

## SUPPLEMENTARY INFORMATION

### **Black Phosphorous/Palladium Functionalized Carbon Aerogel Nanocomposite for Highly Efficient Ethanol Electrooxidation**

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Supplementary Tables S1 and S2

Supplementary Figures S1 – S3

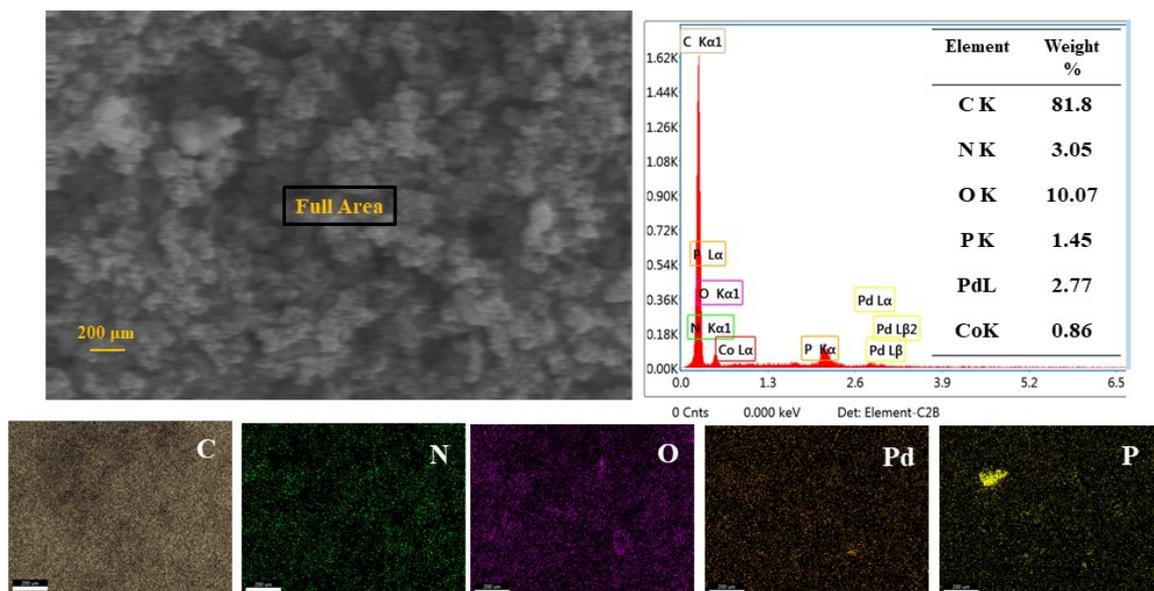
**Table S1.** Textural analysis of the samples. Porosity and surface area values calculated using the BET and BJH models.

Sample	$S_{\text{BET}}$ m <sup>2</sup> /g	$W_0(\text{N}_2)$ cm <sup>3</sup> /g	$L_0(\text{N}_2)$ nm	$V_{0.95}(\text{N}_2)$ cm <sup>3</sup> /g	$V_{\text{meso}}(\text{N}_2)$ cm <sup>3</sup> /g	$S_{\text{BJH}}$ m <sup>2</sup> /g	$V_{\text{BJH}}$ cm <sup>3</sup> /g	$L_0(\text{BJH})$ nm
CA	358	0.175	1.32	0.238	0.062	105.3	0.104	3.9
Pd/CA	277	0.127	1.45	0.253	0.126	123.7	0.131	4.2
BP/Pd/CA	280	0.134	1.45	0.273	0.139	129.7	0.152	4.7

