Electronic Supplementary Information (ESI)

Recycling chicken eggshell membrane for high-capacity sodium battery anodes

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Experimental

Materials Preparation

Eggshells were collected from local bakery, and the eggshell membranes were obtained by etching away the hard eggshell (mainly $CaCO_3$) in 2 M HCl. After cleaning with deionised water, the egg membranes were dried at 80 ° C for 6 h. The temperatures of the thermal treatment were set at 600, 700 and 800 ° C for 5h, and the corresponding obtained CEM were labelled as CEM-600, CEM-700 and CEM-800, respectively.

Materials Characterization

X-ray powder diffraction (XRD) patterns of the products were recorded on a Philips X'pert X-ray diffractometer with Cu Ka radiation (λ = 1.54182 Å). The microstructure was observed on a transmission electron microscope (TEM, H7650), and a field-emitting scanning electron microscope (FESEM, JEOL-JSM-6700F). Raman spectra were recorded on an Invia Raman spectrometer, with an excitation laser wavelength of 514.5 nm. The carbon content was determined by an elemental analyzer (Vario ELIII) at pure oxygen atmosphere. X-ray photoelectron spectroscopic analysis (XPS) was recorded on an ESCALAB 250 spectrometer (Perkin-Elmer) to characterize the surface composition. The Brunauer-Emmett-Teller (BET) surface area was measured on a Micromeritics ASAP 2020 accelerated surface area and porosimetry system. Fourier transform infrared spectroscopy (FTIR) spectra were measured using an IFS-85 (Bruker) spectrometer.

Electrochemical measurements

The electrochemical properties of CEM electrodes were measured with 2032 coin cells with Na metal (purity ≥ 99.5%, SCRC) as counter and reference electrodes which assemble under an argon-filled glove box (H2O, O2 < 1 ppm). Working electrode was prepared by mixing the active material, super P carbon black and polyvinylidene fluoride (PVDF) binder in a weight ratio of 70:20:10. The electrode was dried at 110 ° C for 12 h in a vacuum oven under vacuum before assembly into a coin cell in an argon-filled glove box. The active material density of each cell was determined to be around 1.0~1.5 mg cm^{-2}. The electrolyte was prepared through dissolving 1 M $NaClO_4$ in propylene carbonate (PC) solvents, and glass fiber (GF/D) from Whatman was used as the separator. Galvanostatic measurements were made using a LAND-CT2001A instrument that were cycled between 0.001 V and 3 V at room temperature. Electrochemical impedance spectroscopy (EIS) was carried out on an electrochemical workstation (CHI660D) in the frequency range from 0.1 MHz to about 1 Hz.

Table S1. Elemental Composition Information for the three CEM samples.

	elemental analysis					XPS			
Sample	C [wt%]	N [wt%]	O [wt%]	S [wt%]	H [wt%]	C [wt%]	N [wt%]	O [wt%]	S [wt%]
CEM-600	71.38	10.92	12.83	0.61	1.64	81.34	8.56	9.38	0.27
CEM-700	77.42	9.84	10.53	0.55	1.62	85.57	6.79	7.46	0.19
CEM-800	78.84	7.90	9.51	0.59	1.34	84.23	6.26	9.24	0.27

