Supporting Information

Pomegranate like silicon-carbon composites prepared from lignin-derived phenolic resin as lithium-ion battery electrodes

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1. Characterization and test methods

1.1. Characterization

Scanning electron microscopy (SEM): The powder samples were glued directly to the conductive adhesive of the sample table before SEM testing and then gold sprayed to eliminate static electricity.

Transmission electron microscopy (TEM): The JEM-1400 transmission electron microscope was used to observe the pore size distribution, multi-level layered structure of the carbon silicon material. samples were prepared by the ethanol suspension method prior to TEM testing, dropped onto a copper mesh microgrid, dried and used for observation with an excitation voltage of 200 kV for the electron beam.

X-ray diffraction (XRD): The crystal structure analysis of the polymers was carried out on a Japco Ultima IV combined multifunctional horizontal X-ray diffractometer. Test conditions: X-ray tube with CuKα target (λ= 0.15406 nm), graphite monochromator to eliminate CuKα radiation, tube voltage 40 kV, tube current 200 mA, scanning range 2θ=5-60°, scanning step 0.02°, scanning rate 15°/min, recording "diffraction intensity-2θ" curve.

Thermogravimetric analysis (TGA): The nanocomposites were analysed for thermal weight loss using a thermogravimetric analyser (TA instrument Q600) to determine the carbon content of the The test conditions were 100 mL/min air flow and 10 ºC/min heating from room temperature to 800 ºC.

X-ray photoelectron spectroscopy (XPS): The AXIS Ultra DLD X-ray photoelectron spectrometer (XPS) from Shimadzu, Japan was used to determine the surface chemical composition of the samples, including details of the surface elemental composition and peaks of C (C 1s), O (O 1s) and Si (Si 2p). Samples are detected at concentrations greater than 0.1% and at depths of less than 10nm, with at least two samples prepared for each material and at least three different locations for each sample. The relative elemental content and the type and relative content of the chemical functional groups are included.

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Raman spectra: A small amount of sample was placed on a slide and the sample was analysed by Raman spectroscopy using a Themor DXR532 laser Raman spectrometer under 532nm light excitation.

1.2. Electrochemical measurements

Electrochemical testing of electrode materials was carried out using half cells having Si/C-LPR nanomaterials as working electrodes and lithium metal as counter electrodes. Charge/discharge measurements were carried out on a NEWARE battery test system (Shenzhen, China). Electrochemical tests were performed using a constant current charge/discharge process with a current density of 0.05 A/g over a voltage range of 0.01-1.5 V vs. Li/Li^+ at room temperature. Electrochemical impedance spectra (EIS) were measured using a CHI660E electrochemical workstation (Shanghai, China) with an alternating current (AC) voltage of 10 mV applied over a frequency range of 10^5 Hz to 0.01 Hz. Cyclic voltammetry (CV) was performed on a CHI660E electrochemical workstation (Shanghai, China) at a scan rate of 0.5 mV/s at room temperature.

1.3 Supplementary characterization of TEM

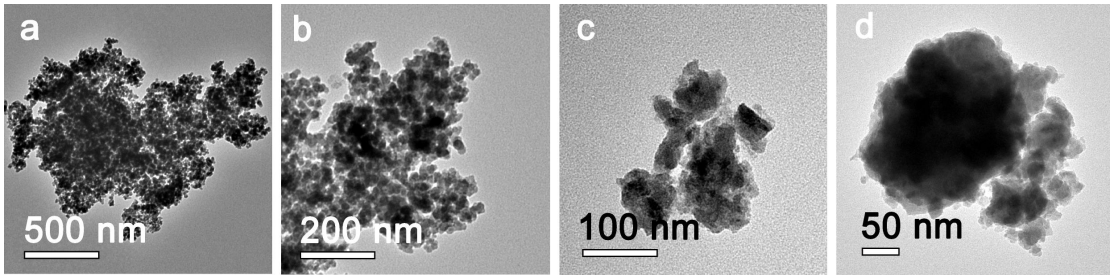

Figure S1 TEM images of Si/C-PR(a,b), Si/C-ALPR(c,d)