A sandwich structured RGO/Cu_6Sn_5 composite as an anode material for Li-ion batteries

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Recent years many efforts have been directed to develop alternative anode materials to improve its specific energy for lithium-ion batteres, including Si, Sn, and their alloys, hydrides, phosphide, oxides, TiO_2-B etc. However, these materials show large volume changes during Li-ion insertion and extraction leading to capacity loss during cycling. In order to improve the cycling performance of these materials, a promising approach is to use a 'buffer matrix', such as carbon, that can compensate for the expansion of the reactants for preserving particle contact essential for charge transmission. These materials are commonly prepared by mechanical mixing, loading, and coating or some combination of these techniques. However, in such formed mixtures the large volume changes upon Li insertion can only be accommodated by carbon to a limited degree, which offers only a modest improvement in cycling stability and uses large amounts of conventional carbon (e.g. Graphite). Long cycling leads to loss electrical pathway, and the cycling stability is limited.

Comparing with these reported carbon materials and its formed composite structure (loading or coating), graphene, a one-atom-thick planar sheet of carbon that is densely packed in a honeycomb crystal lattice, has emerged as an attractive alternative to other carbon allotropes. In the present talk, we introduce a reduced graphene oxide (RGO)/Cu_6Sn_5 composite in which the nanosized Cu_6Sn_5 was sandwiched between graphite interlayer space by soft chemical process. We used sodium borohydride reduction of $SnCl_4$ and $CuCl_2$ solution and graphene as carbon medium. When the mixture solution was added to the GO solution, Sn^{4+} and Cu^{2+} were adsorbed. On chemical reduction, graphene oxide nanosheets were converted to reduce graphene oxide nanosheets, and the anchored Sn4+ and Cu^{2+} ions were reduced to Cu_6Sn_5. This process can ensure the in-situ formation of Cu_6Sn_5 nanoparticles and graphene nanosheets simultaneously, with an advantage to prevent any serious stacking of graphene nanosheets.

Being different from the previous carbon modification technology in which the carbon layer in the carbon coated or core-shell structure will be destroyed during cycling, the graphene layers provide a very useful buffer matrix for the volume change during lithiation and unique electronic conductivity. As a result, the sandwich structure RGO/Cu_6Sn_5 composite demonstrates excellent electrochemical performance as an anode material for LIB. The composite delivers a reversible capacity of 450 mAh/g at a constant current density of 100 mA/g between 0 and 2.0 V (vs. Li+/Li) (Figure 1) and exhibits excellent cycling stability with a capacity retention of 88 % over 250 cycles (Figure 2).

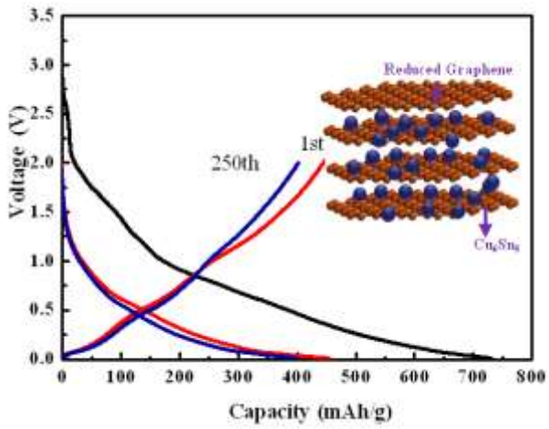

Figure 1 Typical charge/discharge curves of sandwich structure RGO/Cu_6Sn_5 composite at curerent rate of 100 mA/g between 0 and 2.0 V (vs. Li^+/Li)

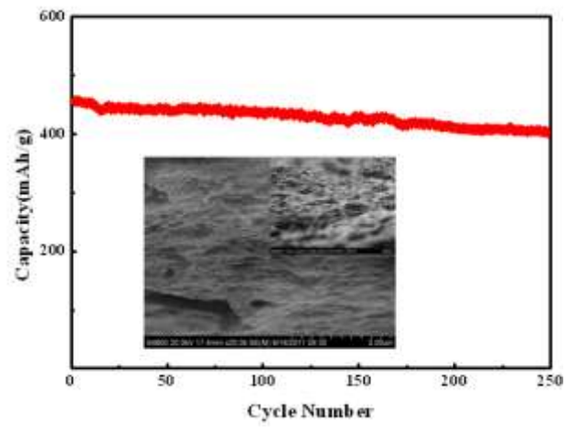

Figure 2 TEM images and cycling stability test of sandwich structure RGO/Cu_6Sn_5 composite.