Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information for

Three-dimensional low-defect carbon nanotube/nitrogen-doped graphene hybrid aerogel-supported Pt nanoparticles as efficient electrocatalysts toward methanol oxidation reaction

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Supplementary Results

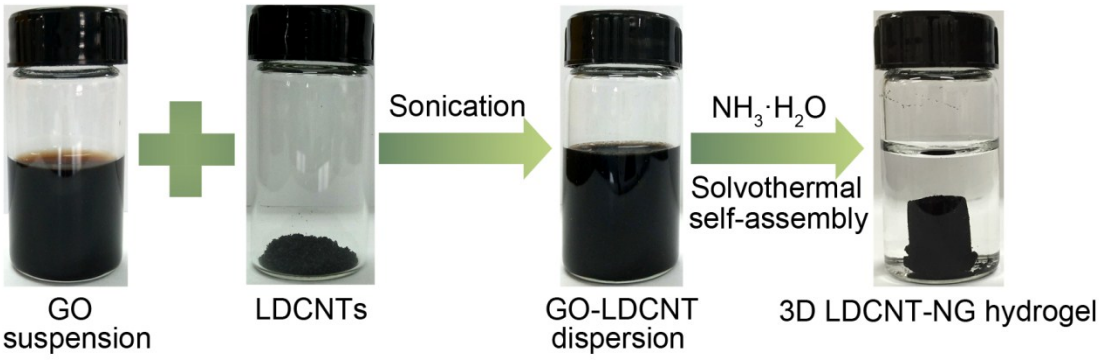

Fig. S1 The synthetic process for 3D LDCNT-NG hydrogel. It includes: (1) dispersion of low-defect CNTs in GO suspension via ultrasonic treatment; (2) formation of 3D LDCNT-NG hydrogel through a solvothermal reaction.

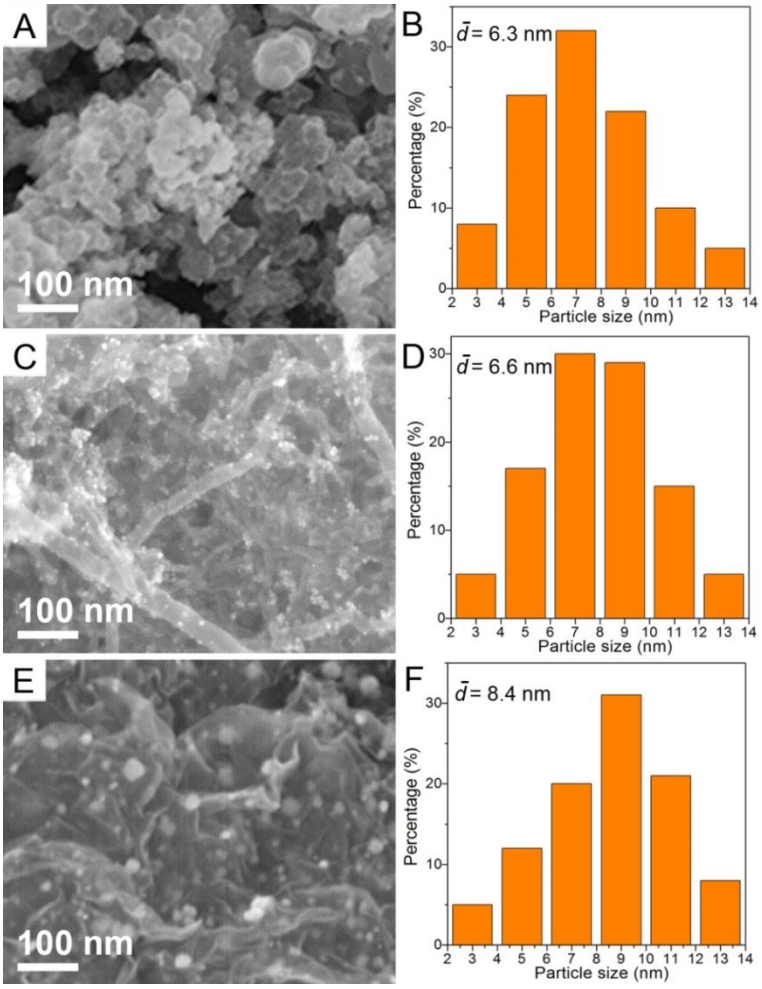

Fig. S2 Representative FE-SEM images and Pt particle size distribution of (A and B) Pt/C, (C and D) Pt/CNT, and (E and F) Pt/G, respectively.

