Flexible Electrochromic Devices Based on Non Hydrolytic Ionic Liquid Gel Polymer Electrolytes

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Many efforts to develop electrochromic devices have spread worldwide in recent years for sustainable energy saving on both large area window as well as flexible substrate applications. For such applications, all solid-state electrochromic devices have unique advantages (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 based on $LiClO_4$ and various polymers (polyethylene oxide (PEO), polyacrylonitrile (PAN). Some of them still present conductivities ($<10^{-5}$ S cm^{-1}), which are too low for practical applications. The gelled-electrolyte alternative has offered liquid-like values for the conductivity.

In this paper, we present the use of ionic liquids (ILs) 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 ILs can successfully be used as solvents for lithium salts leading to hydrophobic lithium electrolytes with high conductivity.

The introduction of these ILs electrolytes in organic polymers still fulfills some requirements for electrochromic applications: $\sigma > 10^{-4}$ S cm^{-1} between -20 and 60 ^{o}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. Their use in complete devices on glass and on flexible plastic substrates will be illustrated.

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