

Supplementary information

Table S1 The composition of DC

Proximate analysis (wt%)				Ultimate analysis (wt%, daf)					impurity element (wt%)					
M _{ad}	A _{ad}	FC _{ad}	V _{daf}	C	H	O	N	S	Ca	Zn	Fe	Si	Mg	Al
0.05	0.85	95.93	3.17	90.21	2.37	3.72	0.84	0.58	0.14	0.066	0.11	0.11	0.030	0.058

FC_{ad} is the fixed carbon on air-dried basis, V_{daf} is the volatile matter content on dry-ash-free basis, M_{ad} is the moisture content on air-dried basis, and A_{ad} is the ash content on air-dried basis.

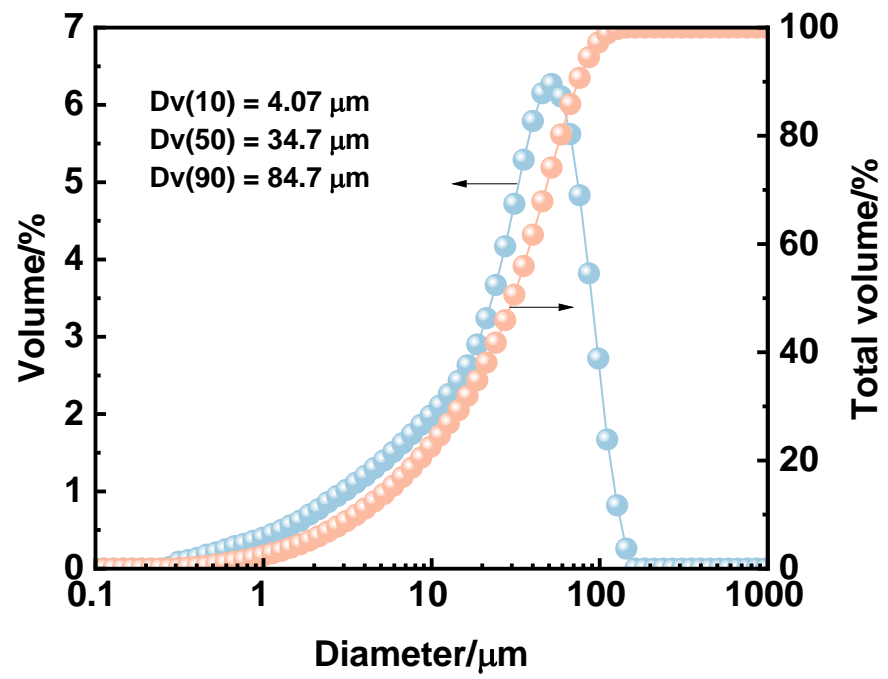


Fig. S1 The particle size distribution of DC

Table S2 Electrolysis products obtained under different experimental conditions

Experimental group	Experimental condition			Electrolysis products
	electrolysis temperature (°C)	cell voltage (V)	electrolysis time (h)	
time	900	2.6	0	DC
	900	2.6	4	EP-4h
	900	2.6	8	EP-8h
	900	2.6	12	EP-12h
temperature	850	2.6	8	EP-850°C
	900	2.6	8	EP-8h
	950	2.6	8	EP-950°C
voltage	900	2.2	8	EP-2.2V
	900	2.4	8	EP-2.4V
	900	2.6	8	EP-8h

Table S3 Structural parameters derived from XRD pattern

sample	2theta(002)	FWHM(002)	2theta(100)	FWHM(100)	d(002)	La	Lc	N	G
DC	25.36	4.15	43.58	3.76	0.3509	4.65	1.94	5.53	-0.81
EP-4h	25.54	3.30	43.49	3.28	0.3485	5.34	2.44	7.01	-0.53
EP-8h	26.38	0.47	42.36	0.17	0.3376	105.58	17.35	51.40	0.74
EP-12h	26.38	0.47	42.40	0.22	0.3376	78.48	17.35	51.40	0.74
EP-850°C	25.20	4.14	43.51	3.26	0.3531	5.37	1.95	5.51	-1.06
EP-950°C	26.36	0.45	42.54	0.21	0.3379	81.45	17.89	52.96	0.71
EP-2.2V	25.41	4.08	43.55	3.77	0.3503	4.64	1.98	5.64	-0.73
EP-2.4V	25.26	3.98	43.62	3.58	0.3524	4.88	2.02	5.74	-0.98