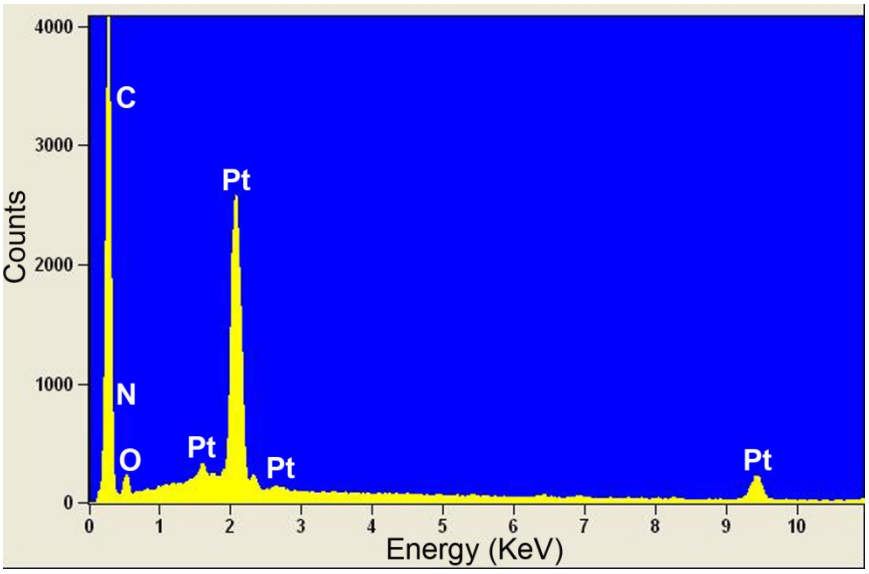

Fig. S3 EDX spectrum of the Pt/LDCNT-NG architecture.

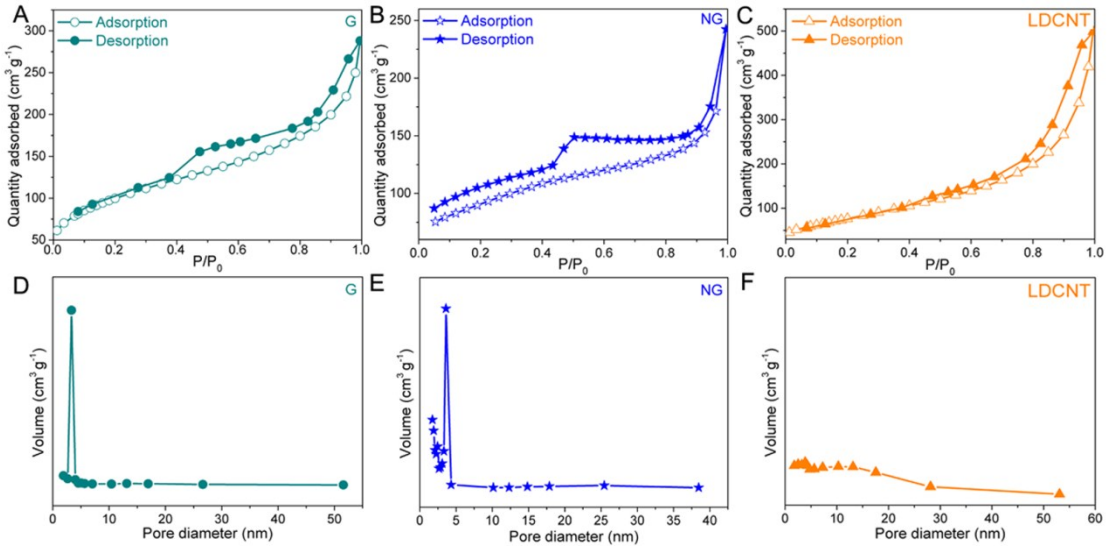

Fig. S4 Nitrogen adsorption−desorption isotherms and pore size distributions of (A and D) G, (B and E) NG, and (C and F) LDCNT samples, respectively.

