Materials Design for Increasing the Reversibility of High Capacity Lithium-ion Battery Anode Materials

Prof. Lee Jim Yang, National University of Singapore

The performance of current lithium ion batteries needs to be substantially improved to meet the needs of large scale applications such as electric vehicles and distributed electrical energy storage. This is best achieved through materials innovation. Anode materials such as those based on tin/tin dioxide have shown the potential to readily increase the current anode capacity by two to three folds (from 372 mAWg for graphite-based anodes to 992 mAh/g for Sn and 782 mAh/g for SnOz anodes). Previous research has focused on the capacity retention of these "new" materials in prolonged cycling but other issues such as initial irreversible capacity losses (ICL) and rate capability are still largely unresolved. This presentation will present our designs and syntheses of tin-based composite anode materials with high capacity, low ICL, stable cycling performance and high rate capability. In many of these designs the tin-based anodes were fabricated as core-shell composites using different core and shell components to satisfy various functional requirements. One particular design involved a core of tin oxide nanoparticle aggregates with sufficient internal porosity to balance between the need for stress relief and high volumetric energy density. Different materials were used for the shell including graphene, lithium titanate and titania. Electrochemical measurements of these core-shell composites confirmed the viability of combining high capacity, low ICL for solid electrolyte interface (SEI) formation, high rate capability and good cyclability even though these designs in their current forms have not been optimized.