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

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

\textsuperscript{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

\textsuperscript{b} Alistore-ERI European Research Institute, Amiens, France

E-mail: denise.prutsch@tugraz.at

In recent years, self-assembled TiO\textsubscript{2} 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, TiO\textsubscript{2} 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 TiO\textsubscript{2} 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 \textmu m 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 SnCl\textsubscript{2}, tribasic sodium citrate and NaNO\textsubscript{3} as Sn deposition solution in combination with high current densities (1 A/cm\textsuperscript{2}) 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: