

Graphene Nanoribbon and Nanostructured SnO₂ Composite Anodes for Lithium Ion

Batteries—Supporting Information

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SUPPORTING EXPERIMENTAL SECTION

Materials characterization. Scanning electron microscope (SEM) images were taken at 15 KeV using a JEOL-6500F field emission microscope. High-resolution transmission electron microscope (TEM) images were obtained with a JEOL 2100F field emission gun TEM. X-ray diffraction (XRD) was performed using a Rigaku D/Max 2550 diffractometer with Cu K α radiation ($\lambda = 1.5418 \text{ \AA}$). X-ray photoelectron spectroscopy (XPS) was performed on a PHI Quantera SXM Scanning X-ray Microprobe with a base pressure of 5×10^{-9} Torr. A monochromatic Al anode with energy of 1486.7 eV, 45° takeoff angle, and a 200 μm beam size was used as an X-ray source. The 26 eV pass energy was for high-resolution scans of Sn, C and O. 140 eV pass energy was for the low-resolution survey scans. The thermogravimetric analysis (TGA) measurement was carried out on a Q50 TGA machine (TA instruments). The heating rate was 5 °C/min. The sample was heated and held at 120 °C for 40 min to remove the moisture before the higher heating command.

SUPPORTING FIGURES

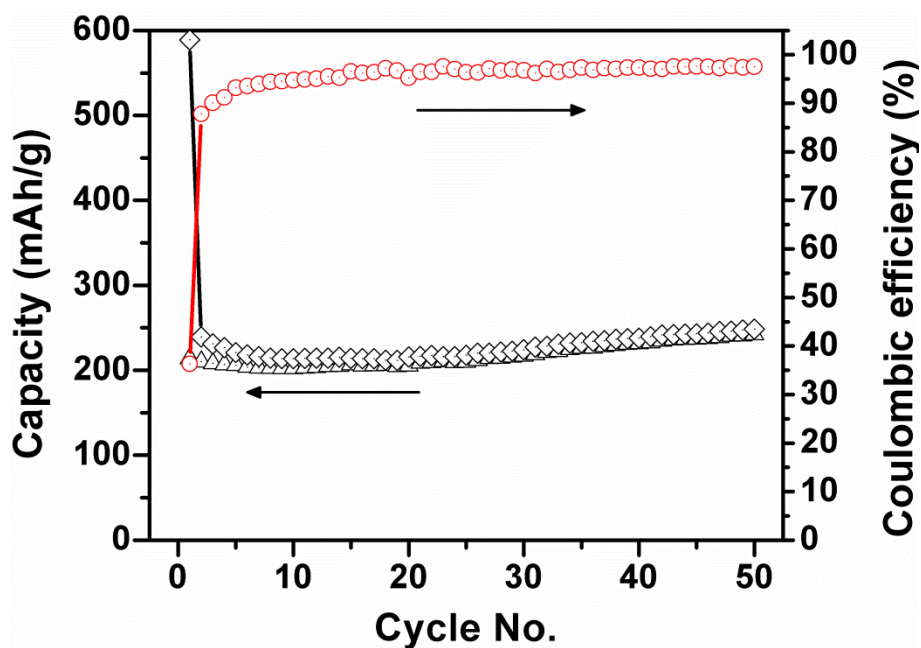


Figure S1. Capacity retention and Coulombic efficiency of GNRs at a current density of 100 mA/g. The specific capacity is quite stable until 50 cycles. While the value is much smaller than the one from GNRs/SnO₂ composite anode electrode.

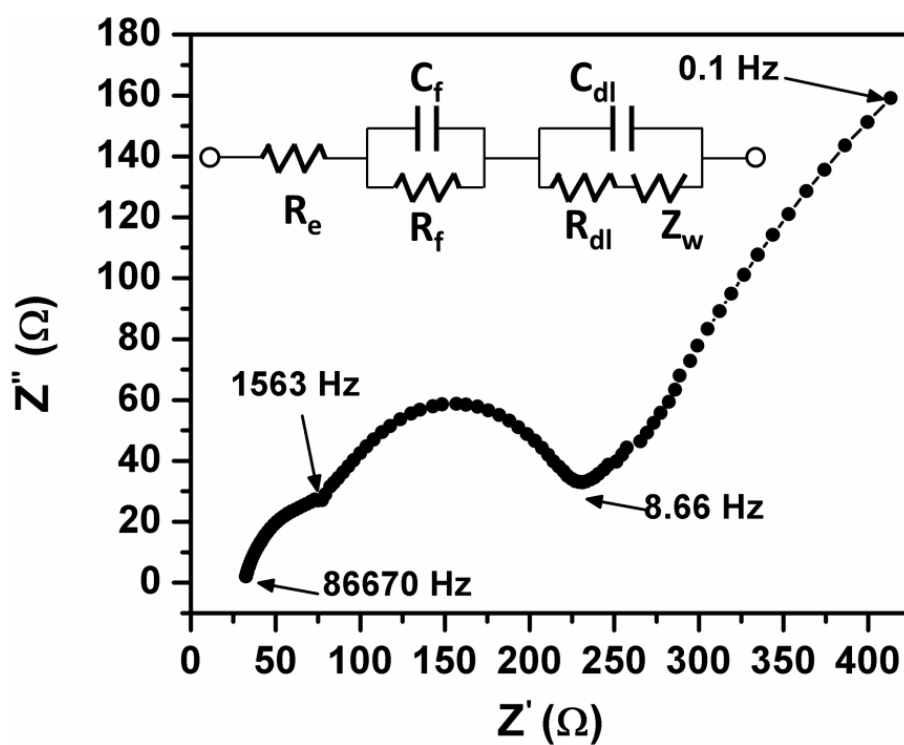


Figure S2. Electrochemical impedance spectrum of GNR/SnO₂ composite anode electrode after 50 cycles, scanning from 0.1 Hz to 100 K Hz. Inset is the Randles equivalent circuit. R_e is the sum of electrolyte resistance and contact resistance; C_f and R_f are the capacitance and resistance of the surface electrolyte interface (SEI) formed on the electrodes, respectively; C_{dl} and R_{ct} are the double-layer capacitance and charge-transfer resistance, respectively, Z_w is the Warburg impedance related to the effect of mass transfer of lithium ions diffusion into the electrodes. There are two relaxation loops. The one evident at high-frequency is attributed to the charging of SEI and the one at low-frequency is aroused by the charge transfer process between the SEI and the electrode. From the Randles circuit, the fitted R_e is $\sim 32.5 \Omega$; R_f is $\sim 38 \Omega$; R_{ct} is $\sim 138 \Omega$; and the Z_w is about 181Ω .