

Supporting information

Rice husk derived Carbon-silica composites as anodes for Lithium ion batteries

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Experimental and Characterizations

Synthesis

The rice husk was collected from a local farmer in Ibaraki prefecture, Japan. 10 g rice husk was leached in 0.1 M HCl (500 mL) at room temperature under magnetic stir overnight to get rid of the metal oxides (e.g. K_2O , Fe_2O_3 , CaO). The mixture was filtered and washed with distilled water and dried in oven at 80 °C. After pretreatment, the rice husk (denoted as RH) was directly heated at 900 °C for 4 hour at a heating rate of 10 K.minute⁻¹ in N₂ atmosphere to obtain the C/SiO₂ composites. The C/SiO₂ composites (denoted as RH-900) were grounded into powders by mortar agate for further tests. SiO₂ was obtained via combusting C/SiO₂ composites in air at 500 °C for 4 hours. Pure carbon was obtained via removal of SiO₂ in 4 M NH₄HF₂ solution.

Characterizations

Elemental composition was determined using a Vario E1 elemental analyzer. TEM experiments were carried out at 200 kV in a JEOL2100F microscope. The porous property of the samples was investigated using physical adsorption of nitrogen at liquid-nitrogen temperature (-196 °C) on an

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automatic volumetric sorption analyzer (NOVA 3200e, Quantachrome). Prior to the measurement, the sample was degassed at 200 °C for 5 hours under vacuum. The specific surface area was determined according to the Brunauer-Emmett-Teller (BET) method in the relative pressure range of 0.05- 0.2. A Raman spectroscopy (Renishaw inVia plus, England) with an excitation wavelength of 514.5 nm and a beam spot size of 1-2 μm was used to characterize sample. Scanning electron microscopy (SEM) images were obtained using a JEOL JSM-5600LV scanning electron microscope operated at an acceleration voltage of 10 kV. The phase structure of the obtained materials were characterized by X-ray diffraction using Cu K α radiation (XRD, $\lambda = 1.54056 \text{ \AA}$, X'Pert Pro MPD) with a step size of 0.03° in the 2θ range of 10° to 60° .

Electrochemical tests

The electrode was prepared by RH-900 powder (80 wt %), carbon black (10 wt %), and polyvinylidene fluoride (PVDF, 10 wt %) in N-methylpyrrolidone (NMP) to form a homogenous slurry. The slurry was then spread onto a copper foil and dried at 100 °C for an overnight in a vacuum oven. Commercial electrolyte LP30 (1 M LiPF₆ in a mixture of ethylene carbonate (EC), dimethyl carbonate (DMC) (1:1 by volume)) was used as the electrolyte for LIBs. The batteries were galvanostatic charged and discharged at 0.2 C between 0.0 V and 3.0 V on a LAND CT2001A cell test apparatus. The cyclic voltammetry curves were measured using a CHI66C electrochemical working station at a scanning rate of $0.02 \text{ mV}\cdot\text{s}^{-1}$. The capacity is calculated by using the active materials of C/SiO₂ composites. The weight of our electrode materials is about $2.0 \text{ mg}\cdot\text{cm}^{-2}$.

Figure S1 (a) SEM images of RH-900, (b) SEM images of enlarged magnification for RH-900, (c) EDX mapping image of C element for RH-900, (d) EDX mapping image of Si element for RH-900.

