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Supplementary Information

The green synthesis of ultrafine palladium-phosphorus alloyed nanoparticles anchored on the polydopamine functionalized graphene used as an excellent electrocatalyst for ethanol oxidation

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1. Sample characterization

Elemental analysis was conducted with a conventional combustion method (CHN, varioMLCRO) based on the burn-off mass of the sample and on the analysis of the evolved gases using a thermal conductivity detector. Inductive coupled plasma optical emission spectrometer (ICP-OES) analysis was recorded on Perkin Elmer (Optima-4300DV). Raman spectra were carried out with inVia Reinishaw confocal spectroscopy with 633 nm laser excitation. X-ray diffraction (XRD) measurements were carried out at room temperature and performed on a Rigaku D/max-2400 diffractometer using Cu-Kα radiation as the X-ray source. X-ray photoelectron spectroscopy (XPS) analysis was carried on PHI-5702 X-ray photoelectron spectrometer. The TEM images were obtained by Tecnai G^2 F^{30} electron microscope operating at 300 kV.

2.Tables and Figures

Table S1 The specific volume of different solution for preparing the catalysts.

	V/K_2PdCl_4 (mL)	V/NaH_2PO_2 (mL)	$V/NaBH_4$(mL)
Pd/GS	5.88	0	6
Pd-P/GS	5.94	0.85	16.5
Pd/PDA-GS	5.88	0	6
Pd-P/PDA-GS-1	5.94	0.85	16.5
Pd-P/PDA-GS-2	5.99	1.44	10
Pd-P/PDA-GS-3	6.21	4.46	8

Table S2 The Pd and molar ratio of Pd/P contents by ICP-OES analysis of as-prepared catalysts.

Catalysts	Pd content (wt.%)	Molar ratio of Pd/P
Pd/GS	11.52	-
Pd/GS	11.39	23.9/1
Pd/PDA-GS	11.23	-
Pd-P/PDA-GS-1	11.43	24.8/1
Pd-P/PDA-GS-2	11.93	16.8/1
Pd-P/PDA-GS-3	12.73	5.4/1