FWHM is full width at half maximum of (002) diffraction peak and (100) diffraction peak; G represents degree of graphitization; Lc and La indicate average crystallite size

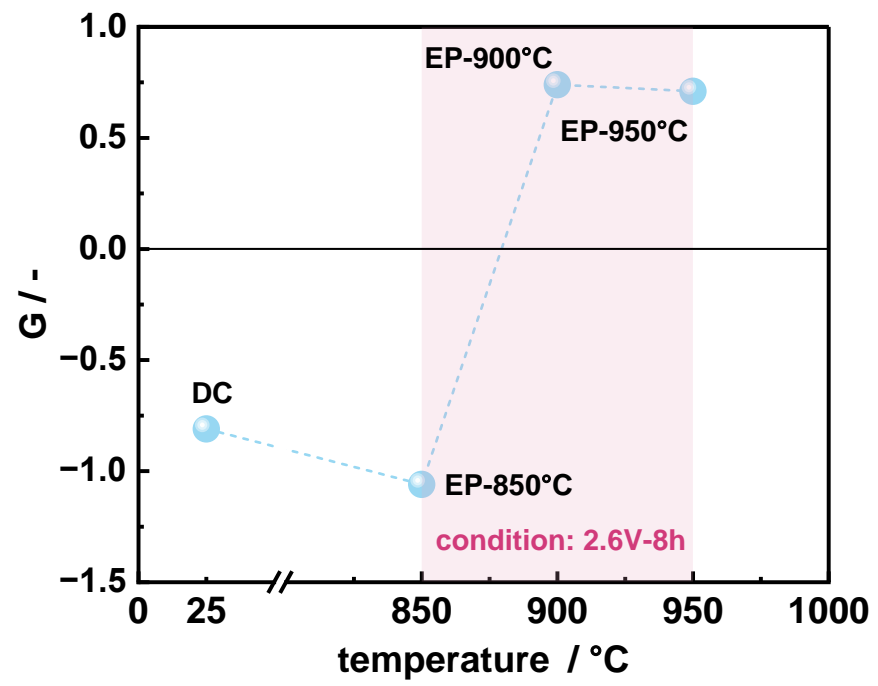


Fig.S2 The relationship between G value and temperature

Table S4 Raman spectral parameters

sample	D4		D1		D3		G		D2		Ratio
	Position	FWHM	Position	FWHM	Position	FWHM	Position	FWHM	Position	FWHM	ID1/IG
DC	1185.00	232.74	1343.24	169.10	1545.85	191.78	1586.56	59.74	1602.35	41.33	1.87
EP-4h	1185.00	199.52	1343.24	117.64	1518.34	215.20	1569.34	37.33	1609.17	50.20	0.96
EP-8h	-	-	1345.39	65.90	-	-	1575.80	30.36	1615.63	32.72	0.29
EP-12h	-	-	1345.39	77.61	-	-	1569.34	31.47	1605.94	34.71	0.20
EP-850°C	1185.00	211.26	1348.62	137.01	1535.67	200.01	1587.64	59.16	1605.63	65.04	2.75
EP-950°C	-	-	1349.70	58.14	-	-	1579.03	27.50	1617.79	35.32	0.22
EP-2.2V	1185.00	194.99	1345.39	132.42	1538.96	199.68	1589.79	52.85	1620.01	44.57	1.84
EP-2.4V	1185.00	189.53	1347.55	129.56	1528.71	193.75	1590.87	59.66	1620.00	60.03	1.78