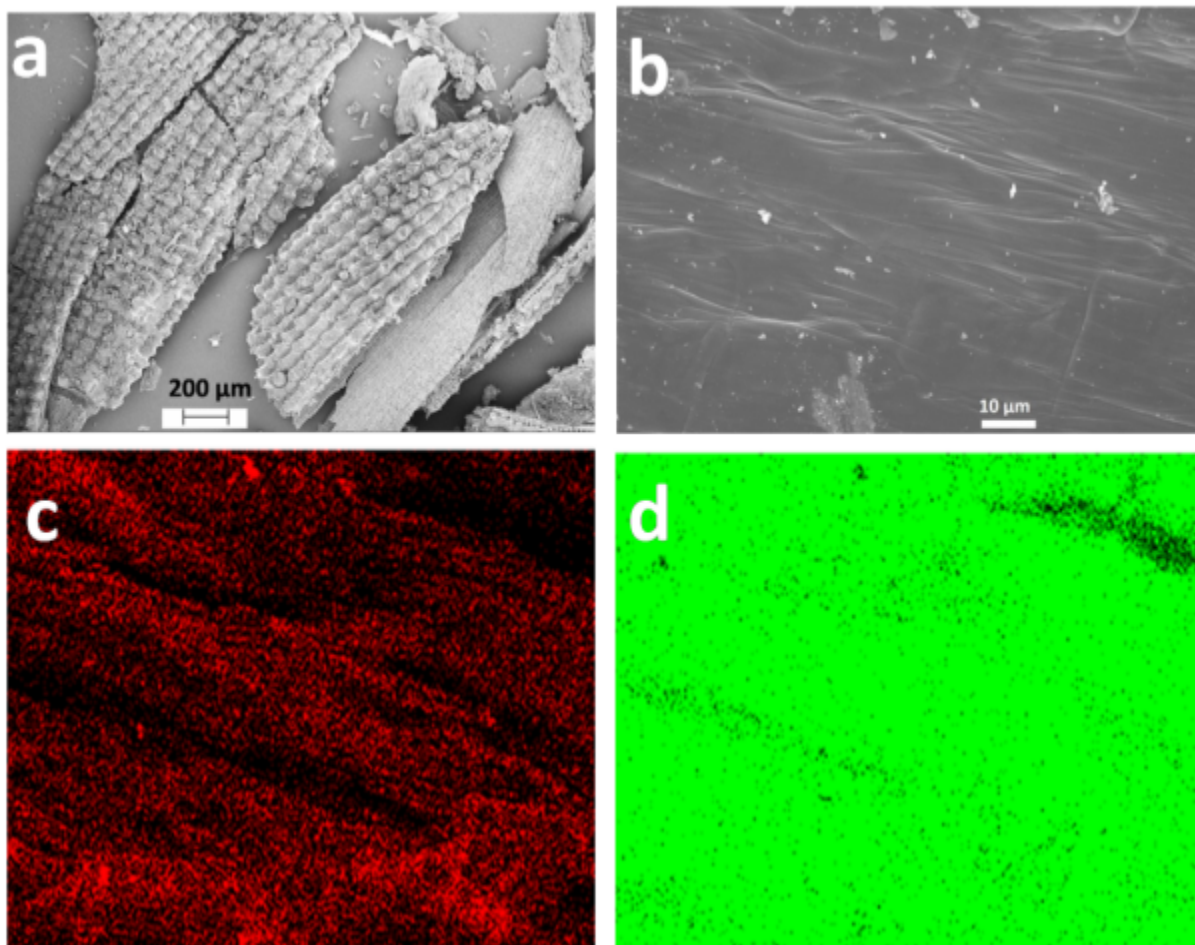


Figure S2 X-ray diffraction patterns of RH and RH-900.

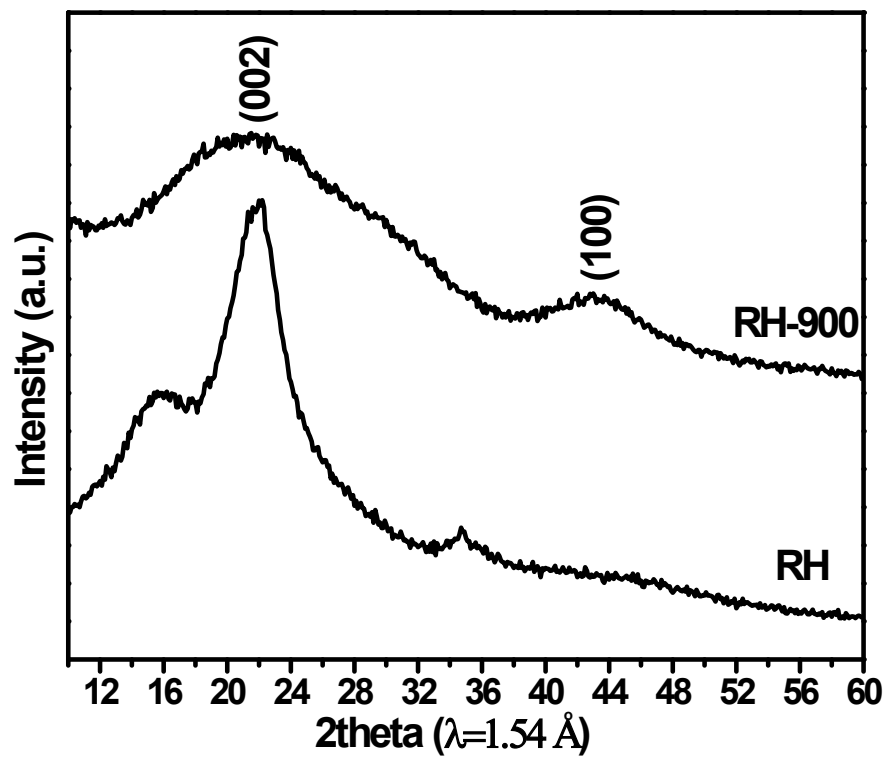


Figure S3 Raman spectra of RH-900.

