Ionic Conductive Hybrid Polymer Membrane for Lithium ion Batteries

H. Rouault[a], G. Besnard[a], E. Gutel[a], J. Abusleme[b], S. Brusseau[c], M-D. Braida[d]

[a]CEA-Grenoble LITEN/DEHT - 17, rue des Martyrs 38054 Grenoble cedex 9 – France

[b] Materials- Solvay - 20, Viale Lombardia, 20021 Bollate – Italy

[c] Materials - Solvay France, 2 avenue de la République, CS 10001, 39501 Tavaux cedex, France

[d] Solvay R&I - 52 rue de la Haie Coq, 93300 Aubervilliers – France

*Corresponding author: Helene.rouault@cea.fr, +33 (0)4 38 78 34 66

Abstract:

In the last several decades, rechargeable lithium-ion batteries have gained great success as energy sources for many applications from portable devices to pure or hybrid electric vehicles. Indeed, lithium based batteries exhibit high specific energy, long cyclelife, high efficiency, high charge/discharge rate capability and low self-discharge.[1-2]

The conventional electrolytes used in most commercial batteries are composed of Li-salt containing liquid organic solvents impregnating a separator. High safety measures are therefore implemented to avoid any critical safety issues, such as electrolyte leakage and/or fire and/or explosion in case of failure[3]. This is why CEA-Liten and Solvay have developed a new, safer and durable ionic conductive hybrid polymer membrane as electrolytic compartment, wherein the liquid electrolyte is strongly confined.

The hybrid polymer membrane is a polymeric network prepared from a Solvay proprietary functionalized poly(vinylidene difluoride), able to be linked by *in situ* synthesized Si-O bonds through a sol-gel reaction in presence of a liquid organic electrolyte. A polymeric solution containing the electrolyte is first elaborated according to a two-step cross-linkage method. It is then coated and dried in air under appropriate conditions.

The mechanical properties of the membrane were also tuned by adjusting the properties of the polymer. Adapting the synthesis conditions accordingly, the membrane can be manufactured using a conventional coating machine in a continuous mode in a dry room, making the method perfectly compatible with an industrial process.

A membrane trapping ethylene carbonate/Propylene Carbonate (EC:PC 1:1) and lithium hexafluorophosphate $LiPF_6$ (1M) as electrolyte was thus manufactured. It is homogeneous and flexible. Retaining fully the aimed amount of electrolyte, it exhibits high ionic conductivity (1-3.7 mS/cm). Tested in 500 mAh cells, it works efficiently with performances at least equivalent to conventional Li-ion cells and exhibits a very stable behaviour with very long cyclelife.

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