Supporting Information

A novel layered sedimentary rocks structure of the oxygen-enriched carbon for ultrahigh rate performance supercapacitors

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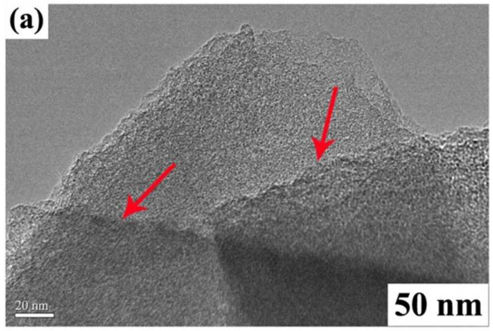

Figure S1. The high magnification TEM images of GA650.

The high magnification TEM image of GA650 clearly indicates its layered sedimentary rock structure with abundant pores in Figure S1.

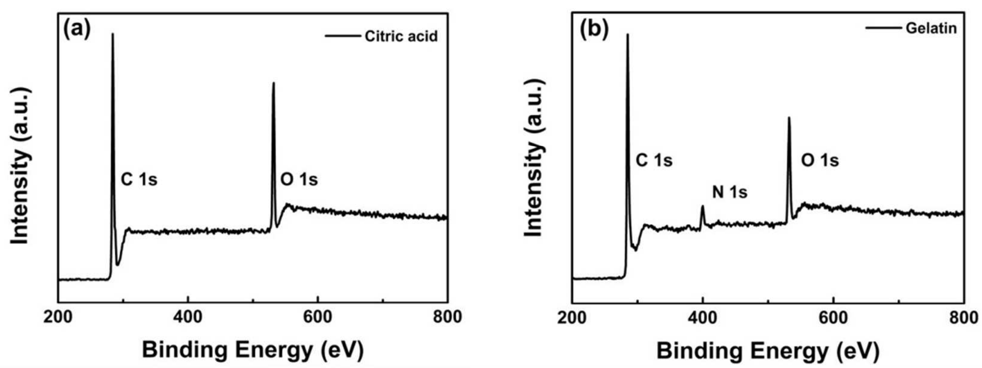

Figure S2. XPS spectra of the obtained carbon derived from calcinations of the pure citric acid (a) and gelatin (b) at the same conditions withGA650.

The XPS spectra of obtained carbon derived from pure the citric acid and gelatin are shown in Figure S2a and S2b. As we expected, gelatin and citric acid play an important role in the dual-doping activated carbon in GA650.

Table S1 The C, O, N, and H contents in gelatin, citric acid, GA, and GA650, GA750, and GA850 derived from elemental analysis.

Samples	C (wt%)	O (wt%)	N (wt%)	H (wt%)
Gelatin	81.336	12.378	4.322	1.964
Critic acid	80.784	18.288	0	0.928
GA	81.984	13.613	3.454	1.249
GA650	80.811	16.215	2.378	0.956
GA750	82.031	14.572	2.122	1.275
GA850	82.198	14.791	1.601	1.410

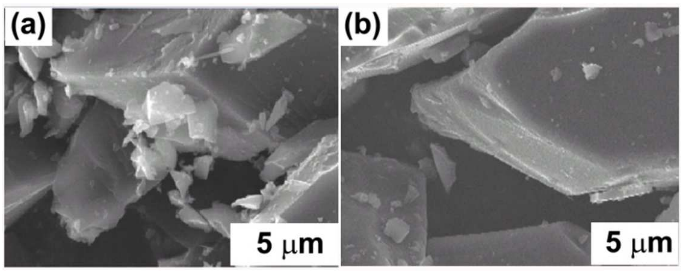

Figure S3. The SEM images of activated carbon obtained from the pure gelatin (a) and citric acid (b).

The SEM images of gelatin and citric acid shown in Figure S3a and 3b show the monolithic carbon with tens of microns. Compared to the SEM image of GA650 with several microns and visible layered sedimentary rock structure, the co-existence of citric acid and gelatin is necessary.

