Supporting Information

Mesoporous carbon sheets embedded by vesicles for enhanced supercapacitor performance

Juan Du, Aibing Chen*, Yifeng Yu, Yue Zhang, Haijun Lv, Lei Liu*

College of Chemical and Pharmaceutical Engineering, Hebei University of Science and Technology, 70 Yuhua Road, Shijiazhuang 050018, China.

Corresponding Authors: E-mail: chen_ab@163.com; liulei@hebust.edu.cn

Experimental Section

Preparation of CS and CS-*v*

0.1 g above iron(III) nitrate was dispersed by solution of 200 mL of H_2O and 100 mL EtOH, and 30 mL of 1-alkyl-3-methylimidazolium bromide, ($[C_{18}Mim]Br$) surfactant solution (110 mM, dissolved in a 2:1 mixture of H_2O and EtOH) was quickly added under vigorous stirring and then add the Resorcinol 0.215 g stirring for 30 min. 2.15 mL of TEOS was added to the reaction mixture and subsequently stirred at ambient temperature overnight. The as-synthesized suspension was centrifuged and dried at 70 ^oC overnight. For carbonization, the obtained product was heated at 800 ^oC for 3 h with a heating rate of 2 $^oC\ min^{-1}$ under N_2 atmosphere. The CS-*v* were obtained respectively after removing the silica with 10 wt% hydrogen fluoride (HF) solution and Fe by 2M

HCl solution for 24 h, respectively.

In order to investigate the formation of carbon sheet, the $[C_{18}Mim]Br$, TEOS and phenolic resin was used to prepare N-doped mesoporous carbon sheet (denoted as CS) as our previous work.[1] The carbon yield was obtained basing on the amount of resin and the carbon yield of CS and CS-*v* is 32 % and 36 %, respectively.

Characterizations

The morphology and microstructure of sample were investigated by transmission electron microscopy (TEM, JEOL JEM-2100). Atomic force microscope (AFM) was used to tested the thickness of sample. Nitrogen adsorption-desorption isotherms were carried out on a Micromeritics TriStar 3020 instrument at -196 °C. The Brunauer-Emmett-Teller (BET) method was employed to calculate the specific surface area , while the Barrett-Joyner-Halenda (BJH) method was applied to analyze the pore size distribution using the desorption branch of isotherm. The total pore volume was obtained from the amount of N_2 adsorbed at the relative pressure (P/P_0=0.97). X-ray photoelectron spectroscopy (XPS) was conducted on a Thermo Scientific ESCALab 250Xi system using an Al-*K*α radiation under a vacuum of 3×10^{-10} mbar. X-ray diffraction (XRD) patterns were achieved using a Rigaku D/MAX-2500. Raman measurements were performed under ambient conditions using a 532 nm (2.33 eV) laser in the backscattering configuration on a Jobin-Yvon HR800 Spectrometer. The composition of C, H and N content in CS-*v* was evaluated using elemental analysis (CHN) on the Flash EA 1112.

Electrochemical Measurements

The working electrode was prepared by coating the viscous slurry (samples, carbon black and polytetrafluoroethylene with the mass ratio of 8:1:1 in ethanol) onto Ni foam current collector. The mass of active material loaded on each working electrode was 4~5 mg after drying at 100 °C for 24 h. Electrochemical measurements were carried out in both three-electrode and two-electrode system using an electrochemical workstation (CHI 760E, Chenhua Instruments, China) with 6 M KOH solution as the electrolyte. For three-electrode system, a Pt wire and Hg/HgO was used as the counter and reference electrodes. For the fabrication of supercapacitor devices, two slices of electrode were immersed in 6 M KOH and were separated by a filtration paper, then tested by the current collector. Electrochemical performances were evaluated by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrical impedance spectroscopy (EIS) analysis. For the two-electrode system, the specific capacitances (C, F g^{-1}), energy density (E, Wh kg^{-1}) and power density (P, W kg^{-1}) were calculated by the following equations: $C=4I\Delta t/\Delta Vm$, $E=0.5C(\Delta V)^2$ and $P=E/\Delta t$, where I (A), Δt (s), ΔV (V) and m (g) are GCD current, discharge time, voltage window, and mass of active material, respectively. In three-electrode system, the specific gravimetric capacitance according to the GCD measurements: $C=I\Delta t/\Delta Vm$.

