

Li Insertion Behaviour of Rutile TiO₂ Nanorods as Anode Material in Lithium-Ion Batteries

M. Uitz,^{1,2} P. Bottke,^{1,2} W. Schmidt,¹ M. Wark,^{2,3} I. Hanzu,^{1,2} and M. Wilkening^{1,2}

¹Graz University of Technology, Christian Doppler Laboratory for Lithium Batteries, Institute for Chemistry and Technology of Materials, Stremayrgasse 9, A-8010 Graz, Austria;

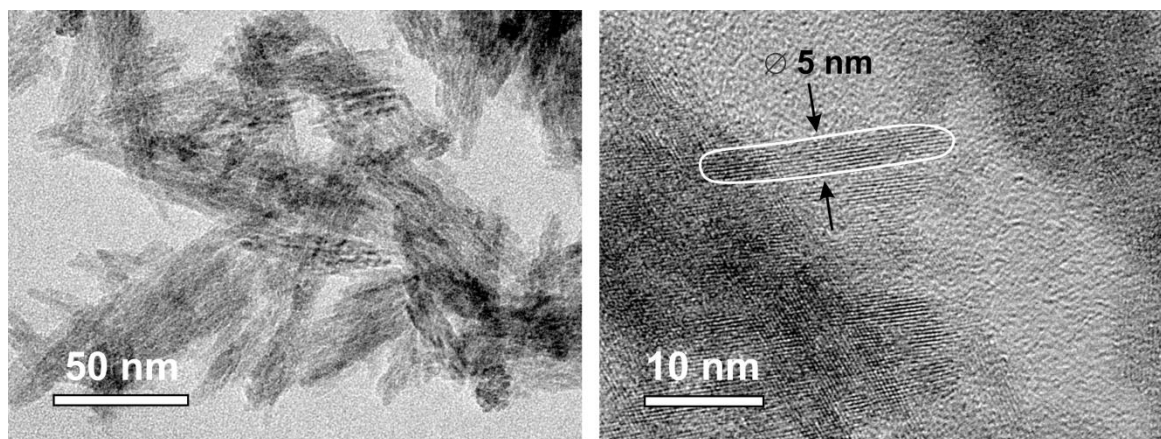
²DFG-Forschergruppe 1277 'molife' Mobilität von Lithium-Ionen in Festkörpern;

³University of Oldenburg, Technical Chemistry, D-26111 Oldenburg, Germany

E-Mail: uitz@tugraz.at, wilkening@tugraz.at

Nanocrystalline transition metal oxides have been intensively studied as promising anode materials in secondary lithium-ion batteries (LIBs) [1]. Compared to their coarse grained counterparts the increased electrochemical performance, resulting in high reversible capacities, is due to the large specific surface area and pore volume. This is beneficial for long-range transport because it reduces both the diffusion lengths of electrons and lithium ions. Besides small volume expansion during Li insertion, the 1D nanostructure of the nanorods investigated might be beneficial for the performance of the anode material in LIBs [2].

After structural characterization of the commercially available TiO₂ nanorods (rutile) by XRD and HR-TEM, Li half-cells were assembled under Ar gas atmosphere by taking advantage of the Swagelok-technique. Depending on the preparation and final composition of the electrode as well as the charge/discharge rate applied (0.1 C ... 1C), capacities of up to 250 mAh/g (0.1 C) can be obtained. Starting with an initial value of 200 mAh/g at a rate of 1C, the capacity reaches ca. 150 mAh/g after 100 cycles. Besides galvanostatic cycling, cyclovoltammetry was used to study the Li insertion behavior of the active material. The measurements will build the basis for a systematic analysis of Li ion dynamics in the Li_xTiO₂ nanorods via ⁷Li solid-state NMR spectroscopy, see ref. [3] for preliminary results obtained earlier.



(HR)-TEM images of TiO₂ nanorods investigated electrochemically. The rods show lengths in the order of 20 to 30 nm; the mean diameter is approximately 5 nm.

References

- [1] A. S. Aricò, P. G. Bruce, B. Scrosati, J.-M. Tarascon, W. van Schalkwijk, *Nat. Mater.* **4** (2005) 366.
- [2] H. Qiao, Q. Luo, Q. Wei, Y. Cai, F. Huang, *Ionics* **18** (2012) 667.
- [3] J. Heine, M. Wilkening, P. Heitjans, *Diff. Fundam.* **12** (2010) 95.