

A universal strategy for green and *in-situ* synthesis of carbon dots-based pickling solution

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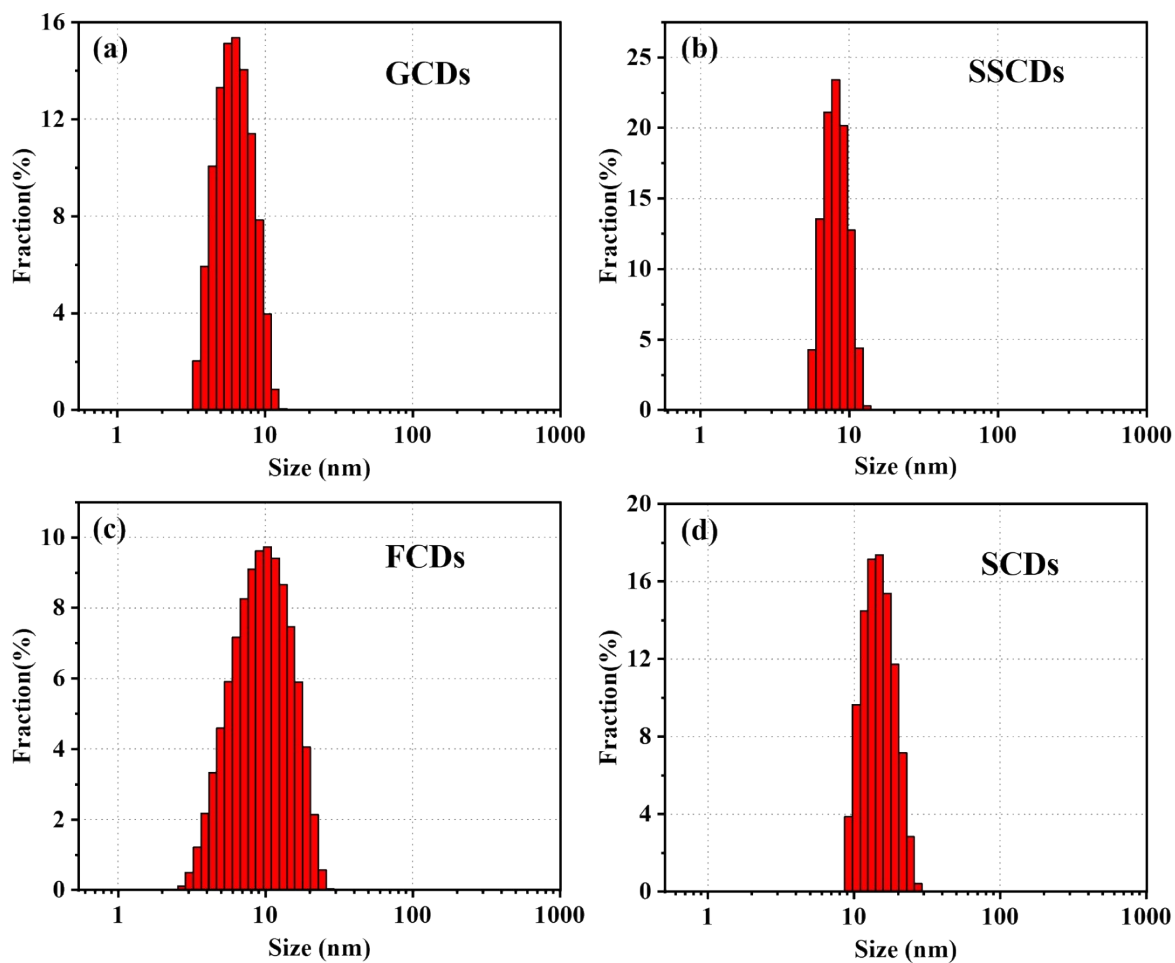


Fig. S1 The size distribution of the four kinds of CDs measured by dynamic light scattering (DLS):
 (a) GCDs, (b) SSCDs, (c) FCDs and (d) SCDs.