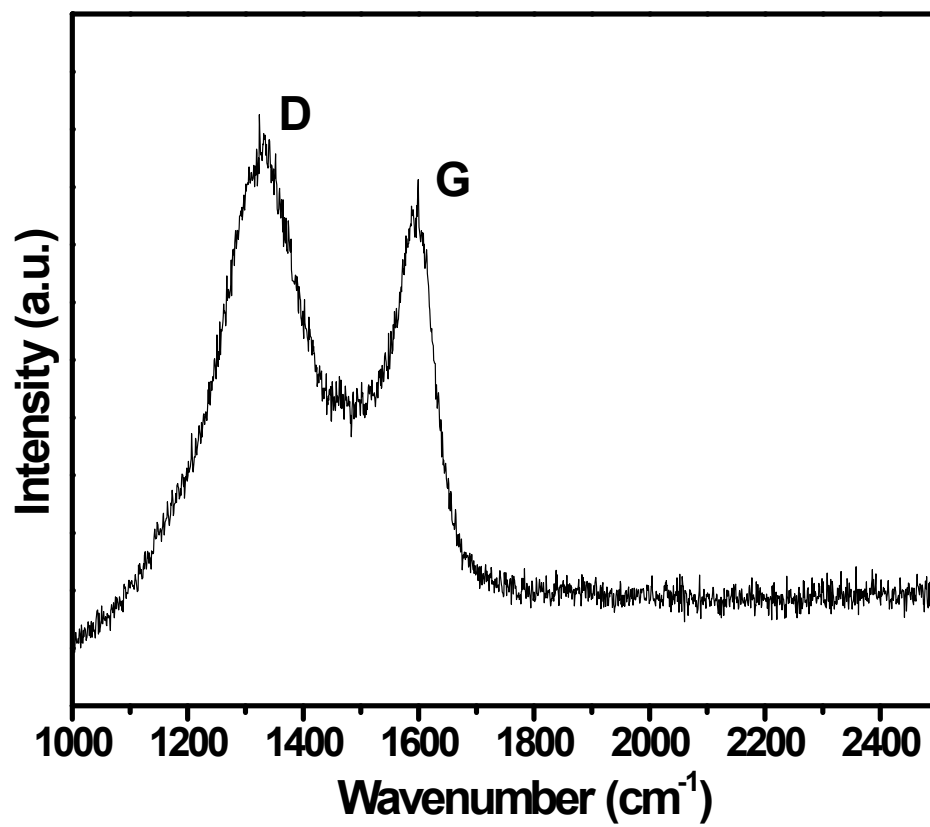


Figure S4 (a) Nitrogen sorption isotherms and (b) pore size distributions (QSDFT) obtained for RH-900.

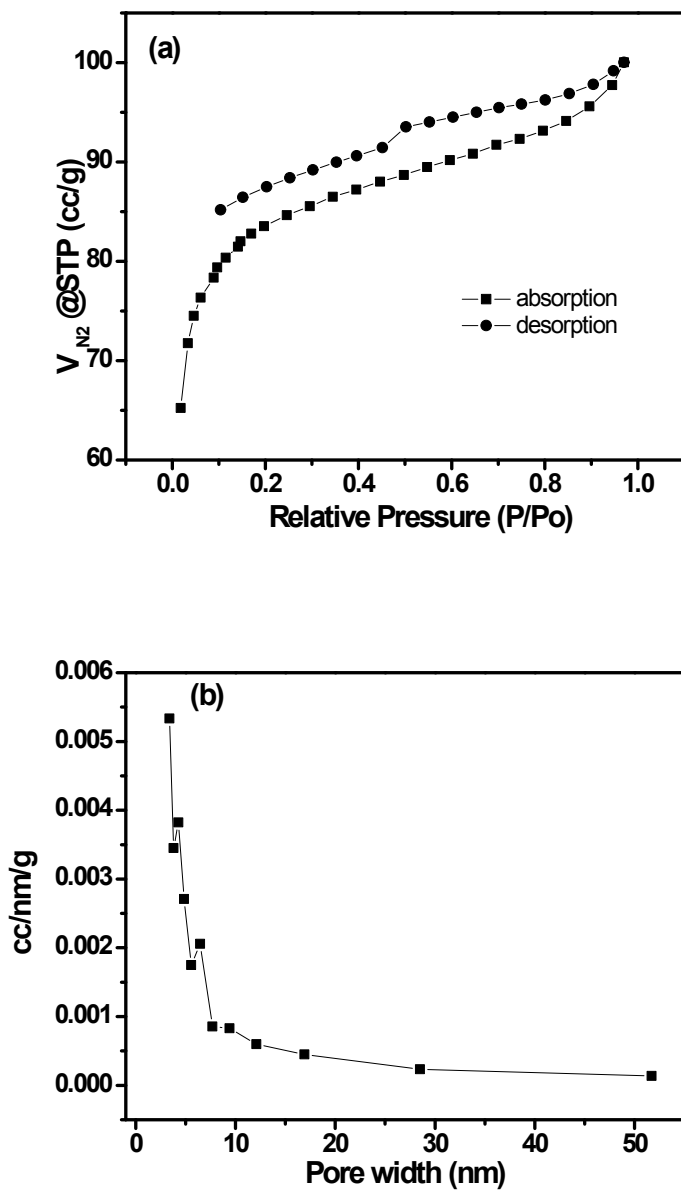


Figure S5 Cycling performance of C (a) and SiO₂ (b) in the voltage range of 0- 3.0 V at a current rate of 74.4 mA.g⁻¹.

