Li-Ion Transport in Nanotubes and Ordered Mesoporous Oxides

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Ordered nanostructures are very attractive for realizing efficient new architectures for battery materials. Already in 2004 Long *et al.* proposed three-dimensional nanostructures with intergrown anode, cathode, and electrolyte [1].

TiO_2 was the first oxide being studied for battery application with defined and ordered 1D, 2D or 3D architectures. We could demonstrate that highly ordered mesoporous 3D-networks of well-crystalline anatase lead to very fast electron/ion transport and large amounts of charges storable in such thin films [2]. The employment of templating polymers ensuring high crystallinity in the applied soft-templating route is an important prerequisite (Fig. 1). Since the polymer stability is that limiting and applicable polymers are very expensive, the nanocasting approach employing porous oxides (mostly SiO_2) or carbons as hard templates rendered high attraction as more practical alternative. Ordered mesoporous oxide films and powders like TiO_2, SnO_2, Co_3O_4 or even $CuCo_2O_4$ [3] have been 3D-nanostructured by nanocasting. Intercalation of Li^+ ions and their dynamics in the pores have been intensively studied by the groups of Bruce [4] and Wilkening [5]. The talk will discuss their findings and will compare them to results on 1D nanotube structures.

TiO_2 nanotubes, for example, have the advantage that they can be much easier prepared in high quantity from a simple hydrothermal route [6]. Involved titanates are interesting for Li ion intercalation by themselves; most promising for battery applications, however, are the quite high amounts of TiO_2-B being formed [7].

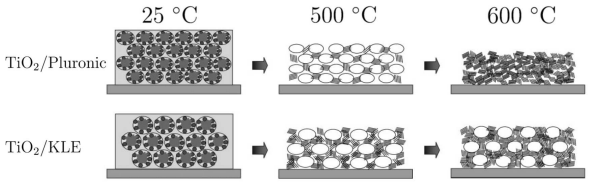

Figure 1: Simplified model for the crystallization of mesoporous KLE- and Pluronic P123-templated TiO_2 films. The more temperature stable KLE-block-copolymer ensures high crystallinity under preservation of the pore ordering and thus the high active inner surface area [2].

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