Electronic Supplementary Material (ESI) for Environmental Science: Nano.
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Electronic Supplementary Information (ESI)

Efficient removal of metal ions by capacitive deionization with straw waste derived graphitic porous carbon nanosheets

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Characterization

The morphologies of GPCS were detected by transmission electron microscopy (TEM, JEOL JEM-200CX) and scan electron microscopy (SEM, Nova NanoSEM 450). Before testing, and powdered samples were dispersed in ethanol by continuous ultrasound for 10 min. X-Ray diffraction (XRD) measurements were taken on a Rigaku D/MAX-RB X-ray diffractometer using Cu Kα radiation (40kV, 30 20 mA) and a secondary beam graphite monochromator. The Raman spectra were detected on a spectrometer (JY H800UV) with the 633 nm laser. Nitrogen sorption isotherms were analysed with an Autosorb-IQ2 (Quantachrome Corporation) after degassed overnight at 593 K in a vacuum line. The Brunauer–Emmett–Teller (BET) method was utilized to calculate the specific surface areas, and the pore size distributions were derived from the desorption branches of the isotherms using Quenched Solid Density Functional Theory (QSDFT). The X-ray photoelectron spectroscopy (XPS) was recorded on a Perkin-Elmer PHI 5000C ESCA system equipped with a dual X-ray source, using the 45 MgKα (1253.6 eV) anode and a hemispherical energy analyser. The Fourier Transform Infrared spectroscopy (FTIR) was detected by NEXUS-670. The contact angle of water on the surface of electrode was measured by a drop shape analysis system (Krüss, DSA100). The electrochemical performances of the electrodes were evaluated by cyclic voltammetry (CV), the electrochemical impedance spectroscope (EIS) using a CHI 660D. Galvanostatic charge-discharge (GC) was conducted on an automatic LAND battery test instrument. All the electrochemical properties were measured from a 3-electrode system in a NaCl solution in 0.5 M NaCl solution.

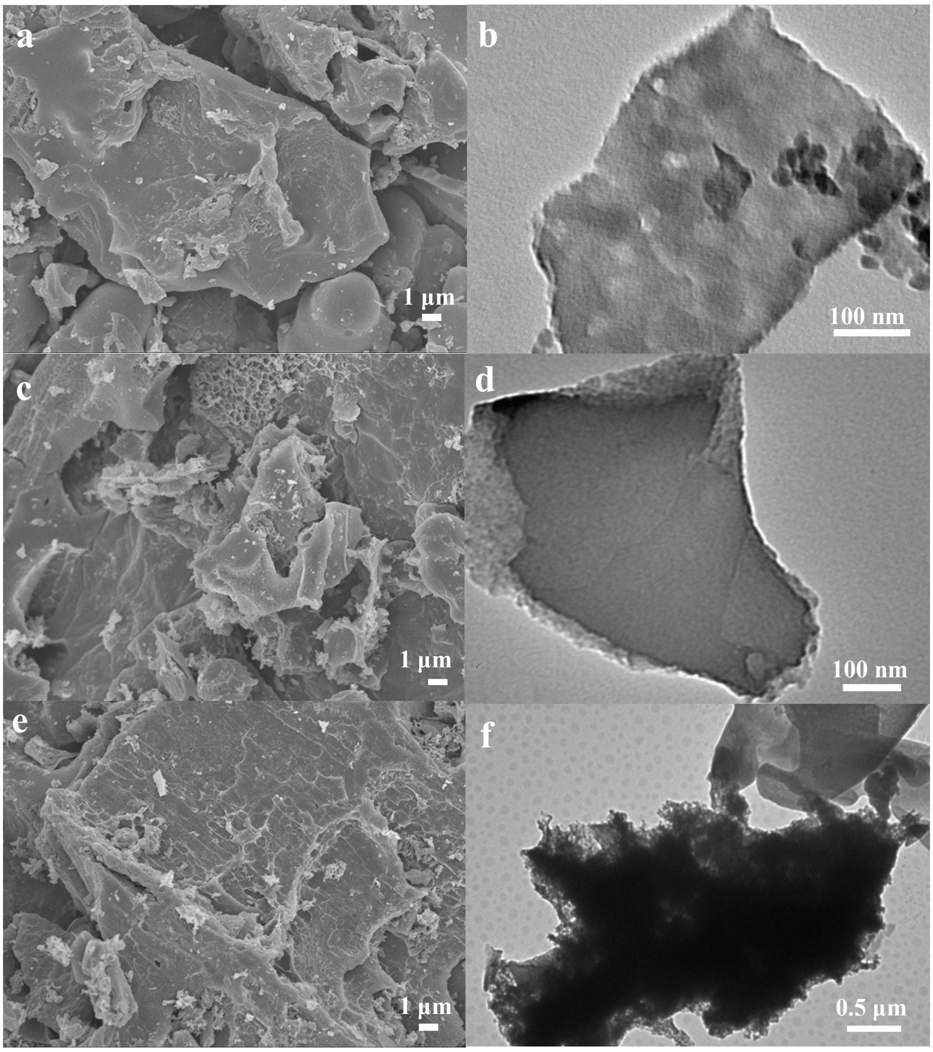

Fig. S1 SEM and TEM images of the (a-b) PC, (c-d) APC and (e-f) CC.

