Supporting Information

Defect-rich Pd@PdOs nanobelts for electrocatalytic oxidation of ethylene glycol

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Experimental Section

Materials Characterization

The morphology and structure of the samples were observed by transmission electron microscopy (TEM, Hitachi HT 7700, 120 kV; Themis Z (3.2)) and energy dispersive X-ray spectroscopy (EDX). The crystallographic data, surface electronic state and elemental composition of samples were investigated by X-ray diffractometer (XRD, PANalytical X'Pert) and X-ray photoelectron spectroscopy (XPS, ESCALAB MK II spectrometer) tests.

Electrochemical measurement

All electrochemical measurements were performed on a CHI 760E electrochemical workstation, where Ag/AgCl served as reference electrodes and a Pt wire as the counter electrode. In the EGOR test, the glass carbon electrode (GCE) of the catalyst coating was used as a working electrode. Electrocatalyst ink was prepared by adding 2 mg catalyst to 1 mL solution containing 900 μL water and 100 μL Nafion (0.5 wt %). Then, 5 μL electrocatalyst ink was poured on the polished GCE surface and dried in a 60 °C oven to obtain the working electrode. The required electrolytes were 1 M KOH (pH = 13.85) and 1 M KOH + 1 M EG (pH = 13.85). The measured potential was converted to a reversible hydrogen electrode (RHE) scale according to the equation E(for RHE) = E^{θ}(Ag/AgCl) + E(Ag/AgCl) + 0.059×pH. According to the hydrogen desorption peak area of CV curve in 1 M KOH solution, the ECSA of electrocatalyst was calculated as follows:

$$\mathrm{ECSA} = Q / m \times 420 \quad (1)$$

Where, m is the Pd load on the electrode surface, 420 μC cm^{-2} is the reducing charge of the Pd oxide monolayer on the Pd surface, and Q is the reducing charge integral of the Pd oxide layer. CV curves were performed at a scan rate of 50 mv s^{-1}.

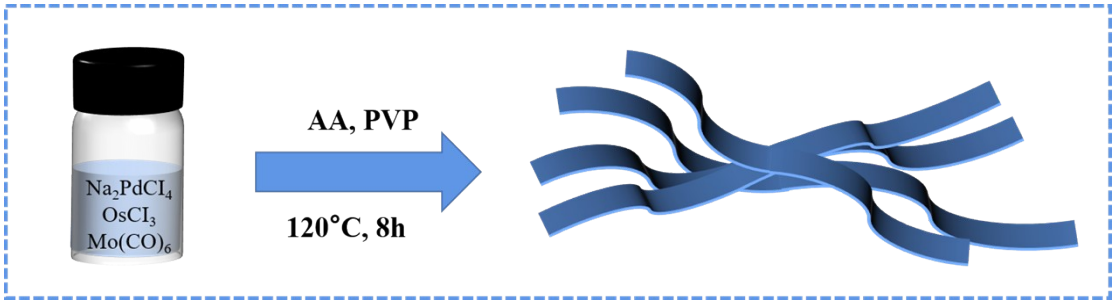

Fig. S1 Schematic diagram of the preparation for the Pd@PdOs NBs.

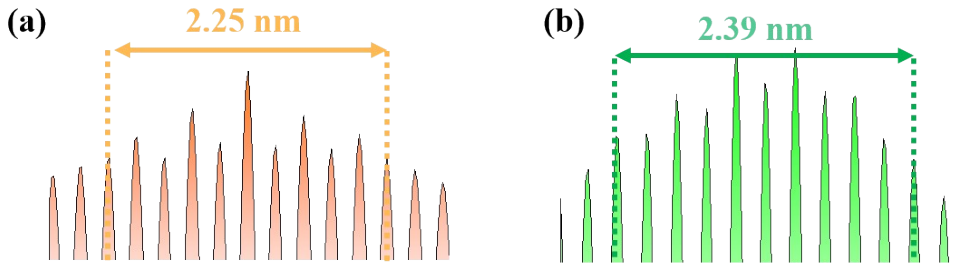

Fig. S2 The intensity profile of the yellow (a) and green (b) box area in Fig. 1f.

