

## Enhanced the electrochemical performance of nano-Sn film anodes by simply surface coating of metallic layers

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Lithium ion batteries are very important power sources for portable electronic devices and others due to their high energy density, long lifespan, flexible design, and so on. However, the commercially available graphite-based anodes have the obvious disadvantage of limited capacity ( $372 \text{ mAh g}^{-1}/837 \text{ mAh cm}^{-3}$ ). Thus, there is a strong demand for the development of new anode materials with higher specific energy to replace the graphite anodes.[1] Among various materials, metallic Sn has been envisioned as a promising anode material due to its high theoretical capacity of  $993 \text{ mAh g}^{-1}/7262 \text{ mAh cm}^{-3}$  in the range of moderate to safe operating potentials. However, the great challenge for using Sn as an anode material is the capacity fading and large initial irreversible capacity loss due to fracture of the electrode, which is induced by the extremely large volume change of Sn during cycling.[2,3]

In order to enhance the electrochemical performance of the Sn-based anode, dispersing the active Sn phase inside a matrix was employed, in which the host matrix component was used to buffer the large volume change of the Sn particles during the Li insertion/extraction processes, so that the electrode integrity and electronic contacts between the particles and conductive phases are maintained. Accordingly, various inactive/active metal elements(M), or high elasticity amorphous carbon materials, or non-crystalline oxide compounds were combined with Sn to form nanostructured intermetallic  $\text{Sn}_x\text{M}_y$  phases[4,5], or kinds of Sn-(M)-C nanocomposites[6], acting as the LIB anodes. The large volume change of Sn upon Li insertion actually can be accommodated to some extent by the oxide/carbon buffer matrices and thus resulted in much enhanced cycle performance of Sn-based anodes. However, the nanostructured Sn/SnO<sub>2</sub> carbonaceous composites have been usually prepared by autocatalytic deposition, ball-milling, chemical reduction, hydrolysis, pyrolysis, sol-gel techniques, partial reduction, and so on. These processes often involve several time consuming steps and offer only limited control of the particle size and distribution. Moreover, the oxide/carbonaceous matrix would inevitably lead to quite large initial irreversible capacity loss due to Li<sub>2</sub>O formation by the oxide reduction and SEI formation due to the electrolyte decomposition on the carbon surface [2].

Based on the above consideration, we would like to enhance the electrochemical performance of nano-Sn film anodes by simply surface coating of various metallic layers. In this work, nano-Sn films were firstly deposited on smooth Cu foil substrates. After then, the surfaces of the nano-Sn films were coated by six kinds of metallic layers, which are Si, Al, Pd, Cu, Cr, and Nd, respectively. Both of the Sn and the metallic coating layers were deposited by magnetron sputtering. And in this presentation, the influence of these metallic coating layers on the microstructure and electrochemical performances of the nano-Sn film anodes were carefully investigated. According to our primary results, it has been found that

the surface coating layers, especially the active Pd and inactive Cr layer, much increase the open current potential (OCP) (see Fig.1) of the Sn film anode, and enhance their cycle performance(see Fig.2).

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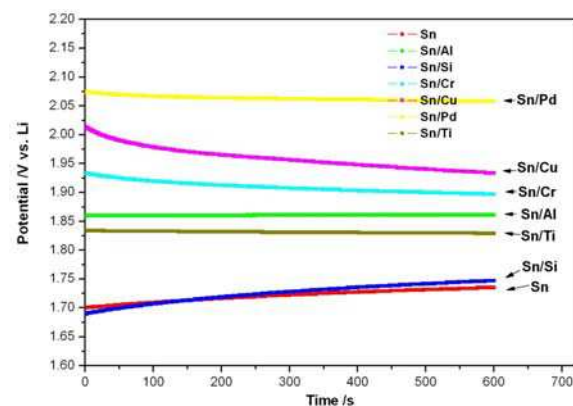


Fig.1 Comparison of the OCP for the Sn and the Sn/M bilayer films

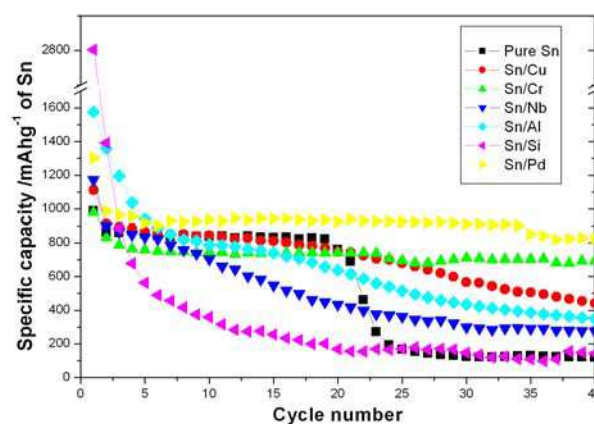


Fig.2. Comparison of the Cycle performance for the Sn and the Sn/M bilayer films