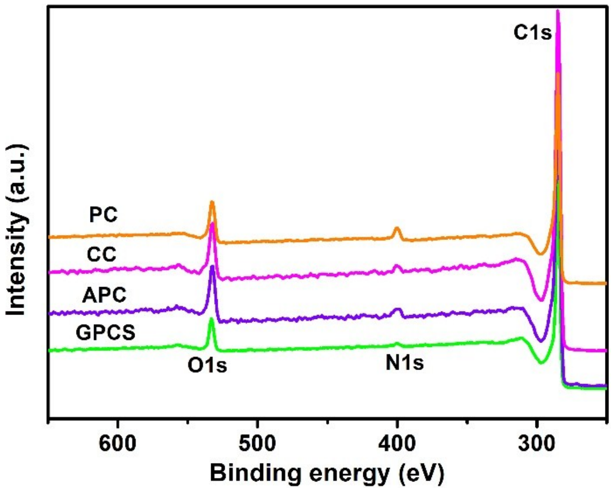

Fig. S2 XPS survey scan spectra of GPCS, PC, CC and APC.

The surface elements of GPCS, PC, CC and APC were well detected by XPS, and the result was shown in Fig.S2. Two obvious peaks can be observed at 284.6 and 533.0 eV in the full XPS spectra, which can be ascribed to C1s and O1s. The oxygen contents of GPCS, PC, CC and APC are 6.07, 8.00, 7.27 and 8.25 at%. Besides, a weak peak appears on the XPS spectra at 400 eV, which belongs to N1s. The nitrogen contents of GPCS, PC, CC and APC are 1.95, 4.72, 1.57 and 2.39 at%. The results suggest that the GPCS has the lowest oxygen and nitrogen contents, indicating that the content of hydrophilic functional groups on the surface of GPCS is lowest.

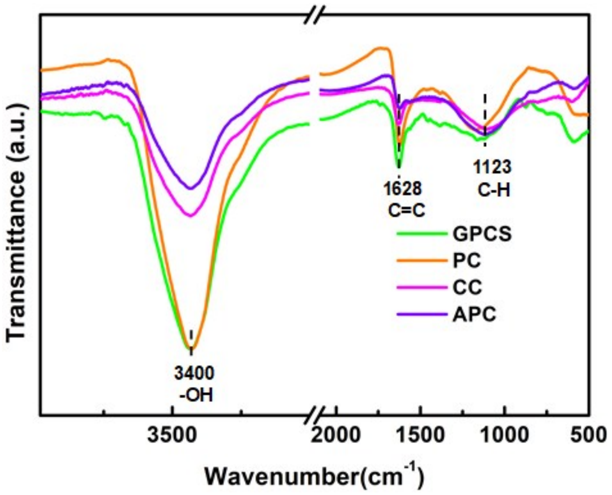

Fig.S3 FTIR spectra of GPCS, PC, CC and APC.

The FTIR spectra of GPCS, PC, CC and APC are shown in Fig.S3. The broad band at around 3400 cm^{-1} is associated with –OH and adsorbed water.[1] The intense bands at 1628 and 1123 cm$^{−1}$ are generated by aromatic C=C and C-H vibrations, respectively.[2, 3] The surface functional groups of GPCS, PC, CC and APC are the same, suggesting the similar surface properties of the four samples.

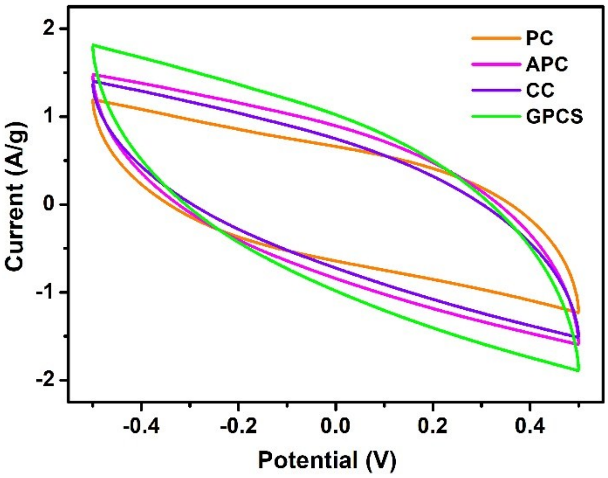

Fig. S4 (a) CV curves of GPCS, APC, CC and PC electrodes at a scan rate of 10 mV s^{-1} in a 0.5 M NaCl solution.

