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

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Electrochemical energy storage and conversion systems are integral to our daily lives and hold significant importance for the future, addressing environmental concerns and the energy crisis. The pursuit of greener, more affordable, and safer rechargeable batteries is currently recognized as a strategically important goal in advancing energy storage technology. Li-ion batteries (LIBs) and Na-ion batteries (NIBs) play a crucial role as energy storage devices for electric vehicles and smart grids. It's widely recognized that a detailed analysis of an electrode reveals that each component—such as the active material, conductive carbon, current collector, and binder—contributes to the overall battery performance. It has been discovered that the binder, despite its relatively low content—typically a few percent (up to 5 wt%, but usually 2 wt%) in relation to the total electrode composition—plays a decisive role in determining electrode performance. This is noteworthy considering its chemical and electrochemical inactivity. Besides, 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]. In addition, particular attention is paid to understanding the impact of PVB as a binder on the properties and behavior of electrodes based on hard carbon, and especially the effects given by the different physical structures of the electrodes toward the electrochemical response in LIBs and NIBs. The choice of PVB as the 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, which lacks 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 [3]. The goal of our group is to exploit new strategies for the reuse in energy storage application of the fraction of PVB, which does not fulfill the requirements for the re-integration in the original glass manufacturing process.

PVB-based membranes were characterized from the physico-chemical and they were tested as separating membranes inside both lithium- and sodium-metal cells. We have made a research of the electrochemical performances of hard carbon with PVB, polyacrylic acid (PAA) and poly(vinylidene fluoride) (PVDF) binders for LIBs and NIBs.

Preliminary results are highly encouraging and pave the way to the development of more sustainable separators and binders from waste products for safe, low-cost energy storage devices.

Acknowledgments

The SUNRISE project (https://sunrise-project.eu/) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958243.

References

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