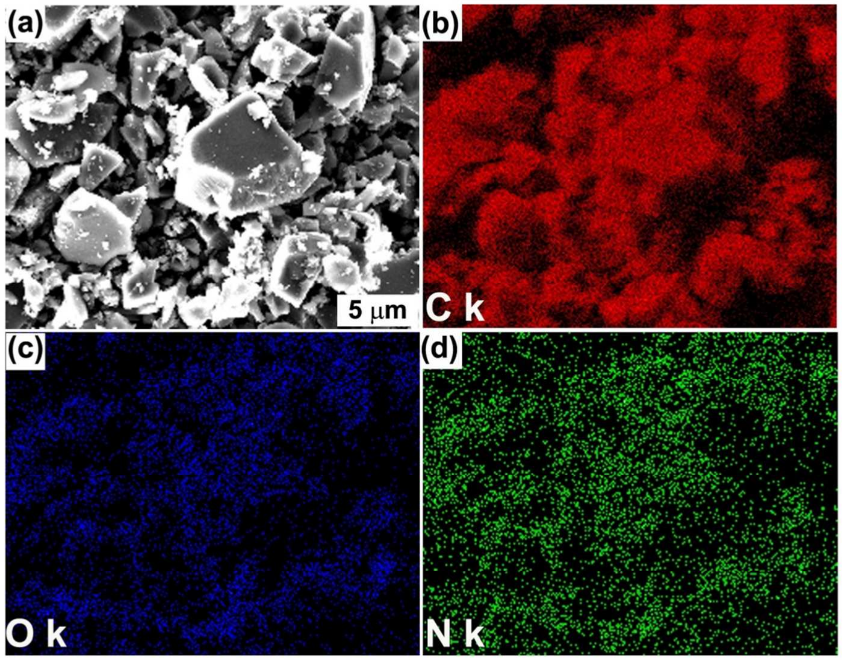

Figure S4. (a) SEM image, (b) C 1s, (c) O 1s, and (d) N 1selemental mapping images of the as-prepared GA650 electrode material.

SEM image of GA650 and elemental mapping of C, O, and N are shown in Figure S4a-d. O and N atoms uniformly distribute on the carbon-based material, which is beneficial for extra pesudocapacitance performance.

Table S2. The specific surface area and pore volumes of the as-prepared samples.

Samples	BET (m^2g^{-1})	Pore volume (cm^3g^{-1})	Average pore diameter (nm)
GA650	827.8	1.004	2.43
GA750	1620.0	2.217	2.22
GA850	1203.0	1.451	1.98

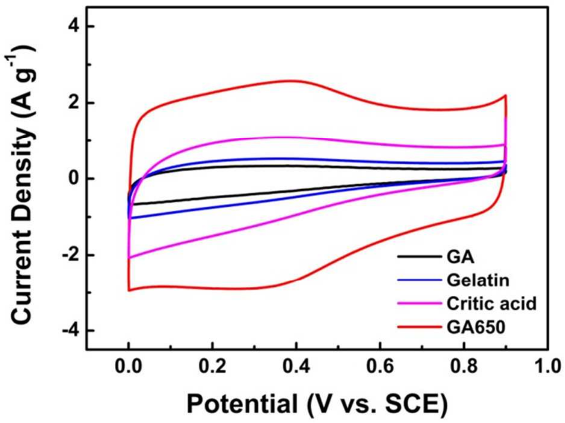

Figure S5. The CV curves of the GA, gelatin, critic acid precursors, and GA650 at 10 mV s^{-1}.

As shown in Figure S5, the integral area of CV curves of GA650 is the largest, which reveals the electrochemical performance of GA650 is much better than the gelatin, critic acid, and GA precursors.

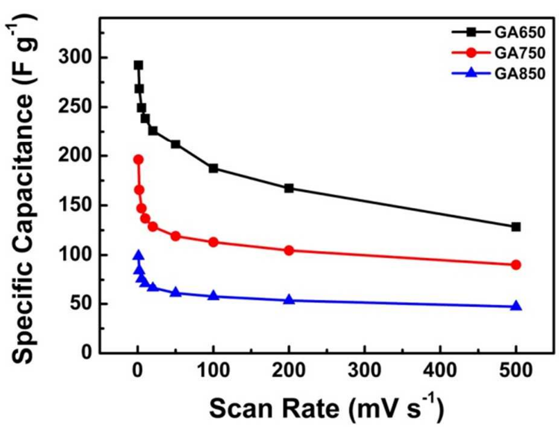

Figure S6. The specific capacitance of the GA650, GA750 and GA850 in the symmetric supercapacitor.