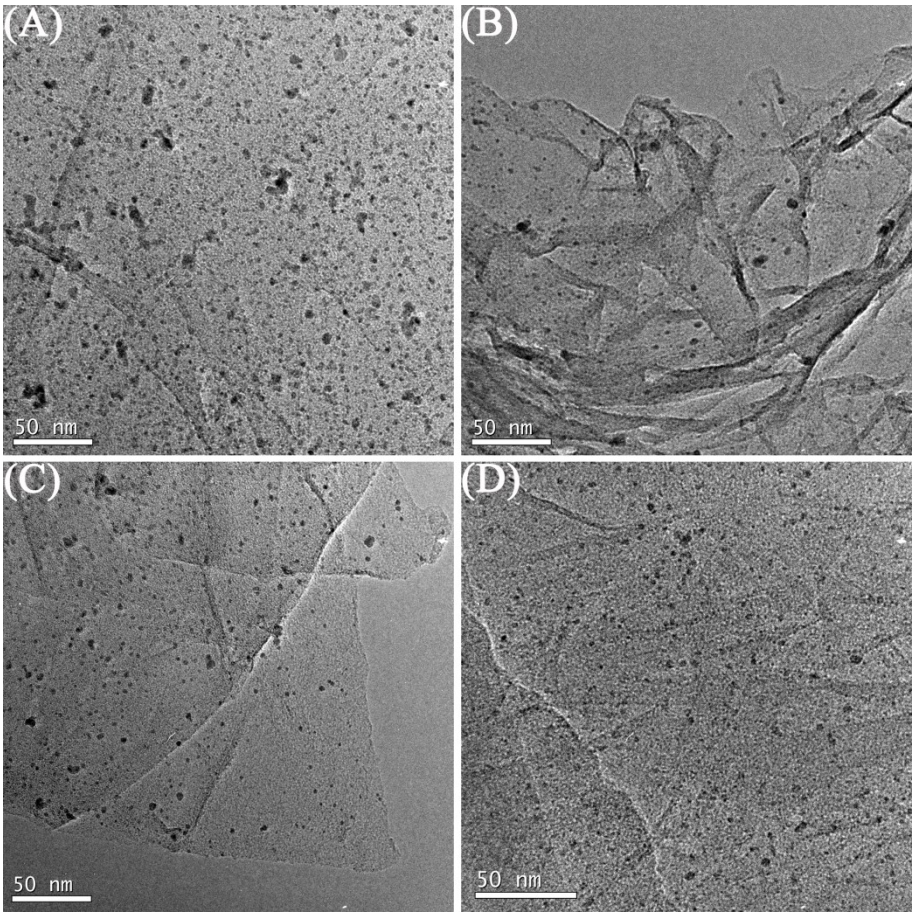

Fig. S1 TEM images of (A) Pd/GS, (B) Pd-P/GS, (C) Pd/PDA-GS and (D) Pd-P/PDA-GS-2.

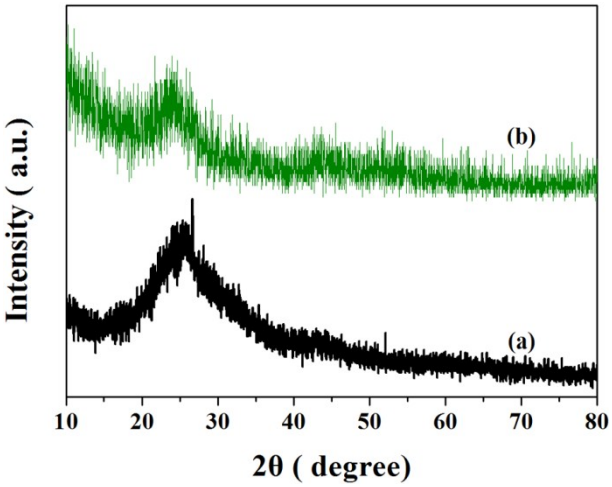

Fig. S2 XRD patterns of (a) GS and (b) PDA-GS.

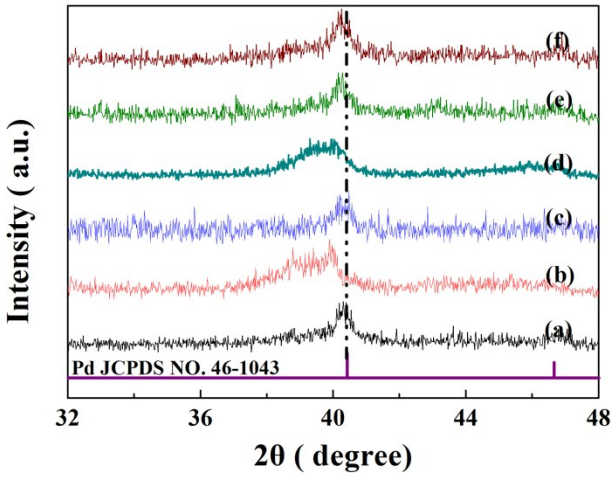

Fig. S3 XRD patterns of (a) Pd/GS, (b) Pd-P/GS, (c) Pd/PDA-GS, (d) Pd-P/PDA-GS-1, (e) Pd-P/PDA-GS-2 and (f) Pd-P/PDA-GS-3.

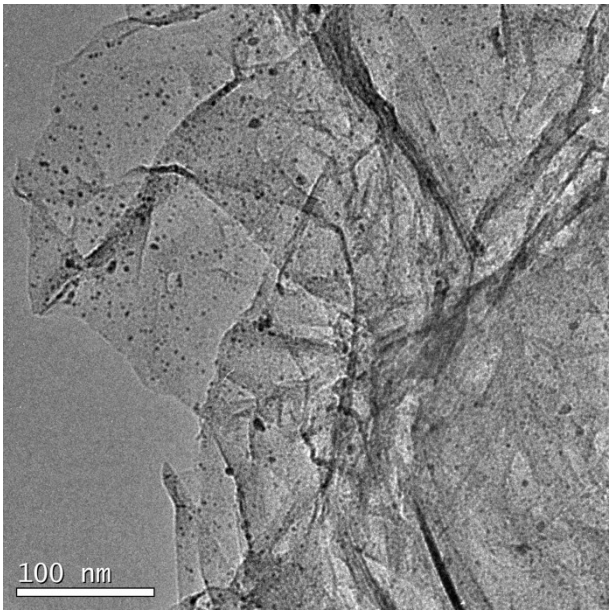

Fig. S4 TEM image after 500 cycles CV scans for Pd-P/PDA-GS-2.