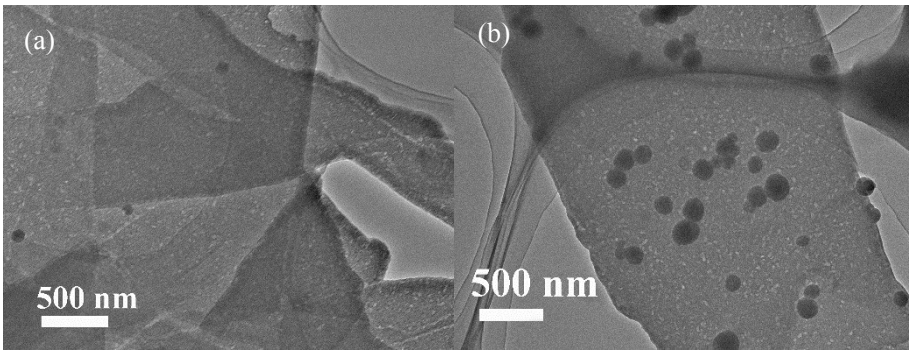

Fig. S1. TEM images of hybridization of silica/resin without (a) or with (b) adding of iron(III) nitrate

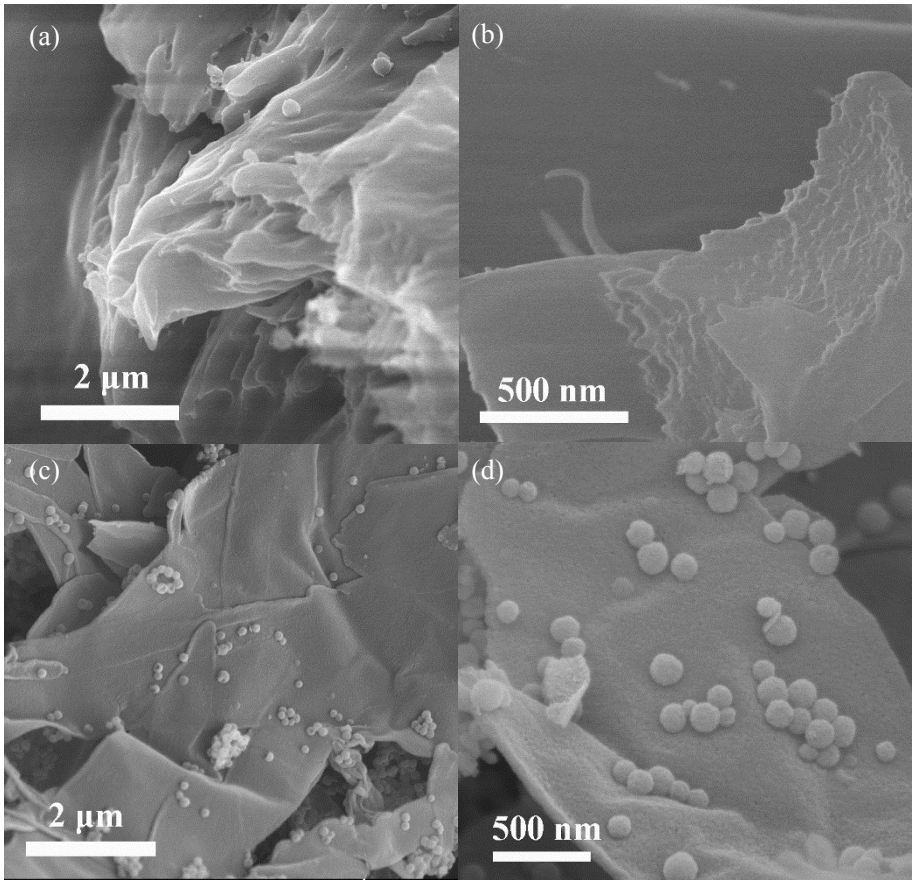

Fig. S2. EEM images of CS (a-b) and CS-*v* (c-d).

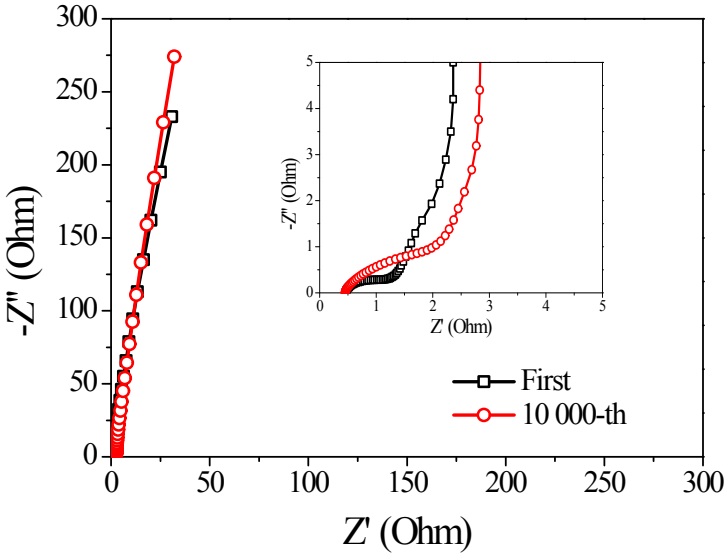

Figure S3. Nyquist plots of CS-*v* before and after the cycling test in two-electrode system.

References

1. J. Du, L. Liu, Y. Yu, Z. Hu, B. Liu and A. Chen, *ACS Appl. Mater. Interfaces*, 2018, **10**, 40062-40069.