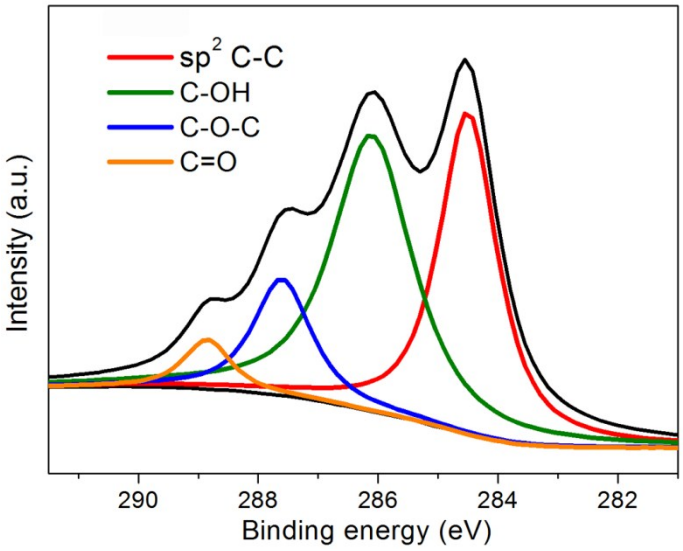

Fig. S5 C 1s core-level XPS spectrum of GO.

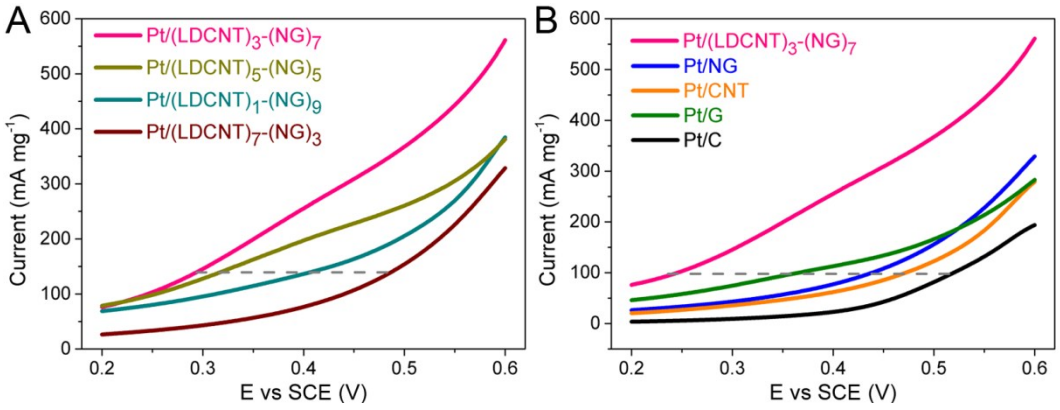

Fig. S6 Linear sweep voltammetrys of (A) the Pt/LDCNT-NG architectures with varying LDCNT/NG ratios, and (B) Pt/$(LDCNT)_3$-$(NG)_7$, Pt/NG, Pt/CNT, Pt/G and Pt/C in 0.5 M H_2SO_4 solution at 50 mV s^{-1}.

