LITHIUM METAL AS KEY MATERIAL FOR FUTURE HIGH ENERGY DENSITY BATTERIES: PRE-LITHIATION OF LI ION BATTERY MATERIALS AND RECHARGEABLE LITHIUM METAL/POLYMER ELECTROYLE CONCEPTS

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The next generation of lithium ion batteries (LIBs) with increased energy density requires not only advanced electrode active materials with enhanced specific and volumetric capacities, but also advanced concepts to mitigate active lithium losses during operation and, therefore, to increase the practical useable energy.[1,2] Pre-lithiation, which refers to the addition of active lithium to the cell before operation, is considered as a highly attractive concept to compensate active lithium losses, *e.g.* caused by formation of the solid electrolyte interphase (SEI). In the 1st part of this presentation, we will compare different pre-lithiation techniques and report on the pre-lithiation kinetics. In addition Li metal pre-treatment will be addressed.[3]

Within the 2nd part of this report, we introduce a new generation of superior solid-state polymer electrolytes based on nano-channels formed by supramolecular assembly for fast lithium-ion transport and enhanced interfacial properties against lithium metal. Supramolecular chemistry, defined as the "chemistry beyond the molecule", refers to assembled molecules that bond and organize through non-covalent intermolecular host-guest interactions, for example hydrogen bonds, metal coordination and π-interactions. For use in lithium batteries, the self-assembly of polyrotaxanes (PRs), where molecular rings (e.g. cyclodextrin (CD)) are threaded onto a polymer chain (e.g. polyethyleneoxide (PEO)), is considered to have important impact for the design of a new generation of solid state-polymer electrolytes. Since the formed nanochannels can provide fast lithium ion transport between the anode and cathode, these systems can be utilized as solid polymer electrolytes or gel-type electrolytes with ionic liquids or organic solvents. CD comprises many hydroxyl groups and can be easily modified. Our results show that rational design of the obtained complexes can tune the structure-property relations resulting in highly promising materials exhibiting high ionic conductivity and transference number and thus remarkable electrochemical performance in rechargeable solid-state lithium metal-based cells with superior interfacial properties.

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