Self-Supporting Lithium Titanate-Carbon Nanotube Films for High-Rate Performance Anodes of Lithium Ion Batteries

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$Li_4Ti_5O_{12}$(LTO) is an anode material having high rate performance and reliability [1], however, has a low electric conductivity and theoretical capacitance (175 mAh/g_{LTO}) compared with the standard graphite anodes. To overcome these issues, we propose a new strategy using carbon nanotubes (CNTs). CNTs have unique one-dimensional nanostructure, and can yield self-supporting, sponge-like flexible papers with good electrical conductivity via simple dispersion-filtration process. 3D CNT current collector will offer sufficient electric path to LTO and reduce the mass of the components not contributing to capacity (i.e., metal foils and polymer binders) [2].

Submillimeter-long few-wall CNTs produced by fluidized-bed chemical vapor deposition method [3] and LTO particles were dispersed in 30 mL ethanol and vacuum filtrated to yield self-supporting LTO-CNT composite papers. The electrochemical analysis was conducted with 1 M lithium hexafluoro-phosphate in ethylene carbonate and diethylcarbonate (v:v=1:1) as the electrolyte and the lithium metal foil as the cathode. The electrode with 1 wt% CNTs showed a high rate performance with discharge capacity of >100 mAh/g_{LTO} at 7.6 mA/cm^2 (5 C-rate). But excess CNTs increased the electrode thickness, causing degradating high-rate performance by increasing ion diffusion distance. We, then, added athethylene black (AB) to LTO/CNT electrode for enhancing conductivity without thickness expansion. Electrode with 1 wt% CNT and 4 wt% AB showed a improved rate performance with a discharge capacity of >100 mAh/g_{LTO} at 12.1 mA/cm^2 (10 C-rate).

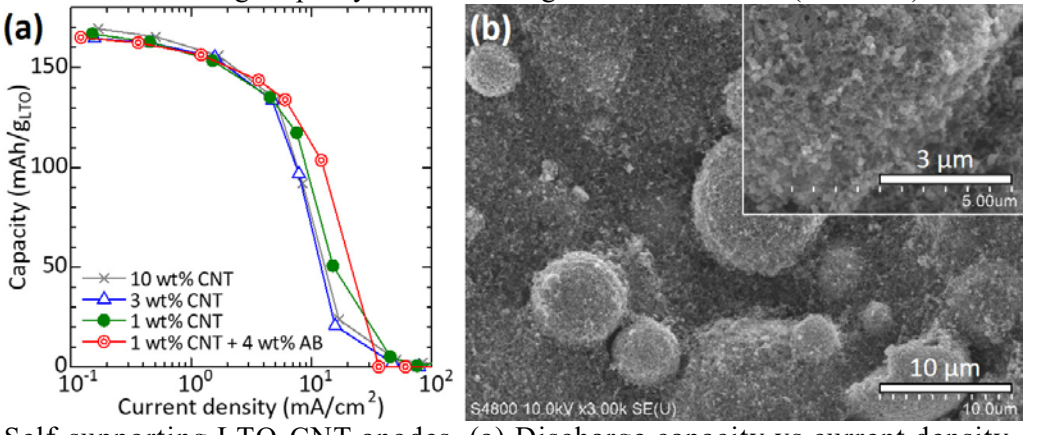

Fig. 1. Self-supporting LTO-CNT anodes. (a) Discharge capacity vs current density. (b) SEM images of LTO anodes with 1 wt%-CNT and 4 wt% AB.

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