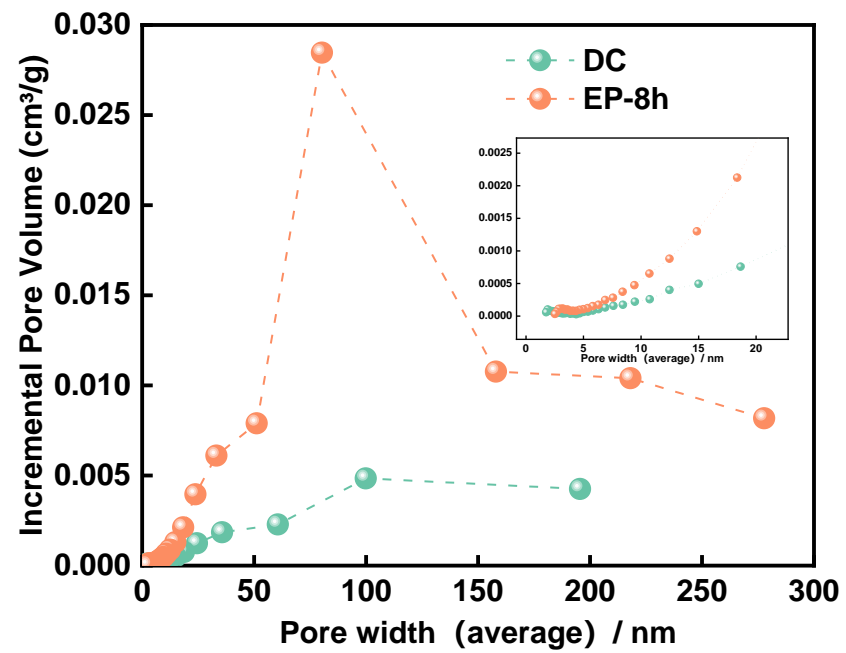


Fig. S3 The pore size distribution of DC and EP-8h

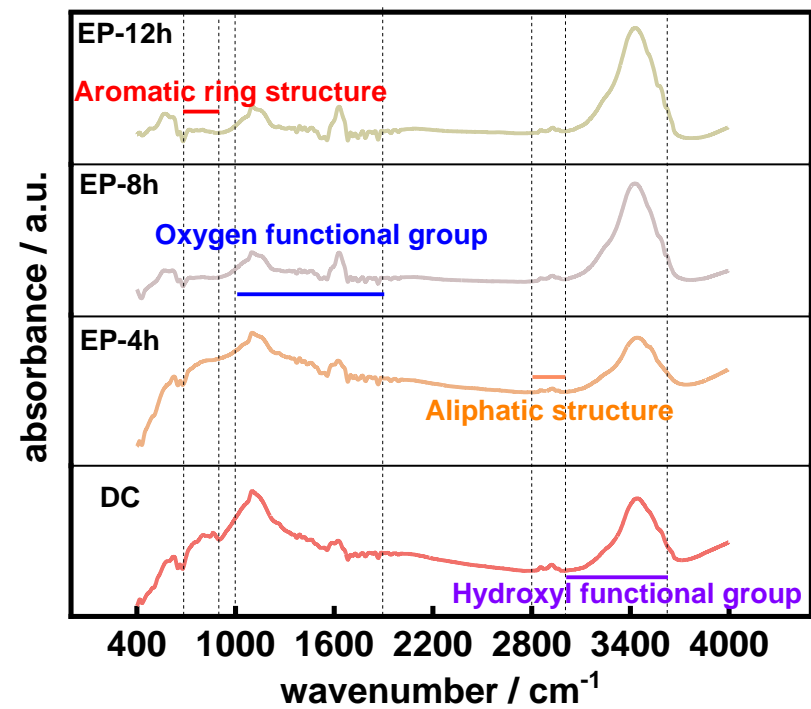


Fig.S4 FTIR spectra of DC and electrolysis products at different time

Table S5 The near-surface chemical composition on the samples surface calculated from XPS spectra (atom, %)

sample	C	O	N	S
DC	91.02	6.65	2.03	0.31
EP-4h	93.93	4.61	1.24	0.22
EP-8h	95.66	3.2	0.98	0.16
EP-12h	96.38	2.71	0.76	0.15

