Towards Solid Batteries Operating at Ambient Temperature Through Safe, Highly Conducting, Solid Polymer-based Electrolytes

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Standard commercial rechargeable batteries use liquid electrolytes, and their flammability clearly raises safety concerns. The most striking solution at present is to switch on all solid-state designs exploiting polymer materials, films, ceramics, etc., particularly in Li-based batteries. [1] To enhance low ionic conductivity/transport properties and stringent processing conditions, several approaches have been proposed including the in-situ preparation of polymer electrolytes using solvent-free processes. [2] Ionic conductivity can be controlled through crystallinity reduction, and by means of addition of plasticisers, ceramic fillers, functionalisation and proper crosslinking.

In the present talk, an overview will be offered of the recent developments on advanced polymer electrolytes for Li/Na-based batteries, chiefly by means of UV-induced photopolymerization (UV-curing), which is easily scalable to an industrial level due to its easiness and rapidity in processing, high efficiency and eco-friendliness as the use of solvent is avoided. Different systems can be prepared allowing the incorporation of high amount of RTIL (aprotic or even protic ionic liquids) or tetraglyme and lithium salt ($TFSI^-$ or FSI^- anion), leading to polymer electrolytes with remarkable homogeneity and robustness. [2-4] To increase even more the cycling ability at (sub-) ambient temperatures, recent efforts have been dedicated to the formulation of composite hybrid polymer electrolytes (CPEs), where the ceramic superionic conducting material is homogeneously embedded in the polymeric matrix [5], thus preserving flexibility, easy processing, and improved ionic transport and interfacial contact with the electrodes. In addition, to achieve high energy density, the development of polyanionic systems, namely Single Ion Conducting Polymer Electrolytes (SICPEs), has been addressed. SICPEs are relatively novel technology, characterized by transport number close to the unity due to the presence of anchored ionic moieties, which avoid ionic polarization issues and side reactions at the interface with the electrodes. [6]

The lab-scale Li-polymer cells assembled with the different electrode materials (e.g., $LiFePO_4$, Li-rich NMC, $LiNiMnO_2$, Silicon, NVPF, etc.) show highly reversible charge/discharge characteristics with full specific capacities, limited capacity fading upon very long-term reversible cycling and stable operation for hundreds of cycles at ambient temperature [2-6].

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