Nanomaterials meet Li-ion Batteries

Katharina M. Fromm, Nam Hee Kwon, Aurelien Crochet, Jean-Pierre Brog, Sivarajakumar Maharajan, Herve Yao

Department of Chemistry, University of Fribourg, Chemin du Musée 9, 1700 Fribourg, Switzerland
Katharina.fromm@unifr.ch

Layered $LiCoO_2$ is one of the most frequently used cathode materials in today's Li-ion batteries. The micron scale material is typically produced via solid-state synthesis methods at high temperature >800°C and over several days. Due to the large particle sizes, only half of the lithium ions can be used for the functioning of the battery. Nanoscale cathode materials have the advantage that the lithium ion diffusion path lengths are much shorter, hence extraction and reinsertion of Li^+ into the cathode material becomes faster and a higher ratio of cations is thus available for the electrochemical reaction.

We developed therefore a synthetic access to multi-gram scale nano-$LiCoO_2$, which will be presented. Furthermore, this material was tested in half-cells with lithium metal as counter electrode to confirm its electrochemical properties. Another new cathode material, $LiMnPO_4$, is based on the olivine-type structure, featuring lithium ion channels. We will present its synthesis, the different particle shapes and sized which we obtain as a function of reaction conditions, as well as the exciting electrochemical results.[1]

On the anode side of current batteries, one of the major challenges is the large expansion of the material upon lithium ion insertion. This leads to crack formation and detachment of the active material from the current collector and hence to a decreased of performance. We therefore design nanorattles where an electron- and ion conductive material forms a shell around the anode-nanoparticles. A void between shell and particle allows the particle to swell upon lithium ion insertion without breaking of the shell. This concept will be exemplified using tin as the anode active material (Fig. 1)

Finally, we propose new ionic liquid based electrolytes for applications in high voltage batteries.

References

[1] N. H. Kwon, J.-P. Brog, S. Maharajan, A. Crochet, K. M. Fromm, Chimia **69** (2015) 734-736

Figures

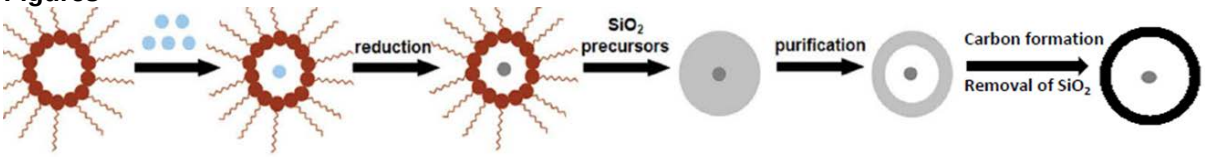

Figure 1: Schematic representation of nanorattle formation