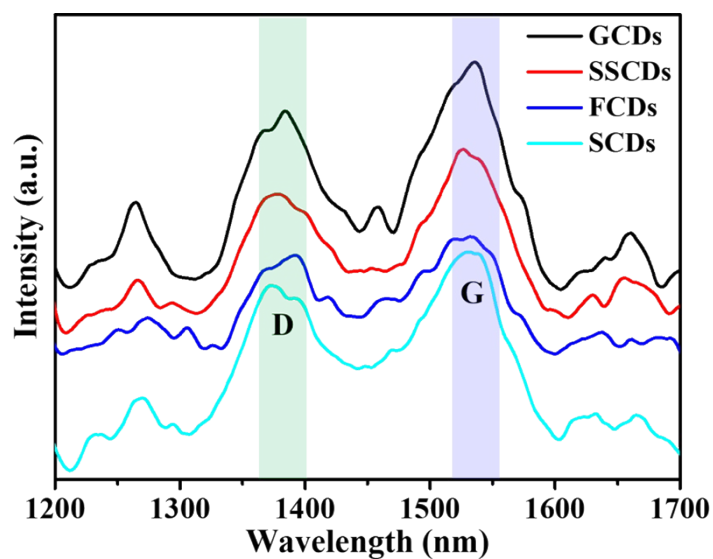


Fig. S2 Raman spectra of GCDs, SSCDs, FCDs and SCDs (they are obtained from GCDs-25, SSCDs-20, FCDs-0.5 and SCDs-0.5, respectively).

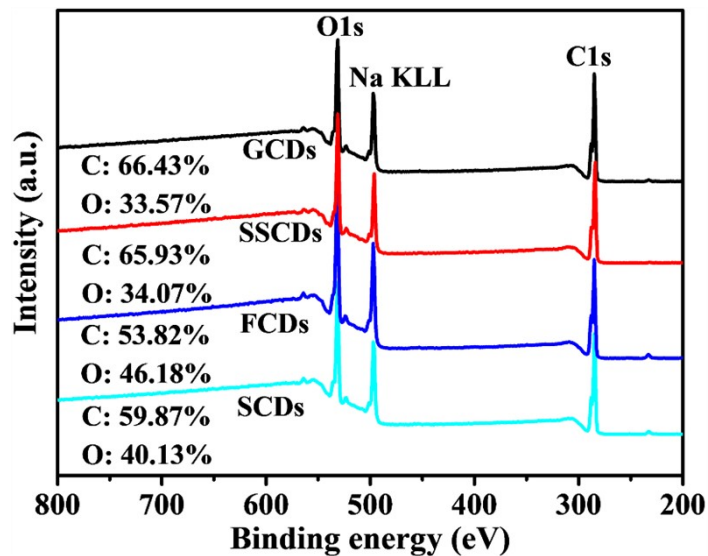


Fig. S3 Full range XPS spectra and atom contents of GCDs, SSCDs, FCDs and SCDs (they are collected from GCDs-25, SSCDs-20, FCDs-0.5 and SCDs-0.5, respectively).

