

Sn-Filled Titania Nanotubes as Anode Material for Rechargeable Li and Na Batteries

Denise Prutsch^a, Bernhard Gadermaier^a, Martin Wilkening^{a,b} and Ilie Hanzu^{a,b}

^a *Institute for Chemistry and Technology of Materials, Christian Doppler Laboratory for Lithium Batteries, Graz University of Technology (NAWI Graz), Stremayrgasse 9, 8010 Graz, Austria*

^b *Alistore-ERI European Research Institute, Amiens, France*

E-mail: denise.prutsch@tugraz.at

In recent years, self-assembled TiO₂ nanotubes formed by electrochemical anodization have attracted significant attention as possible anode material for rechargeable batteries [1]. Moreover, because of the highly ordered nanotubular structure, TiO₂ nanotubes can serve as an excellent substrate for further loading with a second functional material such as metals or semiconductors which results in tubes with either enhanced or completely new properties. Nanostructured Sn-based materials are known as high-capacity anodes for Li-ion and Na-ion batteries [2]. However, these materials suffer from volume expansion and contraction during cycling leading to mechanical disintegration of the anode. Thus, encapsulation of Sn metal *into* such titania nanotubes can prevent coalescence of the Sn nanoparticles most probably ensuring a longer cycle-life of the electrode.

Here, we present the first successful (direct) electrodeposition of Sn metal inside self-organized anodic titania nanotubes. The formation of such highly parallel TiO₂ nanotube layers was achieved by a two-step anodization process in a fluoride containing electrolyte. Filling of these amorphous tubes, showing a length of 2.5 μm and an inner diameter of approx. 100 nm, with tin metal was carried out using a pulsed galvanostatic approach. It turned out that a mixture of SnCl₂, tribasic sodium citrate and NaNO₃ as Sn deposition solution in combination with high current densities (1 A/cm²) at optimized pulse durations gave the best results [3]. The morphology of the newly prepared tin-titania nanocomposite arrays was thoroughly followed up by scanning electron microscopy. The electrochemical behavior is now being investigated by cyclic voltammetry and galvanostatic cycling.

References:

- [1] D. Prutsch, M. Wilkening, I. Hanzu, ACS Appl. Mater. Interfaces 7 (2015) 25757-25769.
- [2] Y.H. Xu, Q.Liu, Y.J. Zhu, Y H. Liu, A. Langrock, M.R. Zachaariah, C.S. Wang, Nano Lett. 13 (2013) 470-474.
- [3] D. Prutsch, M. Wilkening, I. Hanzu, RSC Adv. 6 (2016) 98243-98247.