Li-Insertion into $Li_4Ti_5O_{12}$ (Spinel): Charge Capability vs. Particle Size and Electrolyte dependence in Thin-Film Electrodes

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$Li_4Ti_5O_{12}$ (spinel) materials were prepared with BET surface areas ranging from 1.3 to 196 m^2/g. The corresponding average particle sizes varied from ca. 1 μm to ca. 9 nm. Twenty five different materials were tested as Li-insertion hosts in thin-film electrodes (2-4 μm) made from a pure spinel. Electrodes from nanocrystalline $Li_4Ti_5O_{12}$ exhibited excellent activity towards Li-insertion, even at charging rates as high as 250C.

The variation of charge capability at 50C - 200C with the surface area will be shown, as well as the dependence of charge capability vs. particle size, for some representative samples of $Li_4Ti_5O_{12}$, in different electrolytes: conclusive remarks will be highlighted.

Additionally data showing that these materials can be charged/discharged nearly to the nominal capacity of $Li_4Ti_5O_{12}$ (175 mAh/g) independently of the charging rate at the mentioned conditions will be presented. The Li-diffusion coefficients, determined from galvanostatic chronopotentiometry, decrease by orders of magnitude as the average particle sizes drop from ca. 1 μm to ca. 9 nm. However, the sluggish Li^+-transport in small particles is compensated by the increase in active electrode area.

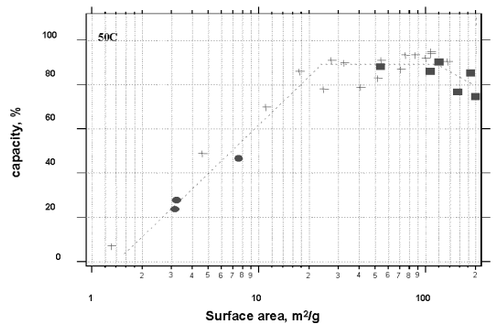

Figure 1. Charge capacity (referred to a nominal charge capacity) of $Li_4Ti_5O_{12}$ materials with varying surface areas. The charging rate was 50C. The charge capacity was determined from galvanostatic chronopotentiometry with the cut-off voltages of 3 and 1 V. The nominal charge capacity was determined from slow cyclic voltammetry at scan rates <1mV/s. Electrolyte solution: 1 M $LiN(CF_3SO_2)_2$ + EC/DME (1:1, v:v).