IONIC CONDUCTIVITY ENHANCEMENT IN THE $(PEO)_9LiCF_3SO_3$:EC POLYMER ELECTROLYTE DUE TO ADDITION OF NANO-SIZE Al_2O_3

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Polyethylene oxide (PEO)-based polymer electrolytes have been extensively studied in the recent past as they have emerged as potential candidates to be used as electrolyte membranes in solid-state electrochemical devices. One of the major disadvantages of these polymer electrolytes, however, is their low ionic conductivity at ambient temperatures. Ionic conductivity of PEO-based electrolytes at ambient temperatures has been enhanced either by adding ceramic fillers or plasticizers. However, up to now, no attempt has been made to study the combined effect of adding both the plasticizer as well as the inert filler.

Composite polymer electrolyte samples were prepared by solvent casting method by adding a mixture of 50 wt % ethylene carbonate (EC) and 10 wt % Al_2O_3 filler of pore size 5.8 nm to the $(PEO)_9LiCF_3SO_3$ electrolyte. Complex impedance measurements were carried out on disc-shaped samples sandwiched between two stainless steel electrodes each of 13 mm diameter, using a Schlumberger SI 1260 impedance analyzer in the 1 Hz to 10 MHz frequency range and in the 25 °C to 100 °C temperature range. Measurements were taken at 10 °C intervals on heating.

Maximum conductivity enhancement was obtained for the system $(PEO)_9LiCF_3SO_3$ + 50 wt% EC + 10 wt % Al_2O_3 compared to the other three systems:(a) $(PEO)_9LiCF_3SO_3$, (b) $(PEO)_9LiCF_3SO_3$ + 50 wt % EC and (c) $(PEO)_9LiCF_3SO_3$ + 10 wt % Al_2O_3. The highest room-temperature-conductivity of the composite electrolyte was 8.06×10^{-5} S cm^{-1}. Thus, a conductivity enhancement of more than two orders of magnitude has been achieved for $(PEO)_9LiCF_3SO_3$ + 50 wt % EC + 10 wt % Al_2O_3 system. It is suggested that the conductivity enhancement occurs mainly by two mechanisms. The plasticizer (EC) would contribute by reducing degree of crystallinity by lowering the glass-transition-temperature of the polymer. Al_2O_3 filler would contribute to conductivity enhancement by producing additional sites for migrating ionic species through transient bonding with O/OH groups on the filler surface through Lewis acid-base type surface interactions.

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