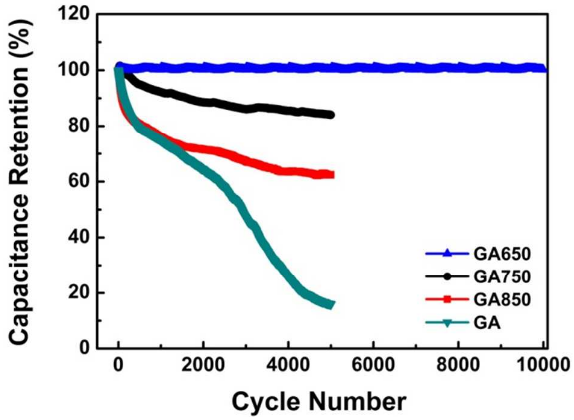

Figure S7. The cycling stabilities of the GA, GA650, GA750, and GA850 in the symmetric supercapacitors.

As shown in Figure S7, the capacitance of GA650 is almost 100% over 10,000 cycles. However, the cycling stabilities of GA750 (84.05% retention of the capacitance), GA850 (62.35% retention of the capacitance) and GA (15.90% retention of the capacitance) is much less than the capacitance retention of GA650, which attributes to the oxygen-enriched (16.215 wt%) and nitrogen-doped carbon with the novel sedimentary rock structure.

Table S3. The specific capacitance of GA650, GA750, and GA850 at 1, 2, 3, 5, 8, 10, 20, 30, 40, 50, 60, 80,100 A g^{-1} in three-electrode system (the error analysis of capacitance is listed in the bracket).

Samples	GA650 (F g^{-1})	GA750(F g^{-1})	GA850(F g^{-1})
1 A g^{-1}	272.6 (±1.51%)	202..0 (±1.62%)	173.4 (±1.30%)
2A g^{-1}	256.0 (±1.16%)	189.3 (±1.32%)	156.5 (±1.19%)
3 A g^{-1}	253.1 (±1.21%)	184.4 (±1.22%)	148.8 (±1.46%)
5 A g^{-1}	242.2 (±1.10%)	176.1 (±1.16%)	141.5 (±1.24%)
8 A g^{-1}	234.6 (±1.31%)	168.2 (±1.78%)	134.7 (±1.49%)
10 A g^{-1}	231.6 (±1.42%)	168.0 (±1.13%)	125.8 (±1.65%)
20 A g^{-1}	223.4 (±1.23%)	152.3 (±1.83%)	120.6 (±1.26%)
30 A g^{-1}	218.4 (±1.31%)	146.6 (±1.34%)	115.3 (±1.42%)
40 A g^{-1}	214.4 (±1.26%)	140.9 (±1.13%)	111.1 (±1.18%)
50 A g^{-1}	208.7 (±1.51%)	140.3 (±1.20%)	111.0 (±1.62%)
60 A g^{-1}	201.9 (±1.16%)	136.4 (±1.41%)	109.7 (±1.53%)
80 A g^{-1}	197.6 (±1.41%)	127.3 (±1.15%)	108.6 (±1.22%)
100 A g^{-1}	197.0 (±1.62%)	117.6 (±1.32%)	106.9 (±1.27%)

Table S4. The specific capacitance of GA650 at 0.5, 1, 2, 3, 4, 5, 8, 10, 20, 30 A g^{-1}in two-electrode system.

Samples	GA650 (F g^{-1})	the error analysis capacitance
0.5 A g^{-1}	181.7	(±1.31%)
1 A g^{-1}	171.7	(±1.46%)
2 A g^{-1}	168.7	(±1.21%)
3 A g^{-1}	163.5	(±1.50%)
4 A g^{-1}	160.7	(±1.31%)
5 A g^{-1}	157.5	(±1.46%)
8 A g^{-1}	155.9	(±1.53%)
10 A g^{-1}	153.4	(±1.21%)
20 A g^{-1}	147.0	(±1.16%)
30 A g^{-1}	140.4	(±1.21%)