Development of SnO_2-upgraded graphite electrodes with excellent cycling stability

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The fast-growing energy demand of emerging applications, such as electric vehicles and stationary storage, requires next-generation Li-ion batteries with improved specific energy and power. One effective approach to increase the specific energy of a Li-ion battery is to develop anodes with higher specific charge. This can be achieved by incorporating defined amounts of a specific-charge-enhancing component (i.e. an element or compound possessing a significant higher specific charge) in a graphite-based electrode. In such electrodes graphite provides good electrical conductivity, Li mobility within the electrode, contributes to the specific charge and lowers the average potential, while the specific-charge-enhancing component contributes to increase the specific charge of the whole electrode above the graphite's standard 372 mAh/g.

Tin oxide (SnO_2), which has been investigated in the last few years as one of the most promising metal oxide anode materials for Li-ion batteries, can act as a specific-charge-enhancing component due to its high theoretical specific charge (1494 mAh/g). Such specific charge is the result of the conversion reaction of SnO_2 to Sn and Li_2O, followed by the alloying reaction of Sn with Li to form Li_xSn during the lithiation. However, the volume changes accompanying the alloying and conversion reactions are detrimental for the electrode causing pulverization of active material and loss of electrical contact between the particles and the current collector [1], and this, in turn, gives rise to a poor cycling stability.

The goal of our work was to investigate the influence of different parameters, such as amount of SnO_2, type and amount of binder, electrolyte additive, voltage cut-off and type of graphite, on the electrochemical performance of SnO_2-graphite electrodes. The optimization of these parameters was performed aiming to obtain the best cycling stability. Furthermore, a post-mortem physicochemical analysis was carried out to understand the reasons of the capacity fading. SnO_2-graphite electrodes containing 50 wt% of SnO_2, KS6L graphite, PAA:CMC binder cycled with 1 V cut-off and FEC electrolyte additive showed a 1st cycle specific charge of 500 mAh/g and 92% capacity retention after 200 cycles.

References:

[1] Reddy, M.V., G.V. Subba Rao, and B.V.R. Chowdari, *Metal Oxides and Oxysalts as Anode Materials for Li Ion Batteries.* Chemical Reviews, 2013. **113**(7): p. 5364-5457.