Rational Material Design for Enhanced Conversion Reaction in Sn-based Nanocomposite Anodes

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Since the reversibility of conversion reaction between Sn and Li_2O to form SnO_x has been demonstrated in SnO_2 lithium-ion battery anode, its theoretical capacity is ideally extended from 782 to 1494 mAh g^{-1}, where the complete oxidation of Sn to SnO_2 occurs over conventional alloying/de-alloying reaction. [1,2] In this study, Sn-doped Fe_3O_4 nanoparticles anchored on reduced graphene oxide are synthesized to promote the oxidation reaction by maintaining a structural integrity. The perfect incorporation of Sn into Fe_3O_4 lattice is identified by X-ray diffraction and X-ray absorption spectroscopy (XAS) analyses. Through the investigation on electronic state and atomic structure of electrode during the progress of cycle with element-specific XAS analysis, the enhanced conversion reaction is confirmed, and the complete oxidation into SnO_2 is attributed to the activation phenomena, the continuous capacity increase upon cycling, along with a reversible growth of organic polymer/gel-like film. This material design not only demonstrates the highest reversible capacity of 1428 mAh g^{-1} at 200 mA g^{-1} after 100 cycles compared with the Sn-based anodes so far, through the reversible conversion reaction of Sn, but also provides an innovative strategy for obtaining high energy density in the Sn-based anodes. More details will be discussed in the meeting.

References:

[1] I.A. Courtney, J.R. Dahn, J. Electrochem. Soc. 144 (1997) 2045–2052.
[2] H. Kim, G.O. Park, Y. Kim, S. Muhammad, J. Yoo, M. Balasubramanian, Y.-H. Cho, M.-G. Kim, B. Lee, K. Kang, H. Kim, J.M. Kim, W.-S. Yoon, Chem. Mater. 26 (2014) 6361–6370.