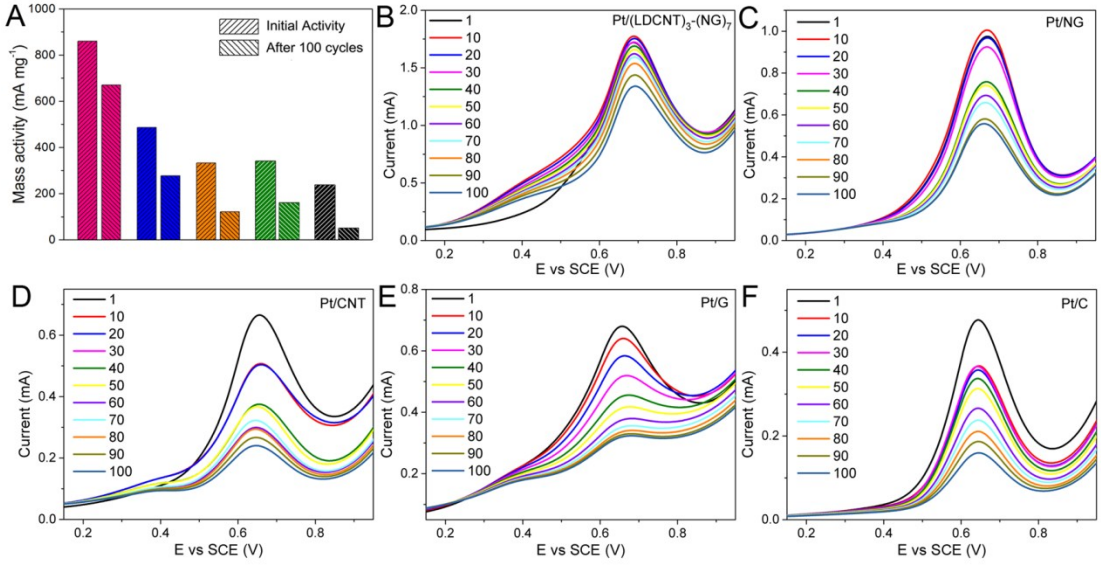

Fig. S7 (A) The mass activities of different catalysts before and after 100 cycles. 100 consecutive cycle scans of methanol oxidation obtained from (B) Pt/$(LDCNT)_3$-$(NG)_7$, (C) Pt/NG, (D) Pt/CNT, (E) Pt/G and (F) Pt/C.

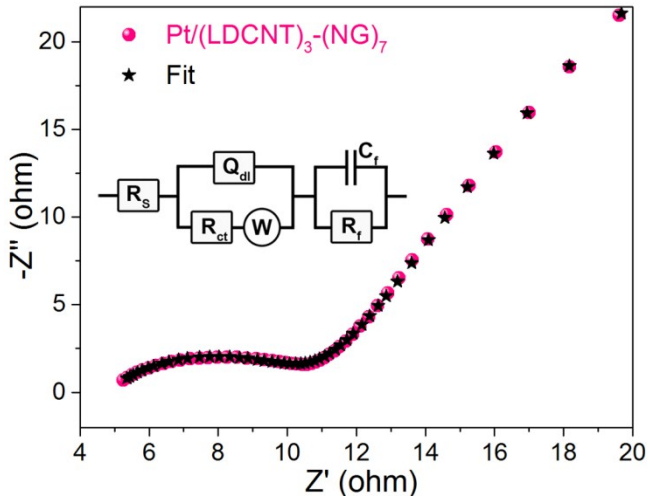

Fig. S8 Nyquist plots of Pt/$(LDCNT)_3$-$(NG)_7$ electrode and the corresponding fitting curve. The inset is the equivalent circuit.

