymer electrolytes has until recently, focused largely on polymers incorporating lithium salts due to possible applications in lithium batteries. A new direction concerns polymer electrolytes containing other cations.They are important in furthering the understanding of the fundamental properties of polymer electrolytes, such as cation mobility, and offer alternative technological applications in electrochemical devices where less expensive and less reactive metals than lithium may be desirable.

The preliminary electrical conductivity results of a new Cu^+ ion conducting solid polymer electrolyte, $(PEO)_7$-CuCNS are presented.

CuCNS powder was prepared as follows:

A copper sponge, free from oxides, was kept suspended in a solution of KCNS and Na_2SO_4 acidified with acetic acid for one week. The resulting precipitate was washed with dilute HNO_3 to remove excess of copper and dried at 110°C in nitrogen gas. Pre-weighed amounts of CuCNS and polyethylene oxide (PEO) of molecular weight $4x10^6$, were dissolved in 2 separate acetonitrile solutions. The 2 solutions were then mixed together to get a PEO : CuCNS ratio of 7:1 and the polymer electrolyte films were solvent cast on inert teflon support. After vacuum drying the films at 60°C for 24h, thin circular disks of diameter 13 mm were cut and used for conductivity measurements. Electrolyte disk was sandwiched between 2 stainless steel blocking electrodes in a spring pressed sample holder. Electrical conductivity was measured upto 120°C, using a Schlumberger 1260 complex impedance analyser.

$(PEO)_7$-CuCNS films had a light brownish colour and looked stable in air and easier to handle, compared to $(PEO)_{10}$-$Cu(CF_3SO_3)_2$ film, which has a greenish colour and a jelly like and hygroscopic nature. For $(PEO)_7$-CuCNS films, impedance plots covering the frequency range from 500 mHz to 10 MHz generally consisted of a semicircle and a low frequency spike, characteristic of an ionic conductor with blocking electrodes.

Log σT vs 1/T plots showed a slight curvature typical of polymeric conductors. The conductivity increased and the activation energy decreased with increasing temperature.

The conductivity Arrhenius plots for $(PEO)_7$-CuCNS were compared with those of $(PEO)_{10}$-$Cu(CF_3SO_3)_2$ polymeric Cu^{++} ion conductors reported in the literature. Although at low temperatures, below 60°C, $(PEO)_7$-CuCNS system shows slightly lower conductivities than the $(PEO)_{10}$-$Cu(CF_3SO_3)_2$ system, at higher temperatures both systems show comparable ionic conductivities and activation energies.

Some of the conductivity data in the amorphous phase at higher temperatures for the $(PEO)_7$- CuCNS system are given below:

Temp	65°C	78°C	97°C	110°C
σ(S cm^{-1})	1.1 x 10^{-5}	2.4 x 10^{-5}	6.6 x 10^{-4}	7.0 x 10^{-4}

$(PEO)_7$-CuCNS polymeric Cu^+ion conductors are mechanically more stable and have similar conductivities compared to other copper ion conductors reported in the literature.

A novel polymeric Cu^+ ion conductor, $(PEO)_7$-CuCNS was synthesised and its electrical conductivity investigated as a function of temperature. The conductivity in the amorphous phase increased from 1.1 x 10^{-5} Scm^{-1} at 65°C to 7.0 x 10^{-4} at 110°C. The films were mechanically stable at room temperature and were easier to handle than other copper ion conducting solid polymeric conductors.