Novel Lithium Titanate for High-Power Applications

Hong Jin
J. Simon Xue
Francis P. Wang
Guanghong Pan

National Institute of Clean-and-Low-Carbon Energy
P. O. Box 001 Shenhua NICE, Future Science & Technology City, Changping District, Beijing 102209, P. R. China

The spinel phase lithium titanium oxide ($Li_4Ti_5O_{12}$, referred as LTO) is considered to be one of the safest anode materials for lithium ion batteries. LTO's unique chemical/physical properties make it a promising lithium ion anode material. Firstly, it is the so-called zero-strain material, i.e. the volume of which does not change during battery charge and discharge, enabling an extremely long cycle life and excellent capacity retention. Secondly, LTO has a low reactivity towards the electrolyte and forms no Solid Electrolyte Interface (SEI) layer during cycling. This unique property leads to enhanced safety especially in an abusive situation. It also aids to a long cycle life and high charge and discharge capability over a wide temperature range. For instance, the LTO cell can deliver over 40% of its original capacity at C-rate at -40° C. Thirdly, the electrochemical potential of LTO vs. lithium is ~1.55V, so no Li dendrite could be formed on the surface of the negative electrode during cycling, which largely improves the LTO battery's safety.

One issue, however, is associated with the low electron conductivity of LTO which is around 10^{-13}-10^{-9} S/cm. The electronic structure of LTO characterized by empty Ti 3d-states with a band gap energy of ~2eV gives an insulating character to this material. This insulating feature prevents the electron transport during charge/discharge of the battery. The challenges facing large scale energy storage or EV applications of LTO batteries include how to increase its energy density, and how to lower its cost, etc. To tackle these issues, we have developed a novel type of lithium titanate material with improved electronic conductivity and energy density that is extremely useful in high power applications such as EV (electrical vehicles), HEV (hybrid electrical vehicles), PHEV (plug-in hybrid electrical vehicles), and renewable energy applications such as wind smoothing.