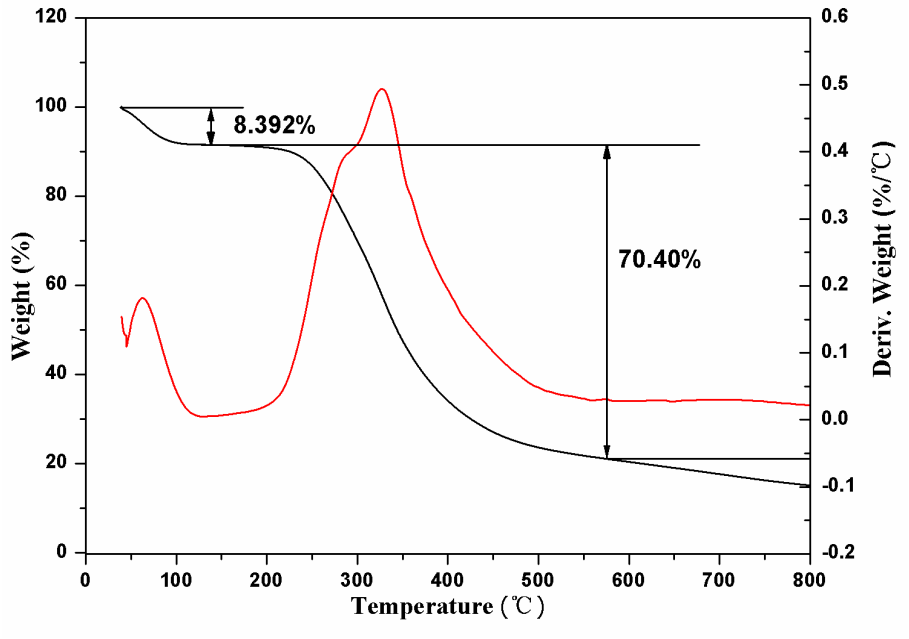

Figure S1. TGA(Thermal Gravity Analysis) curves of eggshell membrane in N_2.

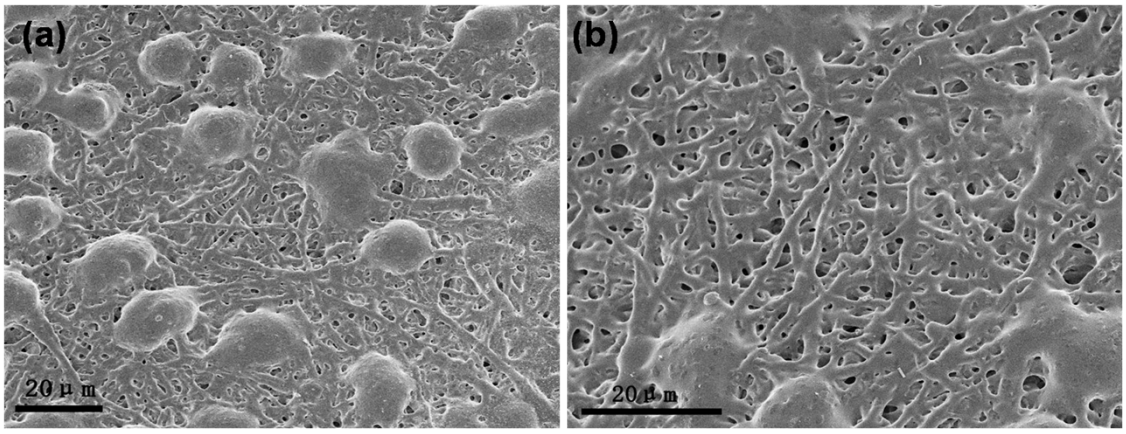

Figure S2. SEM images of the (a) CEM-600 and (b) CEM-700 sample.

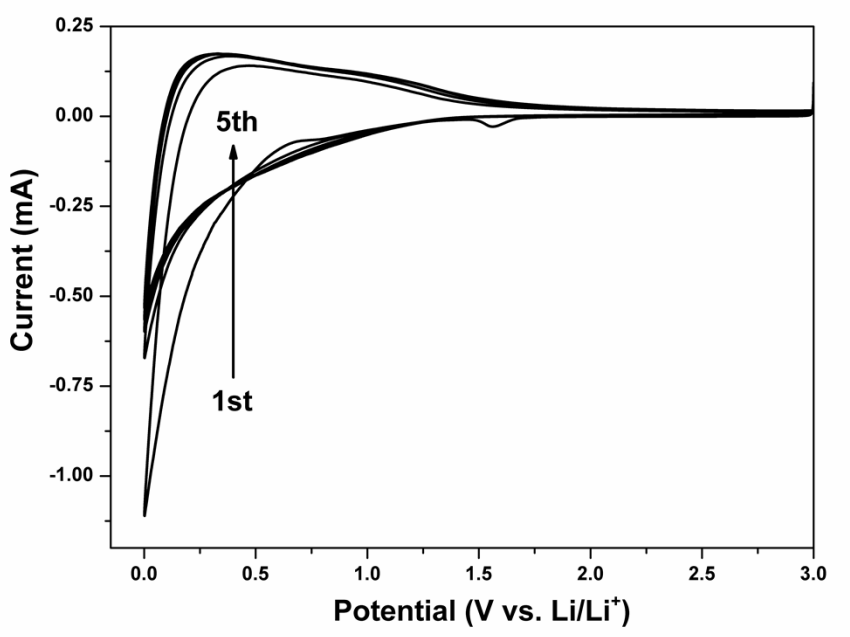

Figure S3. CV curves of the CEM-800 electrode between 0.001 and 3.0 V at a potential sweep rate of 0.1 mV s^{-1} in 1 M $LiPF_6$/EC:EMC electrolyte for Lithium-ion battery.

