Electrodeposition of a tin/tin(IV) oxide composite on gold

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In commercial lithium ion batteries graphite is used as the anode material. However, graphite has a rather limited volumetric and gravimetric capacity which is a drawback when higher energy densities are required as for instance in cars. Here, other materials with higher capacities and energy densities like tin or silicon are hence needed. The latter materials are however subjects to high volume expansion when alloyed with lithium which leads to cracking and pulverization of the anode during cycling and as a consequence to a short life time for the battery. This problem can be reduced by the use of nano-particles, thin films or composites containing corresponding oxide due to the alleviation of lattice stress. [1,2]

Thin films of tin have previously been synthesized via cathodic electro-deposition in solutions containing complexing agents.[3] In other cases tin(IV) oxide and tin/tin(IV) oxide compounds were obtained via electrodeposition in solutions containing nitric acid. In the case of the tin/tin(IV) oxide compound a subsequent anodic oxidation was used to obtain pure nano-crystalline tin(IV) oxide films.[4] Even in other cases thin films of pure tin have been converted to tin(IV) oxide via anodic oxidation.[5] However, electrochemical testing has so far only been carried out for either the pure tin or tin(IV) oxide to a limited extent.

In this work a tin/tin(IV) oxide composite has been synthesized on a gold substrate via the electrodeposition of tin and simultaneous precipitation of tin(IV) oxide caused by a local pH increase in citrate solutions. The compound has been characterized with XRD, XPS, SEM and Raman spectroscopy. In addition, its behaviour as an anode material when cycled versus lithium has been investigated employing cyclic voltammetry in order to gain information about the electrochemical processes during cycling as well as the performance and cycle life as a battery material. Particular attention will be paid to the understanding of the electrochemical reactions taking place during the cycling of a mixture of tin and tin(IV) oxide.

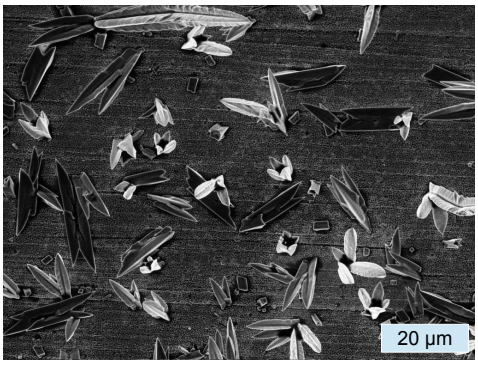

Figure 1: SEM picture of the tin crystals on gold

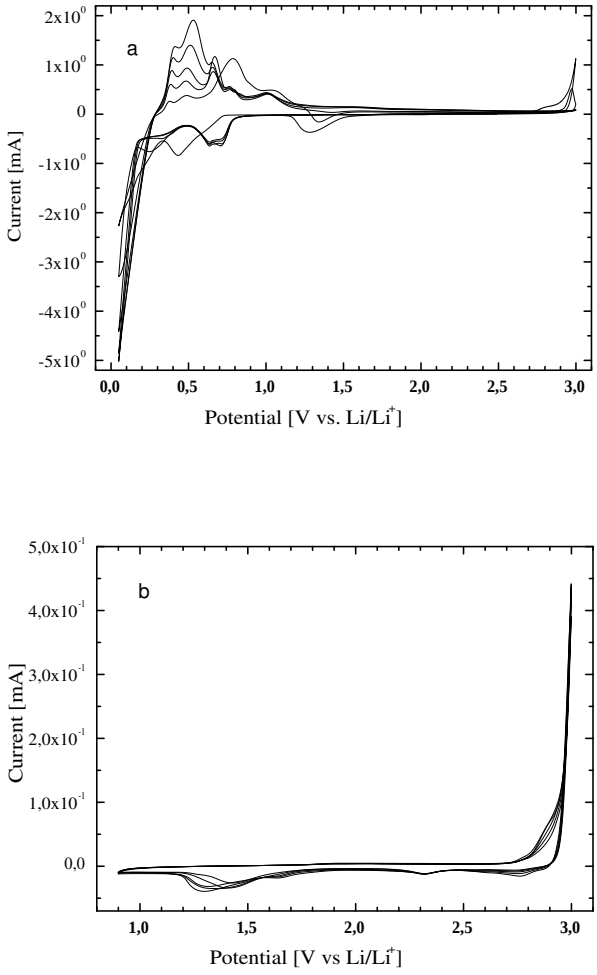

Figure 2: Cyclic voltammograms for the tin/tin(IV) oxide composite when cycled versus lithium between a) 0.05 V and 3.0 V b) 0.9 V and 3.0 V

References

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