

Ionogel-based solid state rechargeable devices

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We are developing ionogels,¹ which are confined ionic liquids (ILs) within various host networks, in order to fabricate self-standing solid-state membranes, all-solid-state Li metal batteries, and all-solid-state supercapacitors with good performance. We analyze as well what are the needed criteria to obtain good cycling efficiency and durability of the Li metal electrode in contact with these ionogel solid electrolytes.

Mesoporous-silica ionogel solid electrolytes were integrated in the porosity of tape-cast thick LiFePO₄ and LiNi_{1/3}Mn_{1/3}Co_{1/3}O₂ positive electrodes, and electrode-electrolyte assemblies with intimate contact and ionic continuity were successfully prepared at the lab scale with equivalent performance to their liquid counterpart.² For easier processing at the industrial scale, new flexible ionogel solid electrolytes synthesized by immobilizing an IL within a hybrid organic–inorganic matrix, exhibit high ionic conductivity and good mechanical properties. Validation of these flexible ionogels as solid electrolytic separators in Li metal solid-state batteries has been shown.³ Development at the industrial scale is underway.

We report as well on novel printable and flexible polymer gel electrolytes, obtained by UV photo-polymerization of acrylic monomers dissolved into an IL. Such photo-ionogels are cast or printed on Li electrode or porous composite LiFePO₄ electrode, thus resulting in all-solid state electrode/electrolyte assemblies. A critical role of the adhesion properties of the photo-ionogel on the long-term stability of the Li electrode interface was found, leading to a promising composition for a polymer gel electrolyte with high ionic conductivity, and low interfacial resistance with lithium electrode,⁴ leading to excellent capacity retention of Li//LiFePO₄ cell for more than 1000 cycles.

Other ionogel materials were developed for applications in all-solid-state symmetrical carbon electrochemical double layer capacitors⁵ and in solder-reflow resistant symmetrical Si nano-wire solid-state microsupercapacitors.⁶

References:

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