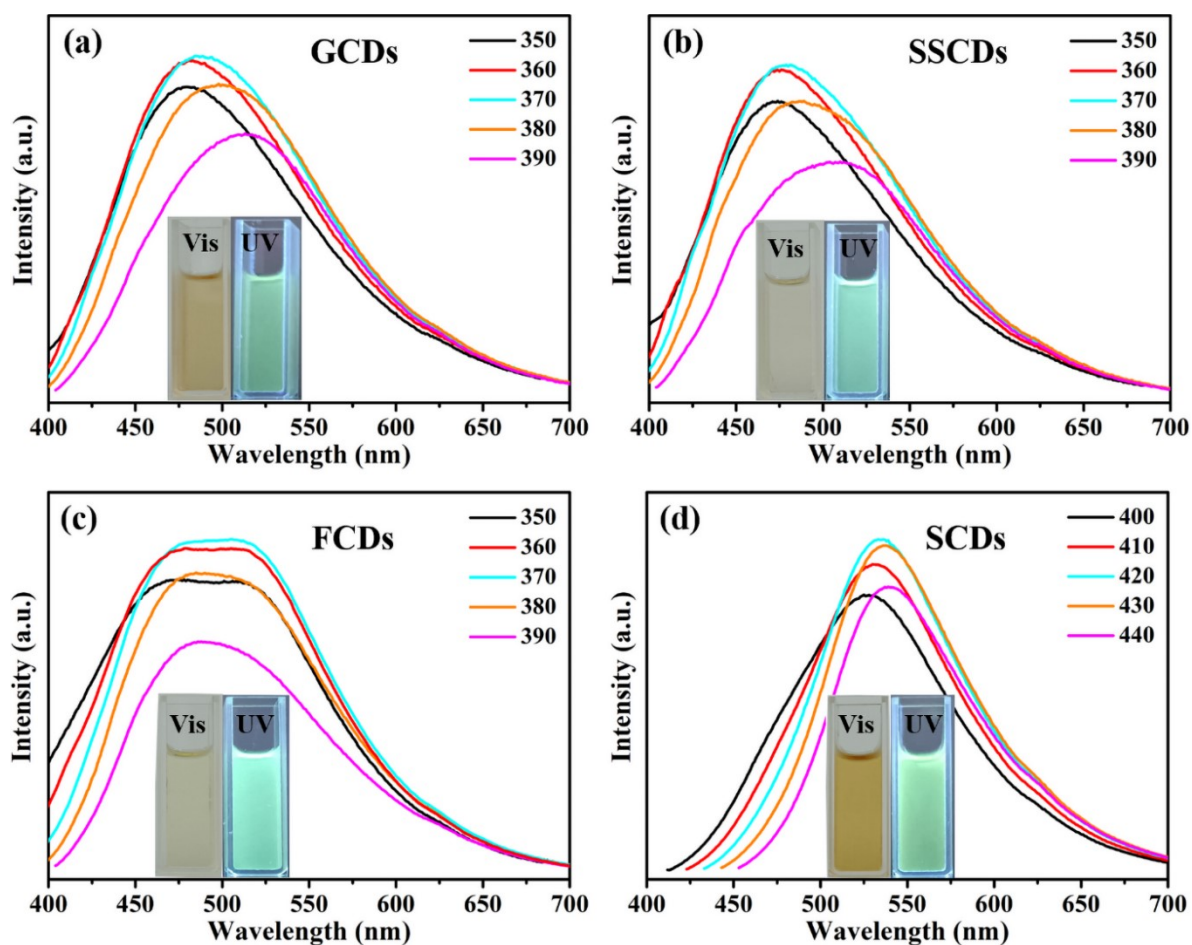


Fig. S4 PL spectra of (a) GCDs, (b) SSCDs, (c) FCDs and (d) SCDs in aqueous solution (with photographs taken under visible light and a 365 nm UV light, inset).