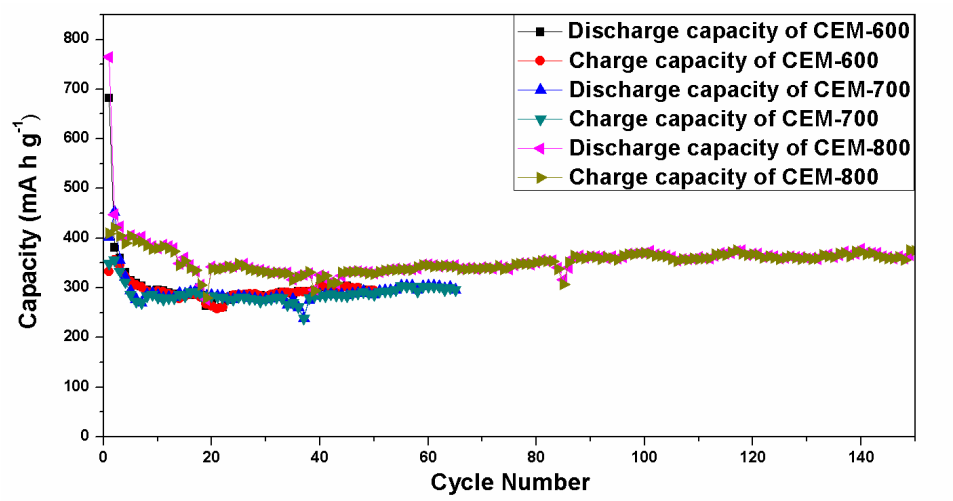

Figure S4. Cycling performance of the three CEM electrodes at current density of 100 mA g^{-1} in 1 M $LiPF_6$/EC:EMC electrolyte for Lithium-ion battery.

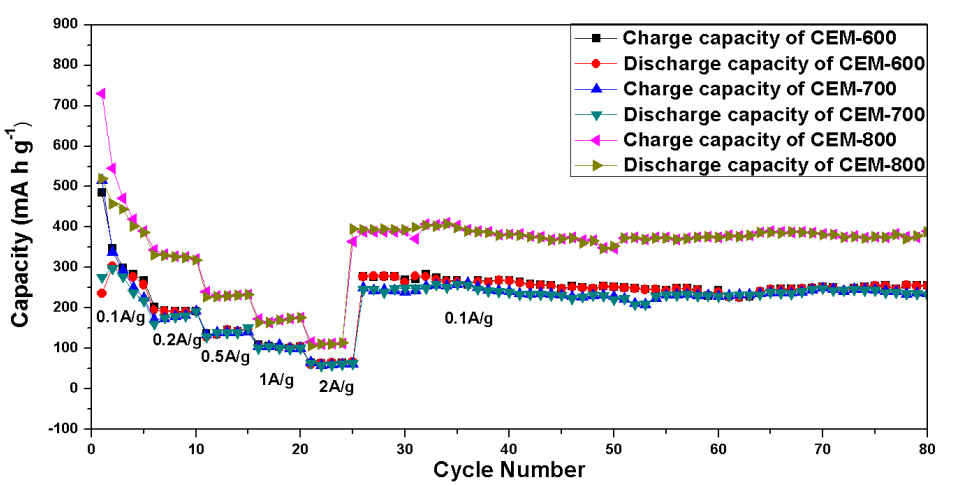

Figure S5. Discharge capacities of CEM-600, CEM-700 and CEM-800 electrodes as a function of discharge rate (100−2000 mA g^{-1}) in 1 M $LiPF_6$/EC:EMC electrolyte for Lithium-ion battery.