MICROSTRUCTURED INTERMETALLIC ANODES FOR LITHIUM ION BATTERIES

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INTRODUCTION

Intermetallic compounds are being investigated as alternative anodes to graphitic carbon in lithium-ion batteries for reasons of structure, overall capacity and safety. Intermetallic anodes offer significantly higher capacity (both gravimetric and volumetric), various reaction potentials (vs. lithium metal) and depending on their constituents, improved safety. Problems to be overcome before these anodes can compete with graphitic carbons include: 1) developing an understanding of the capacity fade mechanism and combating the first-cycle, irreversible capacity loss, and 2) controlling their dramatic volume expansion and contraction during cycling, which leads to loss of electrical contact between particles and short battery lifetimes. One of the more promising intermetallic anodes is Cu_6Sn_5. Previous studies have examined the role that electrode morphology, dopants, and reaction mechanism play in determining electrochemical properties and performance [1-3]. This significant literature history allows for a further study of the role of synthetic methods on performance. Here, we report on the electrodeposition of microporous Cu_6Sn_5-containing copper-tin anodes and their electrochemical behavior in lithium cells in comparison to bulk (powder) Cu-Sn electrodes.

RESULTS

Samples were synthesized by electrodeposition. This synthetic technique, which allows for the creation of microstructured intermetallic electrode materials on a porous, electronically-conducting substrate, was used in an attempt to ensure good electrical contact of the electrode particles at all times during electrochemical cycling. Cyclic voltammograms were used to determine deposition parameters for Cu-Sn compounds from several different deposition baths (Fig. 1). As-grown and annealed Cu-Sn thin films were analyzed by powder X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS). The Cu-Sn films were deposited onto Cu-foams, also synthesized via electrodeposition (Fig. 2), and evaluated in coin cells against lithium metal counter electrodes. The Cu-Sn electrodes were analyzed using XRD, SEM, and EDS at various stages of charge and discharge to monitor changes in the cathode composition, crystallinity, and morphology as a function of cycle life. Preliminary results indicate that electrodeposited microporous Cu_6Sn_5-containing electrodes show a good rate capability and are promising alternative anode materials for Li-ion batteries.

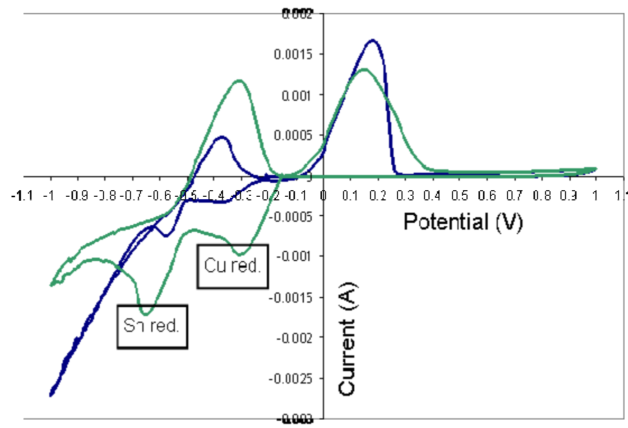

Fig. 1 Cyclic voltammogram of cupric- and stannous chloride solution (SCE reference electrode).

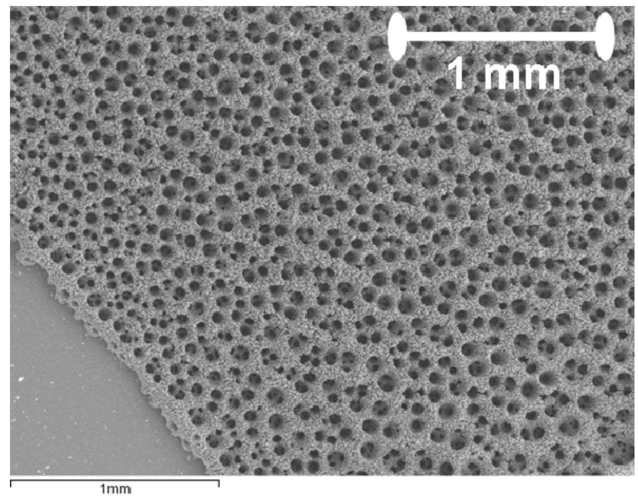

Fig. 2 SEM micrograph of a microporous copper foam current collector before electrodeposition of an active Cu-Sn layer.

REFERENCES

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