New Lithium Titanate as Anode Material for Lithium Ion Batteries

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Lithium titanium spinel $Li_4Ti_5O_{12}$ has been reported by Ohzuku et al. as zero strain lithium insertion host material according to the extremely small variations of the lattice parameters during the charge and discharge processes [1]. During the last years, a significant improvement in terms of capacity and rate capability has been achieved by reducing the material primary particle size and coating the particles with a conductive additive [2,3]. A novel technique was developed to prepare lithium titanate (optionally carbon coated) with much improved electrochemical properties compared to a standard solid state process.

This new process allows the preparation of aggregates of carbon coated or uncoated lithium titanate, with sizes ranging from 1 to 30 microns, which was confirmed by SEM images. The aggregates consist of submicronic sintered primary particles.

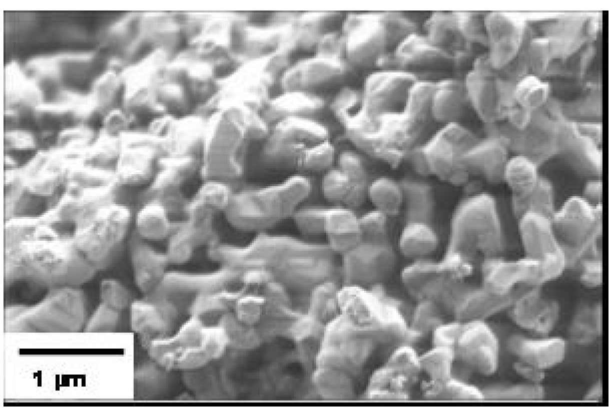

Figure 1: SEM Photograph of an uncoated $Li_4Ti_5O_{12}$

The typical morphology of the unmilled material allows an easy fabrication of uniform electrode films. The specific charge/discharge capacity achieved at low rates of about 165-170 Ah/kg is close to the theoretical value, in contrast with a value of 130-140 Ah/kg for a lithium titanate (coated or not) obtained by a typical solid state reaction at high temperature.

The capacity and the cycle stability in a laboratory half cell are remarkably excellent at the C rate, with an average fading in the magnitude of 0.01 %/cycle. Similar results are obtained for carbon coated samples.

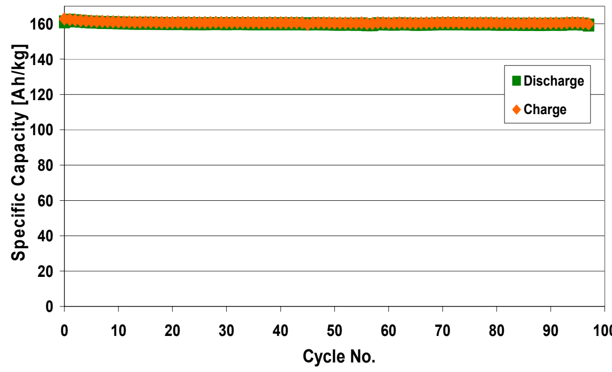

Figure 2: Cycle performance of an uncoated $Li_4Ti_5O_{12}$ in half cell against metallic lithium at the C rate.

Paul Scherrer Institute optimized the electrode formulation of $Li_4Ti_5O_{12}$ for an active mass content of 85 wt. %.Figure 3 displays the rate capability (Li extraction) for an uncoated $Li_4Ti_5O_{12,}$ indicating a capacity retention of 96% even at the 20C rate. All the test cells were cycled in the range 1.0V – 2.0V at 20°C.

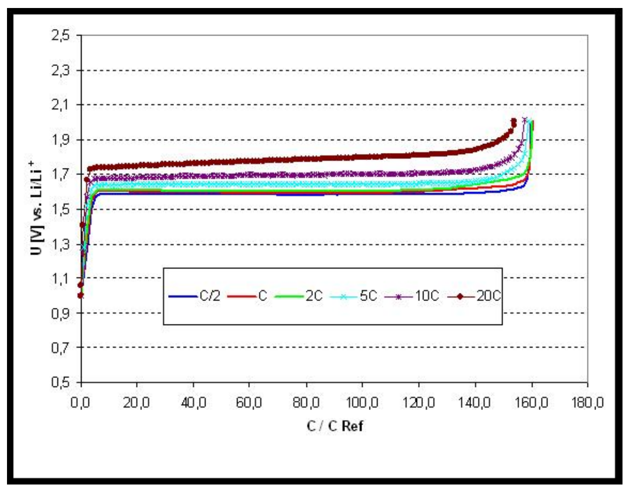

Figure 3: Rate capability of an uncoated $Li_4Ti_5O_{12}$ in half cell against metallic lithium. Active mass loading: 2.8 mg/cm^2.

Those results based on thin electrodes are encouraging for the further development of lithium titanate as anode material for lithium ion batteries in stationary and high power applications.

[1] T. Ohzuku, T. Ueda and N. Yamamoto, J. Electrochem. Soc. Vol. 142 (1995) pp.1431.
[2] L. Kavan and M. Graetzel, Electrochem. Solid State Lett., 5 (2002) pp. 39.
[3] J.R. Li, Z. L. Tang, Z. T. Zhang, Electrochem. Commun., 7 (2005) pp. 894.