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Reduced graphene oxide decorated with SnO_2 nanoparticles as negative electrode for lithium ion capacitors

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Highlights

- Synthesis of SnO_2 nanoparticles (7–8 nm) on a reduced graphene oxide matrix.
- Self-standing SnO_2-rGO composite material as anode for Li ion capacitors.
- *In situ* XRD to follow structural changes during cycling.
- Maximum energy of 140 Wh kg^{-1} at 142 W kg^{-1} (57 Wh dm^{-3} at 59 W dm^{-3}).
- 5- to 3-fold energy density increase as compared to the EDLC counterpart.

Abstract

The effort to increase the energy density of conventional electric double-layer capacitors (EDLCs) goes through the development of lithium-ion capacitors (LICs). Herein, we report a self-standing, binder-free composite as the battery-type negative electrode obtained by a low-cost and easily scalable method. Tin(IV) oxide nanoparticles (<10 nm) embedded in a reduced graphene oxide matrix (SnO_2-rGO) were prepared by an *in-situ* synthetic approach that involves the freeze/freeze-drying of a graphene oxide suspension in the presence of a tin precursor and its subsequent thermal reduction under argon atmosphere. Physicochemical and electrochemical characterization confirmed the optimum nano-structuration of the composite showing ultrafast response at high current densities. Its coupling with a highly porous olive pits waste-derived activated carbon (AC) as the capacitor-type positive electrode, enables the fabrication of a LIC with an excellent energy density output. The newly designed LIC is able to deliver 60 Wh kg^{-1} at 2.9 kW kg^{-1} ($t_{discharge} \approx 1$ min) and still 27 Wh kg^{-1} at 10.6 kW kg^{-1} ($t_{discharge} \approx 10$ s).