Non Hydrolytic Ionic Liquid Based Gel Polymer Electrolytes For Flexible Electrochromic Devices.

I. Litas,[a] S. Duluard,[a] G. Campet,[a] F. Mauvy,[a] F. Malbosc,[b] and M.H. Delville[a*]
[a] Institut de Chimie de la Matière Condensée de Bordeaux du CNRS, ICMCB – UPR 9048 – CNRS, 87 Avenue du Dr. A. Schweitzer, 33608 Pessac cedex, France
[b] Parc Technologique - Delta Sud, P.O. Box BP 24, 09120 Varilhes, FRANCE

Many efforts to develop electrochromic devices have spread worldwide in recent years for sustainable energy saving. The focus of these research programs concerns large area window as well as flexible substrate applications. For such applications, all solid-state electrochromic devices have unique advantages such as reliability and safety when compared to conventional liquid-based devices.

Lithium-based devices have attracted increasing attention because of their environmental stability.
Most lithium-based solid polymer electrolytes are a mixture of $LiClO_4$ and various polymers, such as polyethylene oxide (PEO) and polyacrylonitrile (PAN), and inorganic ion conductors with high conductivity. However, the conductivity of some of the solid polymer electrolytes, ($<10^{-5}$ S cm^{-1} at RT), is still too low for practical applications. The gelled electrolyte alternative, (a solid phase in which a conventional non-aqueous electrolyte is immobilized by a polymer matrix) has offered liquid-like values for the conductivity.

In this paper, we propose the use of ionic liquids as an alternative to more classical non-aqueous electrolytes because of their intrinsic properties: non-volatility, non-flammability, and relatively high ionic conductivity.[1] This presentation will focus on the use of polymer electrolytes based on aprotic solvents such as 1-alkyl-3-methylimidazolium salts with adequate counter anions. These hydrophobic ionic liquids can successfully be used as solvents for lithium salts leading to hydrophobic lithium electrolytes of high conductivity.

The introduction of these ionic liquid electrolytes in organic polymers still fulfills some requirements to be used in electrochromic applications: ionic conductivity > 10^{-4} S cm^{-1} at temperatures ranging from -20 to 60°C, mechanical stability at this temperature range, an electrochemical window of 4 V, and high transparency for the performance of the device. By varying the amount of added polymer and Li salt the viscosity of the ionic liquid is altered to provide mechanical properties similar to that of the solid polymer, while maintaining liquid-like electrical behavior as well as transparency as illustrated in figures 1 and 2.

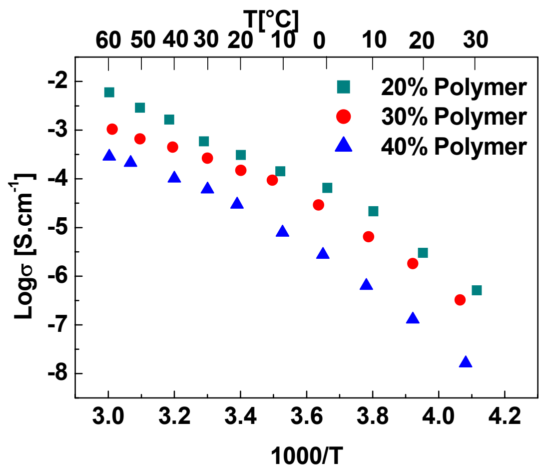

Fig. 1. Thermal evolution of the conductivity of an ionic liquid based lithium electrolyte with various ratios of polymer.

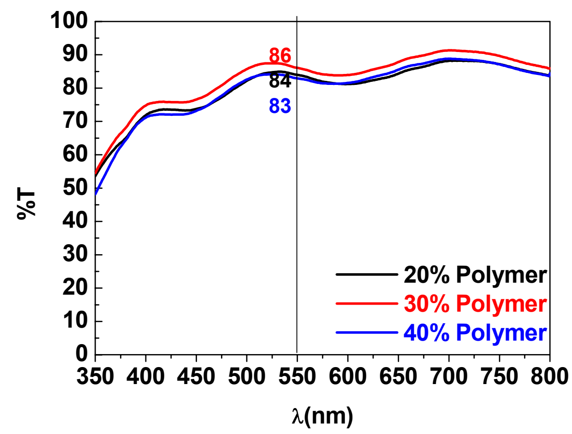

Fig. 2. Transmittance spectra of an ionic liquid based lithium electrolyte with various ratios of polymer.

[1] G. Campet, C. Mingotaud, A. Poquet, J.N. Portier, S. Ravaine, 2000, France Patent N°00 00487