Hydrothermally Synthesized Nanostructured Sodium Titanates as Negative Electrode Materials for Na-Ion Batteries

P. Posch, P. Bottke, M. Wilkening, and I. Hanzu

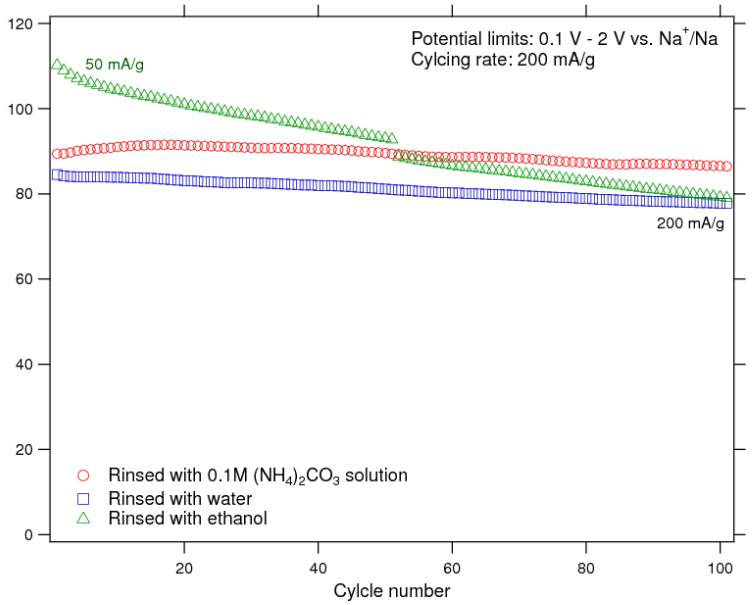
Graz University of Technology, Christian Doppler Laboratory for Lithium Batteries, Institute for Chemistry and Technology of Materials, Stremayrgasse 9, A-8010 Graz, Austria;

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

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

Currently, there is much interest and research efforts dedicated towards electrochemical energy storage systems based on sodium ions. The basic principle of operation of a Na-ion cell is analogous to that of a Li-ion technology: the alkali ions (Na) are reversibly inserted/deinserted from the electrode material when the battery is charged or discharged. In contrast to lithium-ion batteries, Na does not intercalate into graphite as Li usually does. Thus, one of the issues associated with the realization of Na-ion batteries is the difficulty to find cost-effective negative electrode materials able to operate at low potentials. Recently, $Na_2Ti_3O_7$ has been identified as a good anode material that shows good rate capability and competitive capacity.

Here, we present an investigation of the electrochemical properties with respect to Na insertion of some hydrothermally synthesized nanostructured sodium titanates with various Na/Ti ratios. In a typical synthesis, 6 g of commercial titania (anatase, Sigma-Aldrich) was treated for 72 h in a sealed autoclave at 165 °C. Afterwards, the reaction mass, consisting of a hydrated titanate precursor with the general formula $Na_yH_{1-y}Ti_nO_{2n+1}$ and excess NaOH was rinsed according to various methods chosen to remove only the NaOH in excess while leaving most of the Na located in the precursor. Three different rinsing methods were used: (*i*) rinsing with a limited quantity of water, (*ii*) rinsing with ethanol and (*iii*) rinsing with a buffer solution based on ammonium carbonate.



Galvanostatic cycling *vs* Na metal of the nanomaterials prepared. The samples rinsed with ammonium carbonate and those rinsed with a small quantity of water seem to behave the best in terms of cycle life when charged and discharged at relatively fast rates.