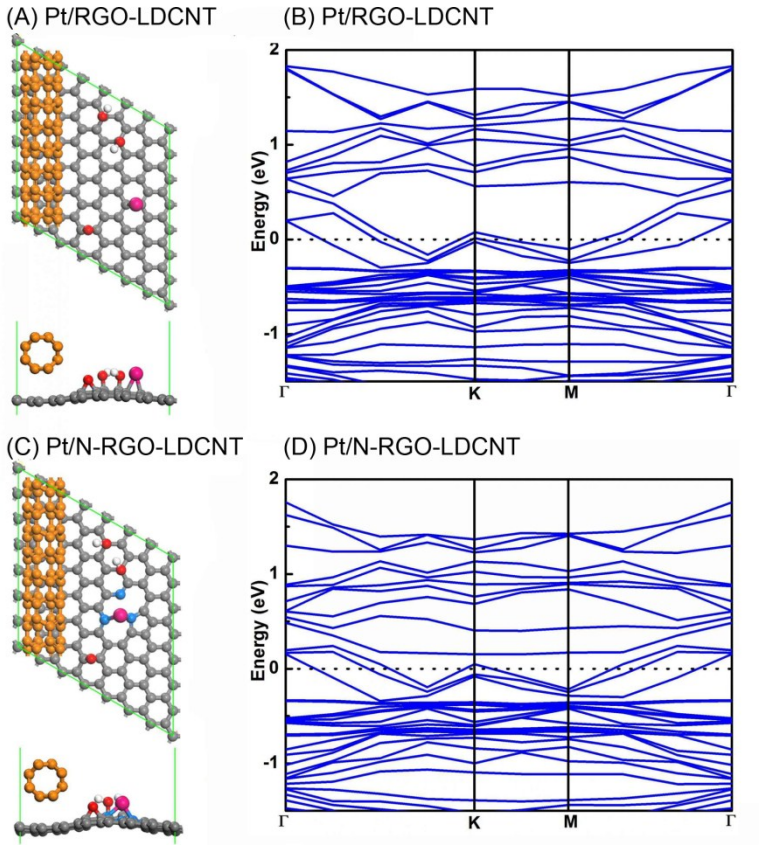

Fig. S9 The relaxed atomic structure of (A) Pt/RGO-LDCNT, and (B) the corresponding band structure. The relaxed atomic structure of (C) Pt/N-RGO-LDCNT, and (D) the corresponding band structure.

Table S1. Comparison of methanol oxidation activity for the 3D Pt/$(LDCNT)_3$-$(NG)_7$ hybrid and recent state-of-the-art Pt-based catalysts.

Catalyst	ECSA ($m^2\ g^{-1}$)	Mass activity ($mA\ mg^{-1}$)	Scan rate ($mV\ s^{-1}$)	Electrolyte	Reference
3D Pt/$(LDCNT)_3$-$(NG)_7$	132.4	871.9	50	0.5 M H_2SO_4 + 1 M CH_3OH	This work
Pt/$[BMIM]BF_4$/ CNT	N.A.	155.0	50	0.5 M H_2SO_4 + 1 M CH_3OH	1
Pt/ionic liquid/ CNT	67.6	~410.0	50	0.5 M H_2SO_4 + 0.5 M CH_3OH	2
Pt/low-defect graphene	63.0	203.8	20	1 M H_2SO_4 + 2 M CH_3OH	3
Pt/graphene	101.3	333.3	50	0.5 M H_2SO_4 + 0.5 M CH_3OH	4
Pt/exfoliated graphene	51.0	~300.0	50	0.5 M H_2SO_4 + 2 M CH_3OH	5
Pt/CNT/graphene	95.6	617.9	20	1 M H_2SO_4 + 2 M CH_3OH	6
Pt/N-doped graphene	N.A.	~400.0	200	0.5 M H_2SO_4 + 1 M CH_3OH	7
Pt/N-doped graphene ribbon	64.6	~390.0	20	1 M H_2SO_4 + 2 M CH_3OH	8
PtAu/N-doped graphene	60.9	417.0	50	0.5 M H_2SO_4 + 0.5 M CH_3OH	9
Pt/B-doped graphene	58.8	~410.0	50	0.5 M H_2SO_4 + 0.5 M CH_3OH	10
PtRu/N-doped CNT-graphene	N.A.	500.5	10	0.5 M H_2SO_4 + 1 M CH_3OH	11
3D Pt/C_3N_4/ graphene	69.0	612.8	20	1 M H_2SO_4 + 2 M CH_3OH	12
Pt/mesoporous carbon	N.A.	~450.0	20	0.5 M H_2SO_4 + 1 M CH_3OH	13
Pt/macroporous carbon	N.A.	81.6	50	0.5 M H_2SO_4 + 0.5 M CH_3OH	14
Pt/N-doped porous carbon	24.6	343.0	50	0.5 M H_2SO_4 + 1 M CH_3OH	15
3D Pt/RuO_2/ graphene	122.7	646.5	20	1 M H_2SO_4 + 2 M CH_3OH	16
AuPtCu nanowires	N.A.	~500.0	50	0.1 M $HClO_4$ + 1 M CH_3OH	17

FePtPd nanowires	N.A.	488.7	50	0.1 M $HClO_4$+ 0.2 M CH_3OH	18
PtPd dendrites	N.A.	490.0	50	0.5 M H_2SO_4 + 1 M CH_3OH	19
PtPd dendrites/ graphene	81.6	647.2	50	0.5 M H_2SO_4 + 1 M CH_3OH	20
PtAu dendrites/ graphene	100.8	365.0	50	0.5 M H_2SO_4 + 1 M CH_3OH	21

Table S2. The charge-transfer resistance (R_{ct}) for different catalysts.

Electrode	R_{ct}	
	Value (ohm)	Error (%)
$Pt/(LDCNT)_3$-$(NG)_7$	5.3	1.9
Pt/CNT	22.5	6.1
Pt/G	9.6	9.1
Pt/C	1.6×10^3	4.8

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