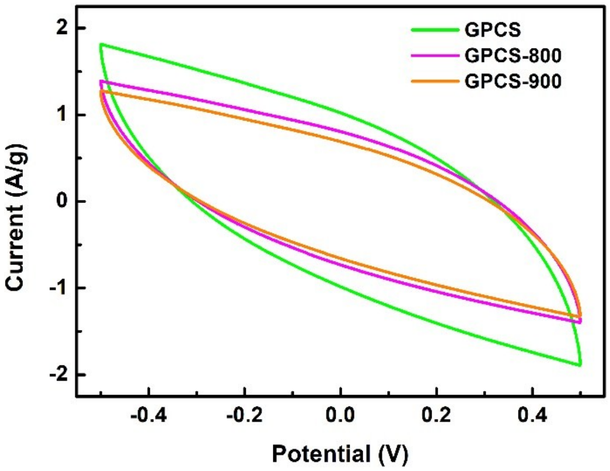

Fig. S5 CV curves of the GPCS electrode obtained from different calcination temperature at 10 mVs^{-1} in a 0.5 M NaCl solution.

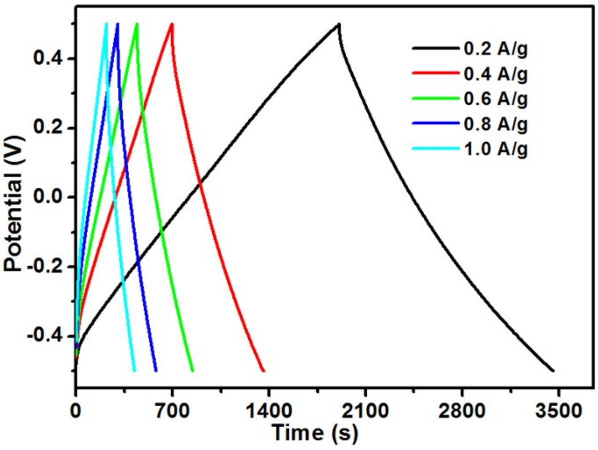

Fig. S6 GC curves of the GPCS electrode at various current densities in a 0.5 M NaCl solution.

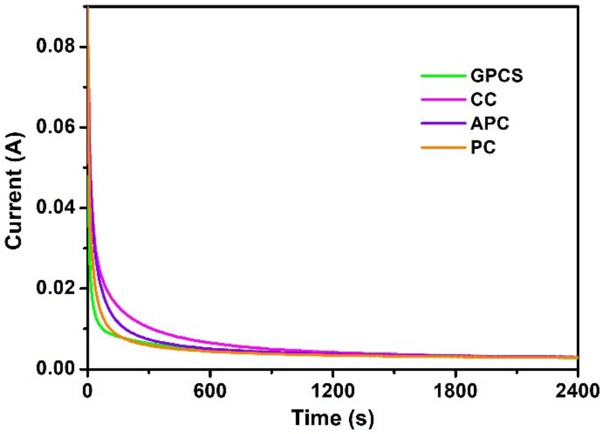

Fig. S7 Current transient for GPCS, PC, CC and APC electrodes in a 500 mg L^{-1}NaCl solution at 1.2 V.

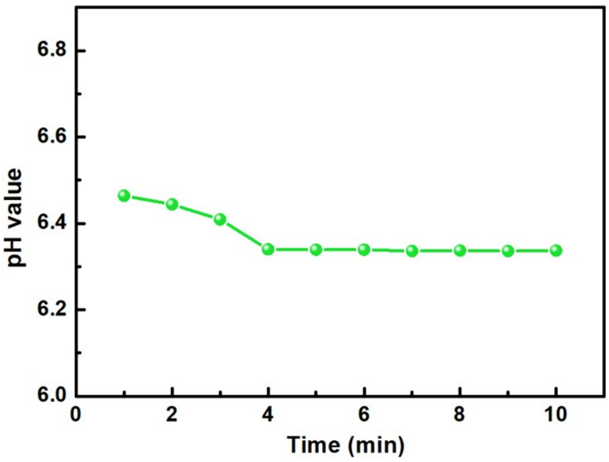

Fig. S8 Plots of pH value *vs.* time for the GPCS electrode in a 500 mg L^{-1}NaCl solution at 1.2 V.

Table S1 Adsorption kinetics parameters for the GPCS, APC, CC and PC electrodes in a 500 mg L^{-1} NaCl solution at 1.2 V.

Sample	Pseudo-first-order-model			Pseudo-second-order-model		
	k_1 (min^{-1})	q_e (mg g^{-1})	R^2	k_2 (g mg^{-1} min^{-1})	q_e (mg g^{-1})	R^2
GPCS	0.1161	12.56	0.9511	0.0157	20.75	0.9994
APC	0.0916	13.45	0.9264	0.0075	16.84	0.9912
CC	0.1088	19.21	0.9517	0.0034	18.65	0.9990
PC	0.078	10.22	0.9822	0.0044	13.14	0.9971

References

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