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Electronic Supplementary Information

Polydopamine-induced surface functionalization of carbon nanofiber for Pd deposition enabling an enhanced catalytic activity for oxygen reduction and evolution reactions

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Figure S1 I HRTEM of (A) bare Carbon nanofiber and (B) Polydopamine coated Carbon nanofiber.



Figure S2 I SEM images of Pd deposited on unmodified CNF illustrating the significance of polydopamine coating. All images were obtained at 1μ m magnification.



Figure S3 | Sample EDS images of Pd-on-CNF: (A) SEM of PdCNFs and (B) Pd, (C) C, (D) N distributions on the CNFs

	Atomic percent (%)			Atomic percent (%)			
	Concentration			Time			
Element	PDAC1 (1mg/ml)	PDAC2 (2mg/ml)	PDAC3 (3mg/ml)	PDAT1 (6hrs)	PDAT2 (12hrs)	PDAT3 (24hrs)	Pd/C(Co mm.)
С	59.85	57.42	57.76	57.77	54.49	57.76	63.52
N	40.01	42.29	41.84	41.47	45.05	41.84	35.91
Pd	0.14	0.29	0.39	0.76	0.49	0.39	0.57

Table S1 | Composition of Pd, N, and C determined using EDX analysis on low magnification SEM images



Figure S4 | X-Ray Diffraction pattern for PDAC1, PDAC2, PDAC3, (A) and PDAT1, PDAT2, PDAT3 (B). RAMAN spectra for PDAC1, PDAC2, PDAC3, (C) and PDAT1, PDAT2, PDAT3 (D)



Figure S5 I The variation of reaction time: XPS Pd3d spectra for (A) PDAT1, (B) PDAT2, (C) PDAT3; XPS N1s spectra for (D) PDAT1, (E) PDAT2, (F) PDAT3.

Table S2I Percentage composition of Pd on PDA-CNF based on deconvoluted XPS spectra

	Pd3d _{5/2} (%)		Pd3d _a	_{3/2} (%)
	Pd ⁰	Pd ²⁺	Pd ⁰	Pd ²⁺
PDAC1	35.92	17.68	29.41	17.00
PDAC2	38.90	14.60	32.63	13.87
PDAT3	43.54	11.09	34.59	10.78
PDAT1	47.99	6.41	39.29	6.30
PDAT2	46.53	9.52	35.39	8.56
PDAT3	43.54	11.09	34.59	10.78

	N1s					
	Pyridine- oxide N	Graphitic N	Pyrollic N	Metal-N _X	Pyridinic N	Imine N
PDAC1	13.41	29.36	11.30	10.32	26.85	8.76
PDAC2	12.08	29.37	14.53	11.63	22.58	9.88
PDAC3	10.74	28.87	15.18	12.85	23.83	10.31
PDAT1	14.79	17.26	21.62	16.85	16.01	13.51
PDAT2	14.06	18.46	20.74	15.86	18.79	12.10
PDAT3	10.74	28.87	15.18	12.85	23.83	10.31

Table S3I Percentage composition of N on PDA-CNF based on deconvoluted XPS spectra



Figure S6 I Schematic diagram of the mechanism of polydopamine formation and the plausible intermediary tautomers and end-products.



Figure S7 I Electrochemical analyses for PDAT1, PDAT2, PDAT3 using *Lithium oxygen cells*: (A)Full range discharge capacity curves with the cut-off voltage at 2.0V, (B) First charge/discharge curves with the limited capacity up to 0.2mAh/cm², (C) Cycle performance with the limited capacity up to 0.2mAh/cm². *Rotating Disc Electrode*; (D)CV curves at scan rate 50mV/s (E)Linear Sweep Voltammograms at 5mV/s and 1600rpm (F)Koutecky–Levich (K-L) plot for ORR in O₂ -saturated 0.1 M KOH solution.



Figure S8 I SEM images of discharged and charged cathodes of bare CNF(A,B), PDAC1(C,D), PDAC2(E,F), and PDAC3(G,H). All images were obtained at 1μ m magnification.



Figure S9 I SEM images of discharged (A) and charged (B) cathodes of PdC(commercial). All images were obtained at 1µm magnification.



Figure S10 I SEM images of discharged and charged cathodes of PDAT1 (A, B), PDAT2(C, D), and PDAT3 (E, F). All images were obtained at 1µm magnification.



Figure S11 I TEM images of discharged cathodes of PDAT1(A), PDAC3(B), and PdC(C).



Figure S12 I XPS Li1s spectra for (A) PDAT1, (B) PDAC3 and (C) PdC; XPS Pd3d spectra for (D) PDAT1, (E) PDAC3 and (F) PdC. All samples are electrodes harvest after full-range discharge.

Sample	Onset Potential(V)	Half-wave Pot.(V)	Electron Transfer No.
PDAC1	0.76	0.61	1.71
PDAC2	0.76	0.63	3.31
PDAC3	0.77	0.66	3.47
PDAT1	0.84	0.73	4.43
PDAT2	0.79	0.69	3.38
PDAT3	0.77	0.66	3.47
Pd/C(Comm.)	0.74	0.65	3.60

Table S4 I Summary of Electrochemical Performance from RDE Analysis