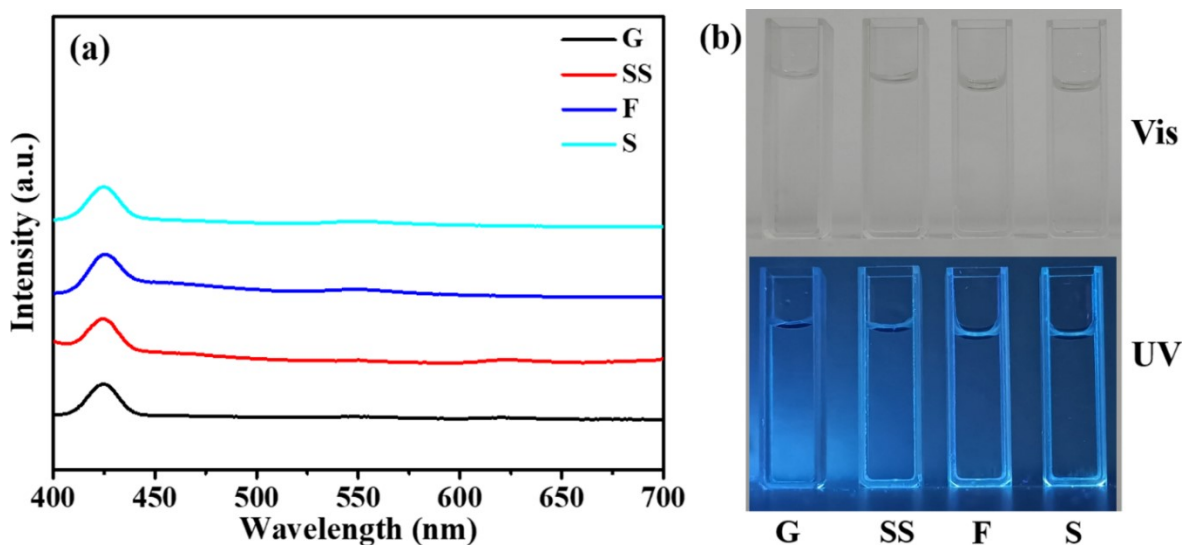


Fig. S5 (a) PL spectra of precursors groups (G, SS, F and S represent the groups using glucose, soluble starch, fructose and saccharose as inhibitors, respectively) excited by 370 nm and (b) photographs taken under visible light and UV irradiation at 365 nm.