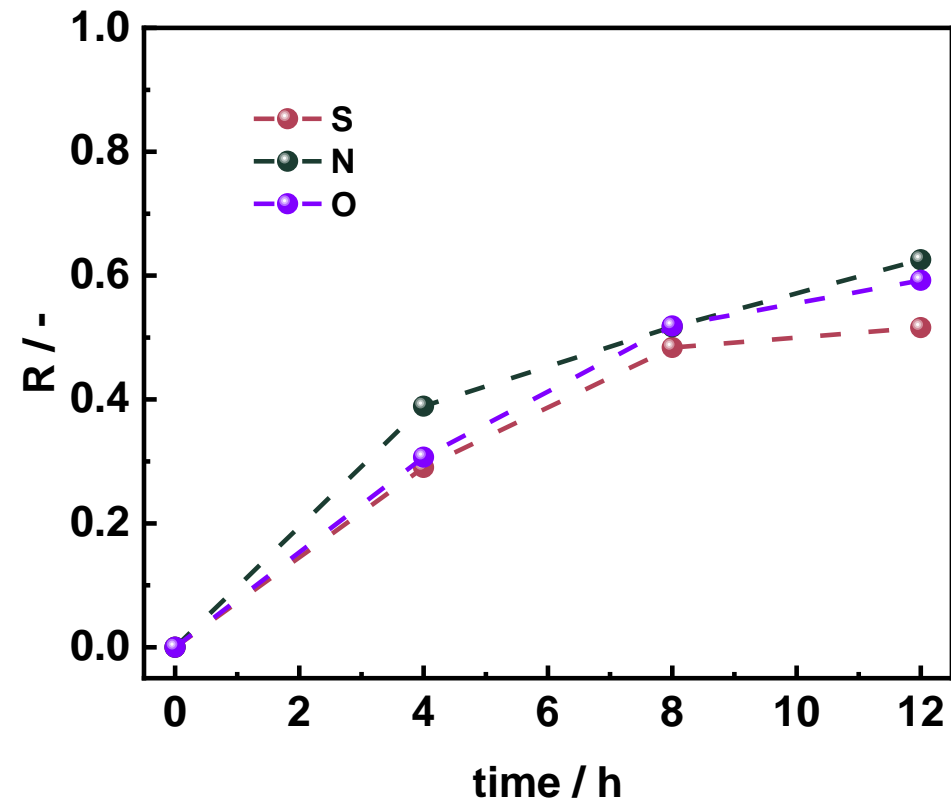


Fig.S5 The atomic conversion rate of S、N、O on the surface of the samples

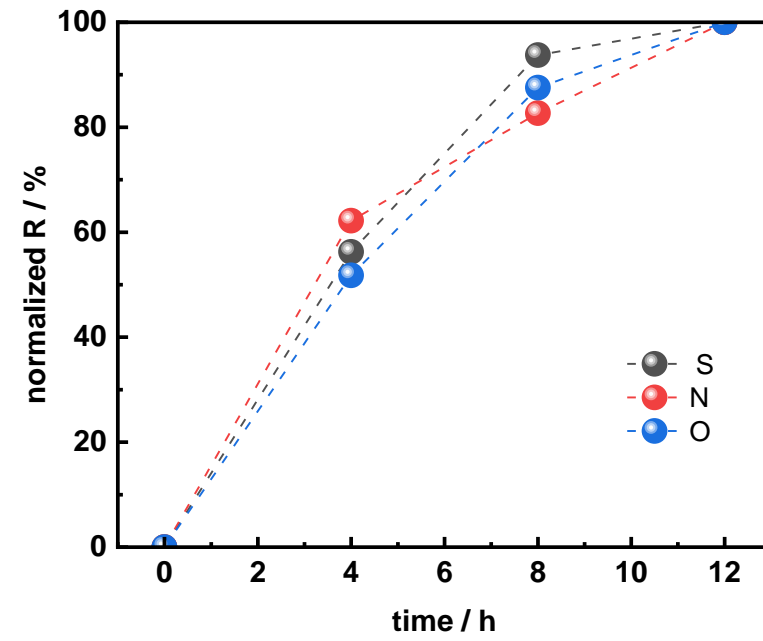


Fig.S6 The atomic conversion rate (normalized) of S、N、O on the surface of the samples

Table S6 Results of chemical bonds (area) calculated from XPS measurements.

sample	sp ²	sp ³	π - π^*	sp ² / sp ³
DC	102556.200	37185.960	29761.830	2.758
EP-4h	82266.630	23581.250	17563.210	3.489
EP-8h	118223.300	27757.740	27757.740	4.259
EP-12h	121069.600	27755.140	26099.110	4.362