Ceramic fillers in Li-ion battery electrolytes

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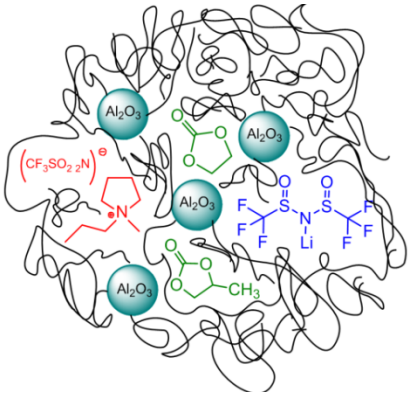
Electrolytes are crucial components in a Li-ion battery cell with respect to the linkage of the electrodes by Li-ions. Up to date, liquid and polymer gel electrolytes are used in commercially accumulators based on organic carbonates, $LiPF_6$, PVdF, and various additives. However, in the literature, prospective investigations are already described by adding solids, namely nano- or micro-structured particles like Al_2O_3 or SiO_2. The addition of such particles may have positive effects with respect to an optimized Li^+-transport. In addition, the replacement of $LiPF_6$ and organic solvents with high vapor pressures is more and more stipulated because of safety issues. Here, ionic liquids are one possible alternative for such critical solvents in respect to safety, electrochemical stability against lithium and high intrinsic ion conductivity.

In this study, ceramic fillers are investigated regarding to their potential in Li-ion battery electrolytes. First, different approaches are presented how the fillers can be stabilized in an ionic liquid based liquid electrolyte. However, because of the lack of the persistent colloidal stability in such liquid systems, gel polymer electrolytes are investigated in a second step. Methacrylate based gel electrolytes are chosen and it is shown that these gel electrolytes can be principally used in a Li-ion battery cell based on graphite and $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ (NMC). Subsequently, the stabilization of ceramic fillers in these gel electrolytes is investigated in detail. It could be shown that it is possible to produce feasible gel electrolytes with selected ceramic fillers. In the figure, a schematic model is depicted to illustrate the complex interaction between the electrolyte components.



Schematic illustration of the polymer matrix including the polymer, Al_2O_3, ethylene carbonate, lithium bis(trifluoromethylsulfonyl)-azanide, propylene carbonate, and N-methyl-N-propylpyrrolidinium bis(trifluoromethyl-sulfonyl)azanide.