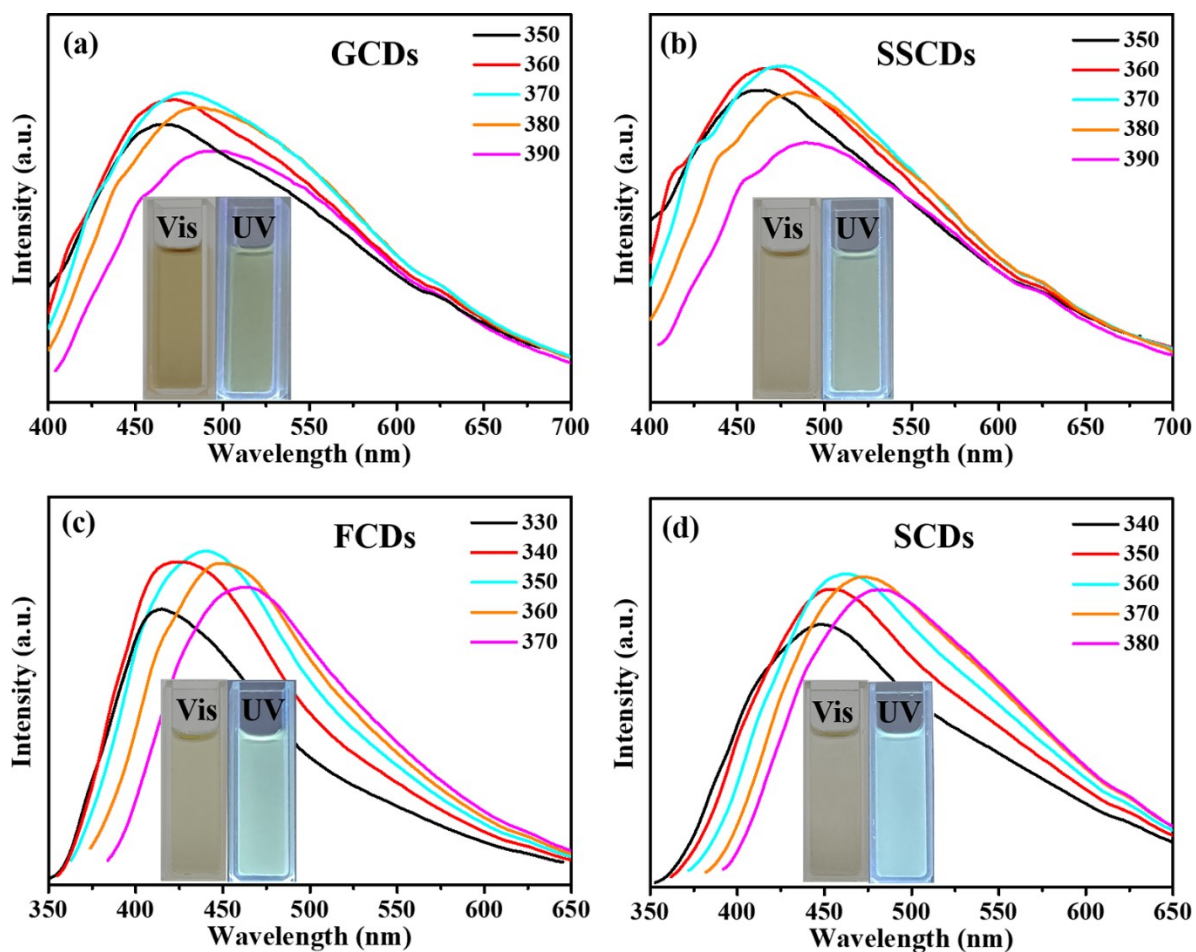


Fig. S6 PL spectra of (a) GCDs, (b) SSCDs, (c) FCDs and (d) SCDs in 0.5 M H₂SO₄ solution (with photographs taken under visible light and UV irradiation at 365 nm after one-month standing, inset).

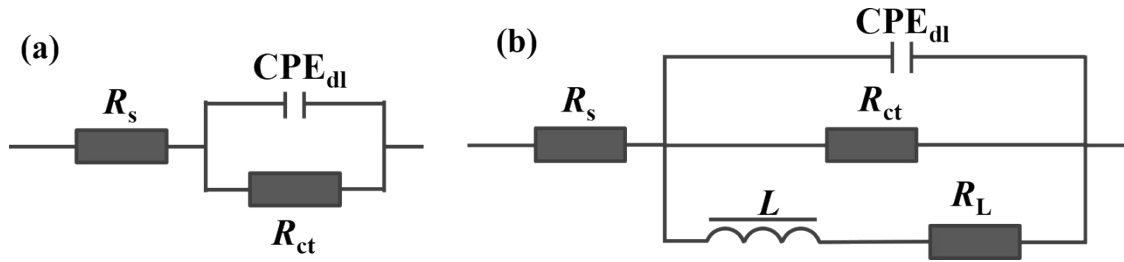


Fig. S7 Equivalent circuit models used to fit the EIS results for different groups: (a) blank, precursors and SSCDs groups; (b) GCDs, FCDs and SCDs groups.

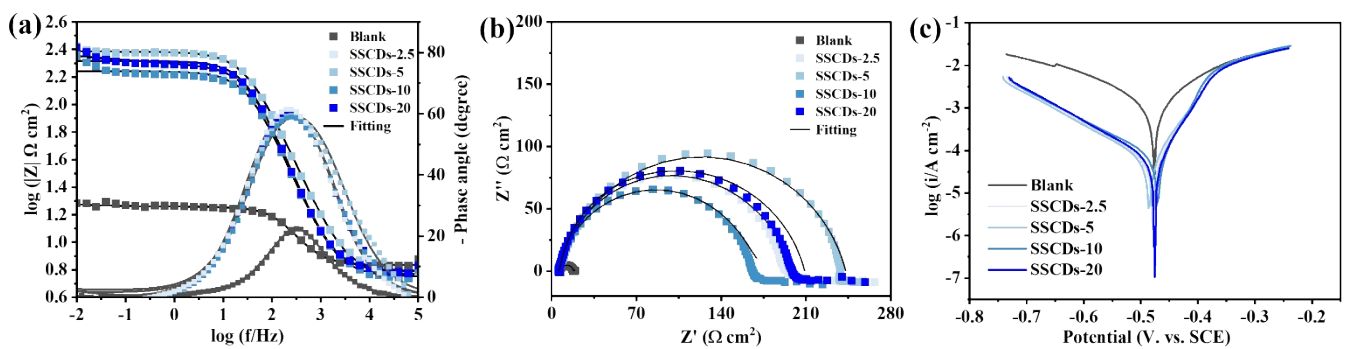


Fig. S8 (a) Bode plots, (b) Nyquist plots and (c) PDP curves of Q235 carbon steel in blank group and different SSCDs groups (SSCDs-2.5, SSCDs-5, SSCDs-10 and SSCDs-20; the number after SSCDs represents the acid oxidation time).

