Innovative Polymeric Separators from recycled PVB for both Li- and Na-ion Batteries

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Large-scale energy storage systems are becoming fundamental for the modern society, particularly to fully exploit major advantages from renewable energy sources, such as wind and solar light. In this respect, secondary sodium-based batteries may represent the key technology since they possess high-energy density, low-cost, simple design and easiness in maintenance. Nevertheless, the state of art materials are rather far from a mass commercialization. Beside electrode materials, an essential role is played by electrolytes and separators, which are deepened in this work. Indeed, many factors must be considered while selecting the best separator, including electronic insulation, low ionic resistance, mechanical stability, chemical resistance to degradation, wettability and uniform thickness [1].

In this context, we prepared polyurethane-based membranes starting from polyvinyl butyral (PVB) and diisocyanate, by means of a coagulation bath [2,3]. The choice of PVB as polymer is related to the European project *SUNRISE*, which aims to find different recycling pathways for this material, normally used as polymeric interlayer into laminated glasses for construction and automotive. At the moment, the PVB fraction collected after disposal, that lacks of optical and mechanical requirements for its original purpose, is incinerated or landfilled, causing tons of losses every year, even though it could find a second life within the energy storage panorama [4].

After preparation by a quick and scalable procedure, our PVB-based membranes were characterized from the physico-chemical point of view by means of thermal analysis (DSC and TGA), dynamic mechanical analysis (DMA), infrared spectroscopy (IR) and field-emission scanning electron microscopy (FESEM). Successively, they were tested as separating membranes inside both lithium- and sodium-metal cells, wetted with the following electrolyte solutions: 1) lithium exafluorophosphate ($LiPF_6$) 1M in EC:DMC, 2) sodium exafluorophosphate ($NaPF_6$) 1M in EC:DMC. Ionic conductivity, plating and stripping processes, cyclic voltammetry and galvanostatic cycling were evaluated, to demonstrate the practical application of the developed materials in laboratory scale Li- and Na-based electrochemical cells at various conditions of current rate, temperature and aging. Preliminary results are highly encouraging and pave the way to the development of more sustainable separators from waste products for safe, low-cost energy storage devices.

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