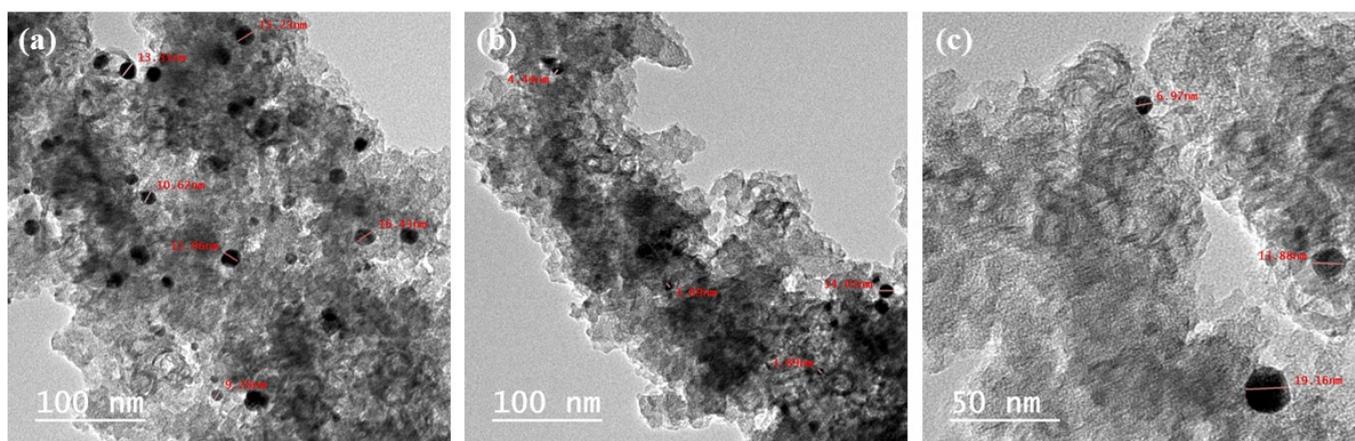
$S_{\text{BET}}$  = total surface area;  $W_0(\text{N}_2)$  = micropore volume;  $L_0(\text{N}_2)$  = mean micropore width;  $V_{0.95}(\text{N}_2)$  = total volume of nitrogen adsorbed at a relative pressure of 0.95;  $V_{\text{meso}}$  = mesopores volume calculated by  $V_{0.95}(\text{N}_2) - W_0(\text{N}_2)$ ;  $S_{\text{BJH}}$  = mesopore surface area;  $V_{\text{BJH}}$  = mesopore volume estimated by the BJH method;  $L_0(\text{BJH})$  = mean mesopore width.

**Table S2.** Position and full width at the half maximum (FWHM) of the C-C peak obtained from the deconvolution of XPS  $C_{1s}$  spectra of the samples. The mean particle size ( $d_{\text{XRD}}$ ) of Co (in CA) and Pd (in Pd/CA and BP/Pd/CA) NPs estimated from the XRD Cr (110) and Pd (111) peaks using the Scherrer's equation.

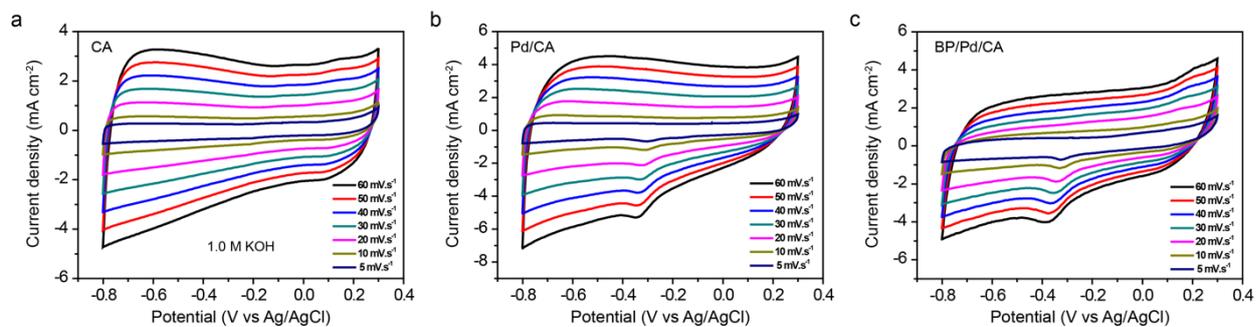
Sample	$C_{1s}$ peak position	$C_{1s}$ FWHM	$d_{\text{XRD}}$ (nm)
	(eV)	(eV)	
CA	284.8	2.15	13.9 (Co)
Pd/CA	284.8	2.09	17.5 (Pd)
BP/Pd/CA	284.9	1.98	19.2 (Pd)



**Figure S1.** Energy dispersive spectroscopy (EDS) and elemental mapping analysis of BP/Pd/CA.



**Figure S2.** High-resolution TEM images of the BP/Pd/CA sample at different magnifications, highlighting the particle size of the catalytic NPs.



**Figure S3.** Room-temperature cyclic voltammograms of (a) CA, (b) Pd/CA, and (c) BP/Pd/CA in 1.0 M KOH solution at various scan rates.