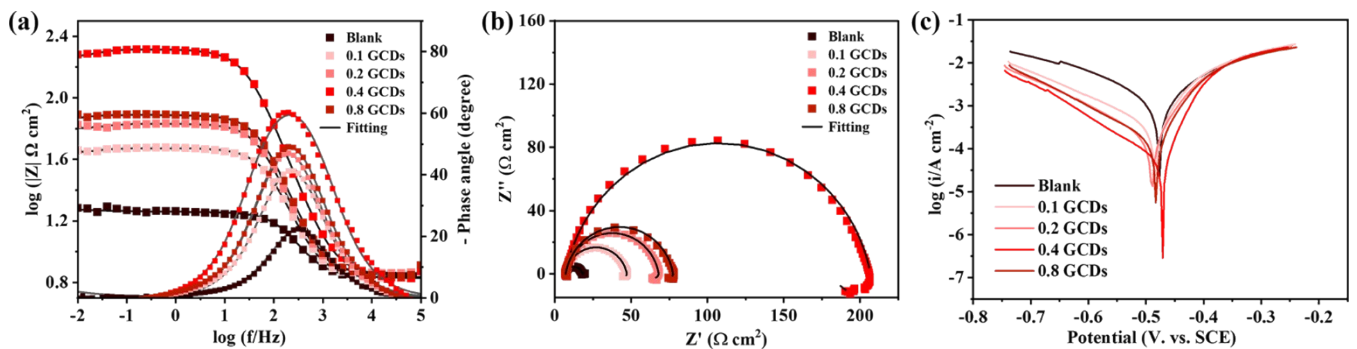


Fig. S9 (a) Bode plots, (b) Nyquist plots and (c) PDP curves of Q235 carbon steel in blank group and various GCDs groups (0.1 GCDs, 0.2 GCDs, 0.4 GCDs and 0.8 GCDs; the number before GCDs denotes the quality (g) of glucose).

