Novel Sn/SnO_2@rGO self-standing 3D architectures as anodes for Lithium ion batteries

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Abstract The rapid development of portable electronic devices and electric vehicles requires high energy density rechargeable batteries. Lithium-ion batteries (LIBs) are the promising candidates for such applications.

Graphene and graphene based materials are gaining interest as anode in LIBs due to their great properties, such as excellent mechanical flexibility and high electrical conductivity, surface area and chemical diffusivity of Li. The beneficial role of graphene composites and the synergistic effects between metals and graphene has been demonstrated [1] in the earlier literature. Metallic Sn offers high capacity anodes for the lithium ion batteries; the theoretical capacity of $Li_{4.4}Sn$ is 993 mAh/g [2]. However, it has several problems: i) volume change during the lithiation/delithiation process (it can be up to 300 %); ii) the material is highly degraded by these volume changes and the cyclability is affected; iii) high decomposition of the electrolyte. To overcome these problems and improve the stability of Sn anodes different Sn/C composites have been developed. The carbon matrixes can accommodate the volume change of Sn during charge–discharge process and thereby provide a better cyclability. These composites show better cycle performance than pure metallic Sn anode material. Recently, Sn/Graphene composites have been developed. These LIBs anodes present better rate capacity (680 mAh/g at 2 A/g) and longer cycle life (1000 cycles) than other Sn/C composites [2]. However, in our knowledge, self-standing Sn/SnO_2@reduced graphene oxide (rGO) composites (without any binder and any support) as electrodes for LIBs have not been reported so far.

The aim of this work, in order to obtain a good specific capacity while maintaining structural stability, was to evaluate different novel self-standing composites of Sn/SnO_2@rGO 3D architectures as anodes for Lithium ion batteries. For this, different composites were synthesized by dissolving a certain amount of a Sn precursor within the GO suspension previously prepared by modified Hummer method [3]. The mixture was then processed and further reduced at different temperatures to obtain the Sn/SnO_2@rGO self-standing composites.

Electrochemical measurements were carried in CR2032 type coin cells assembled inside a glove box under Argon atmosphere. The electrolyte employed was 1.2 M $LiPF_6$ in ethylene carbonate and dimethyl carbonate 1:1 (v/v). Lithium metal foil was used as counter/reference and glass fiber as separator. The Sn@rGO self standing film presented a capacity higher than 600 $mA{\cdot}g^{-1}$ at 50 $mA{\cdot}g^{-1}$ and a stable feature after 40 cycles.

References

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Figures

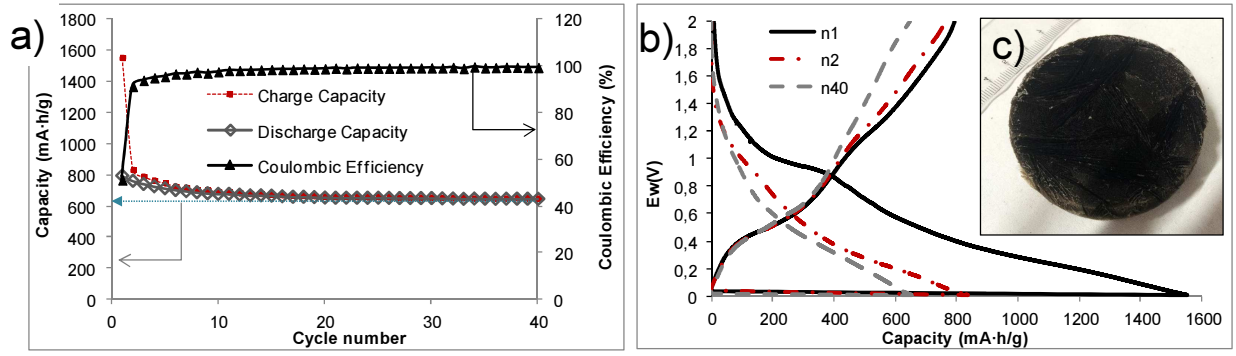

Figure 1. a) Charge/discharge curves and b) galvanostatic cycling of c) 3D-Sn/SnO_2@rGO electrode.

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