Electronic Supplementary Information

Anchoring nanosized Pd on three-dimensional boron and nitrogen-codoped graphene aerogels as a highly-active multifunctional electrocatalyst for formic acid and methanol oxidation reactions

Ying Yang^a, Huajie Huang^{a,*}, Binfeng Shen^a, Ling Jin^b, Quanguo Jiang^a, Lu Yang^a, and Haiyan He^{a,*}

^aCollege of Mechanics and Materials, Hohai University, Nanjing 210098, China

^bJiangsu & Nanjing Energy Conservation Center, Nanjing 210007, China

*huanghuajie@hhu.edu.cn (Huajie Huang), he.haiyan@hhu.edu.cn (Haiyan He)

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Supplementary Results



Fig. S1 The synthetic process for 3D BNG hydrogels, which includes: (1) mixture of GO suspension and NH₄BF₄ by magnetic and sonicating; (2) generation of 3D BNG hydrogels by a solvothermal process.



Fig. S2 Typical TEM images and Pd particle size distribution of (A, B) Pd/G and (C, D) Pd/C, respectively, indicating that the Pd particles can easily form large clusters in the conventional samples.



Fig. S3 EDX spectrum of 3D Pd/BNG catalyst verifies the presence of B, N, C, O, and Pd components in the hybrid.



Fig. S4 High-resolution C 1s XPS spectrum of GO, suggesting that the carbon sheets possess a large number of oxygen functional groups.



Fig. S5 Linear sweep voltammograms of Pd/BNG, Pd/G and Pd/C catalysts in (A) 0.5 M H₂SO₄ with 0.5 M HCOOH, and (B) 0.5 M NaOH with 1 M CH₃OH solution at 50 mV s^{-1} .



Fig. S6 The AC impedance spectrum of Pd/BNG electrode and the corresponding fitting curve are in good agreement with the fitting results. Embedding is an equivalent circuit: R_s and R_{ct} represent the resistance of electrolyte and catalyst, Q_{dl} is a constant phase element, W represents the semi-infinite diffusion of electrolyte and electrolyte and capacitance of Nafion-Carbon film, respectively.



Fig. S7 The relaxed atomic structures of Pd atom on pristine graphene, where the gray and pink balls represent C and Pd atoms, respectively.

Electrode	ECSA (m ² g ⁻¹)		Specific activity		Mass activity	
			(mA cm ⁻²)		(mA mg⁻¹)	
	DFAFC	DMFC	DFAFC	DMFC	DFAFC	DMFC
Pd/BNG	84.6	82.1	20.6	20.0	728.5	707.5
Pd/G	33.1	36.8	10.5	9.6	371.7	338.7
Pd/C	17.9	17.6	5.2	2.8	182.6	100.4

Table S1. Electrochemical Properties on Pd/BNG, Pd/G and Pd/C Electrodes in DFAFC and DMFC Conditions.