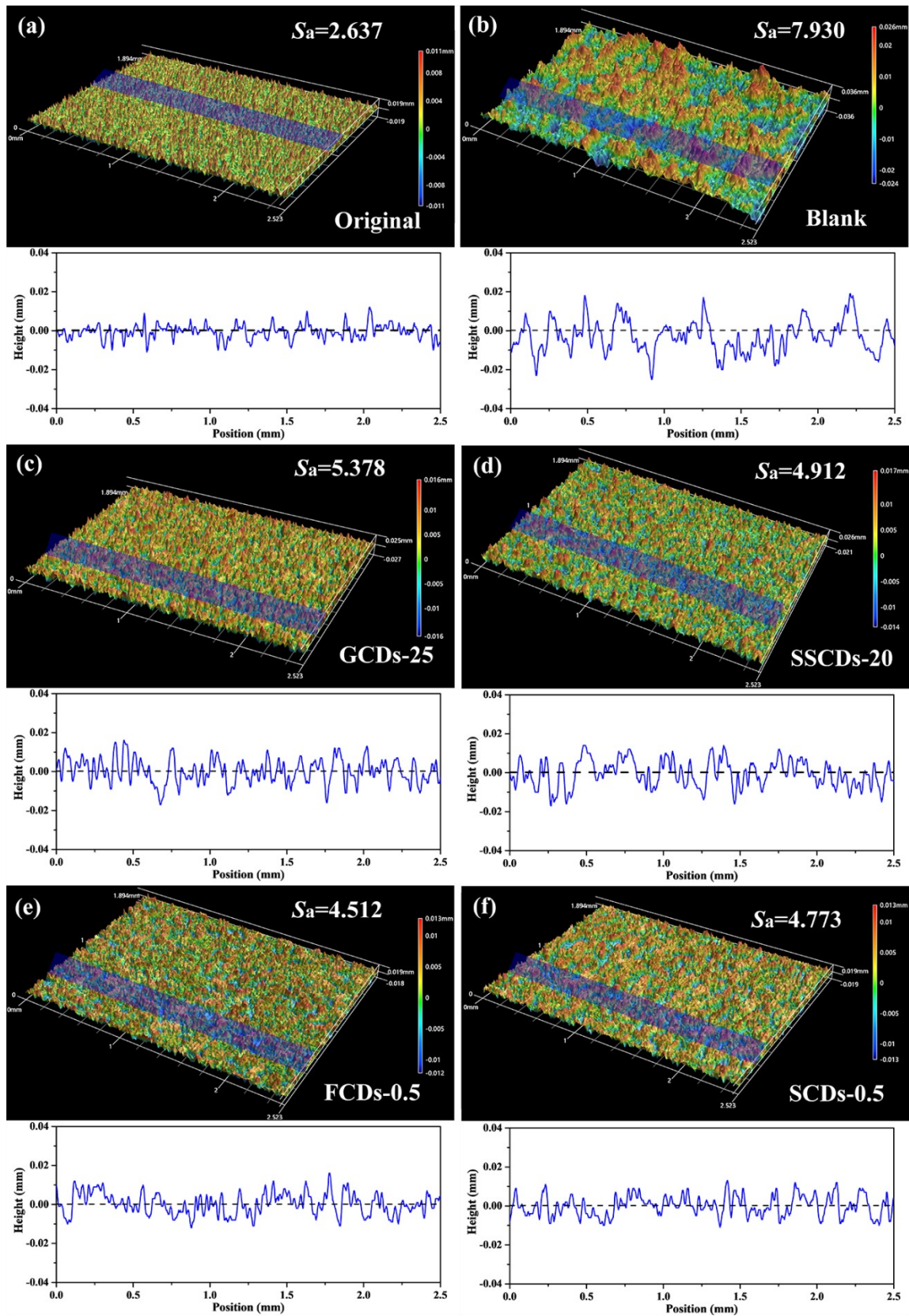


Fig. S10 3D morphologies and height profiles along blue surfaces of Q235 carbon steel specimens in different states: (a) original state, and states after immersion of 24 h in (b) blank group, (c) GCDs-25, (d) SSCDs-20, (e) FCDs-0.5 and (f) SCDs-0.5.

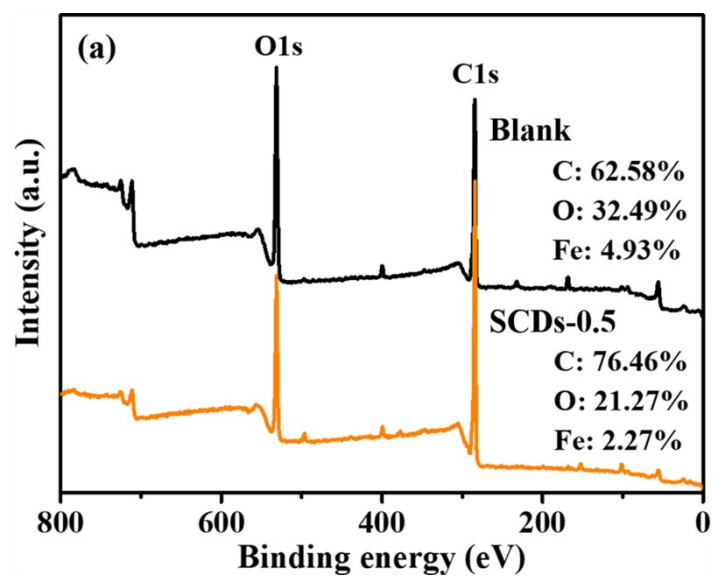


Fig. S11 Full XPS spectra and atom contents of Q235 carbon steel specimens after immersion of 24 h in blank group and SCDs-0.5.

Table S1 The fitting parameters obtained from EIS results of blank group and various SSCDs groups (SSCDs-2.5, SSCDs-5, SSCDs-10 and SSCDs-20; the number after SSCDs represents the acid oxidation time).

Groups	R_s ($\Omega \text{ cm}^2$)	R_{ct} ($\Omega \text{ cm}^2$)	CPE_{dl} ($\mu\text{F cm}^{-2}$)	n	γ (%)
Blank	6.8	11.5	196.7	0.869	–
SSCDs-2.5	6.0	148.3	43.7	0.892	92.24
SSCDs-5	5.8	237.1	48.4	0.838	95.15
SSCDs-10	5.6	139.8	50.5	0.876	91.77
SSCDs-20	6.1	201.3	47.4	0.884	94.28

Table S2 Electrochemical parameters obtained from PDP of blank group and different SSCDs groups (SSCDs-2.5, SSCDs-5, SSCDs-10 and SSCDs-20; the number after SSCDs represents the acid oxidation time).

Groups	E_{corr} (mV/ScE)	i_{corr} ($\mu\text{A/cm}^2$)	β_c (mV/dec)	β_a (mV/dec)	IE (%)
Blank	-477	2013.7	236	163	
SSCDs-2.5	-480	67.5	147	61	96.65
SSCDs-5	-485	67.8	150	61	96.64
SSCDs-10	-471	101.1	194	63	94.98
SSCDs-20	-476	34.2	105	54	98.30

Table S3 The fitting electrochemical parameters obtained from EIS results of blank group and various GCDs groups (0.1 GCDs, 0.2 GCDs, 0.4 GCDs and 0.8 GCDs; the number before GCDs denotes the quality (g) of glucose).

Groups	R_s ($\Omega \text{ cm}^2$)	R_{ct} ($\Omega \text{ cm}^2$)	CPE_{dl} ($\mu\text{F cm}^{-2}$)	n	L (H cm^2)	R_L ($\Omega \text{ cm}^2$)	γ (%)
Blank	6.8	11.5	196.7	0.869	-	-	-
0.1 GCDs	6.7	40.4	106.9	0.884	3049	499	71.53
0.2 GCDs	7.2	60.8	84.1	0.898	3126	700	81.06
0.4 GCDs	6.9	200.1	48.8	0.880	10880	1565	94.25
0.8 GCDs	7.0	70.4	75.1	0.893	11210	843	83.66

Table S4 Electrochemical parameters obtained from PDP of blank group and different GCDs groups (0.1 GCDs, 0.2 GCDs, 0.4 GCDs and 0.8 GCDs; the number before GCDs denotes the quality (g) of glucose).

Groups	E_{corr} (mV/ScE)	i_{corr} ($\mu\text{A}/\text{cm}^2$)	β_{c} (mV/dec)	β_{a} (mV/dec)	IE (%)
Blank	-477	2013.7	236	163	
0.1 GCDs	-484	614.2	272	101	69.50
0.2 GCDs	-490	279.2	195	84	86.13
0.4 GCDs	-471	96.2	188	61	95.22
0.8 GCDs	-484	185.4	160	75	90.79

Table S5 The fitting EIS parameters of blank group and different precursors groups (G, SS, F and S represent the groups using glucose, soluble starch, fructose and saccharose as inhibitors, respectively).

Groups	R_s ($\Omega \text{ cm}^2$)	R_{ct} ($\Omega \text{ cm}^2$)	CPE_{dl} ($\mu\text{F cm}^{-2}$)	n	γ (%)
0	6.8	11.5	196.7	0.869	-
G	6.2	13.6	116.1	0.908	15.31
SS	6.4	12.0	150.1	0.900	4.40
F	6.1	11.3	179.8	0.885	-1.59
S	7.1	12.8	331.7	0.882	9.80

Table S6 Electrochemical parameters obtained from PDP of blank group and different precursors groups (G, SS, F and S represent the groups using glucose, soluble starch, fructose and saccharose as inhibitors, respectively).

Groups	E_{corr} (mV/ScE)	i_{corr} ($\mu\text{A}/\text{cm}^2$)	β_{c} (mV/dec)	β_{a} (mV/dec)	IE (%)
0	-477	2013.7	236	163	-
G	-480	1706.9	219	141	15.24
SS	-480	1665.4	181	149	17.30
F	-478	2046.6	239	143	-1.63
S	-473	2008.7	249	162	0.25

Table S7 Elemental compositions on Q235 carbon steel surfaces after immersion of 24 h in various groups (blank group, GCDs-25, SSCDs-20, FCDs-0.5 and SCDs-0.5).

Groups	Fe (%)	O (%)	C (%)
Original	70.93	6.76	22.31
Blank	30.36	54.26	15.38
GCDs-25	48.53	29.88	21.59
SSCDs-20	55.34	26.59	18.07
FCDs-0.5	57.65	12.49	29.86
SCDs-0.5	60.09	20.12	19.79