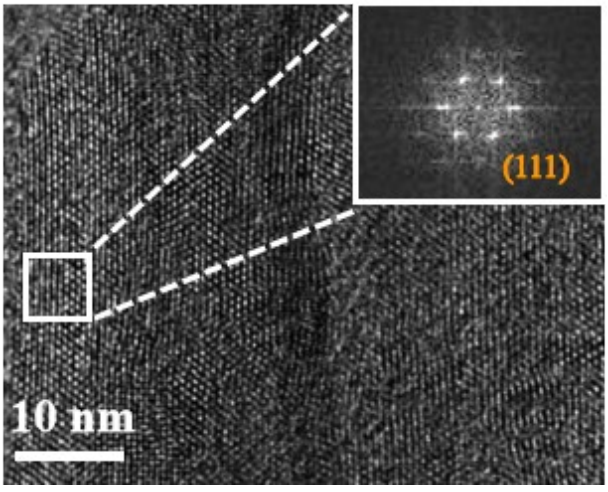

Fig. S3 HRTEM image of Pd@PdOs NBs and corresponding FFT image.

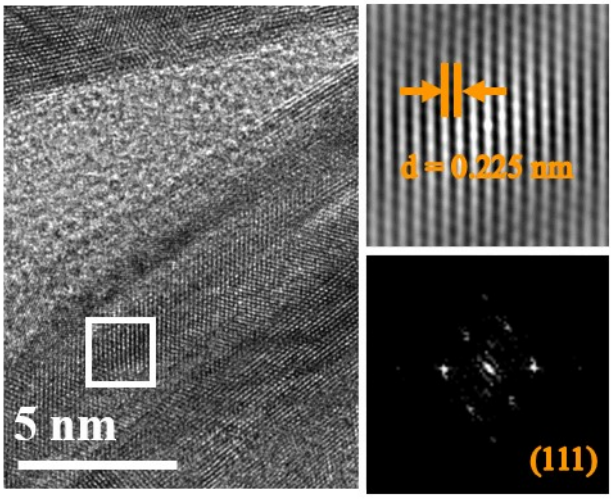

Fig. S4 HRTEM image, lattice fringes image, and the corresponding FFT pattern of the Pd NBs.

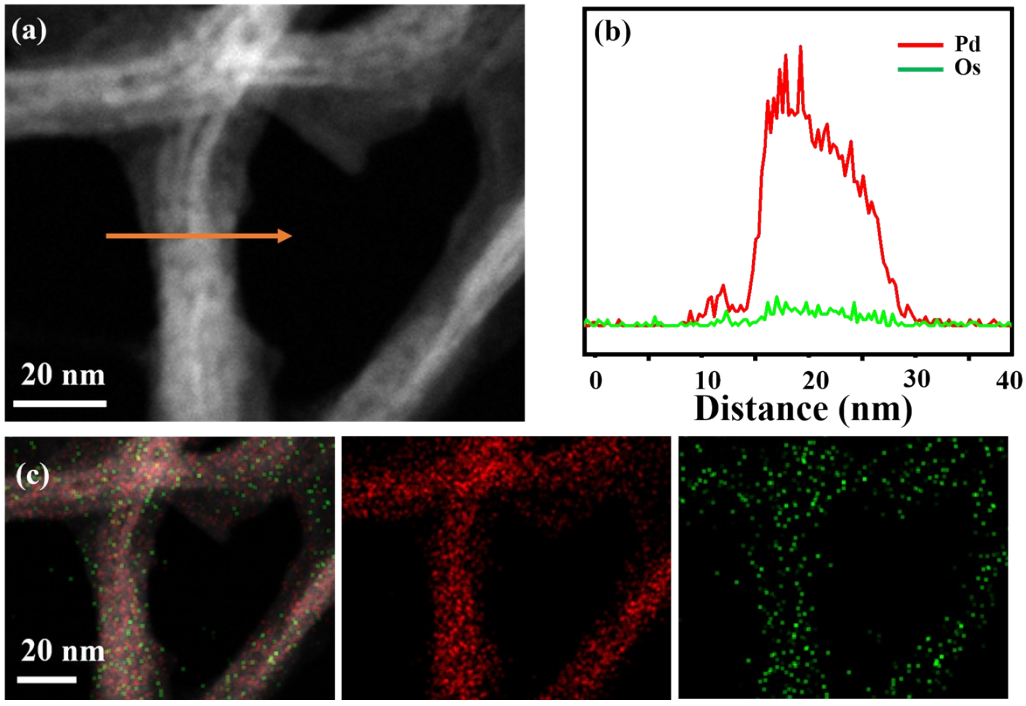

Fig. S5 (a) HAADF-STEM image and (b) line-scan profile of Pd@PdOs NBs. (c) Elemental mapping images of the Pd@PdOs NBs.

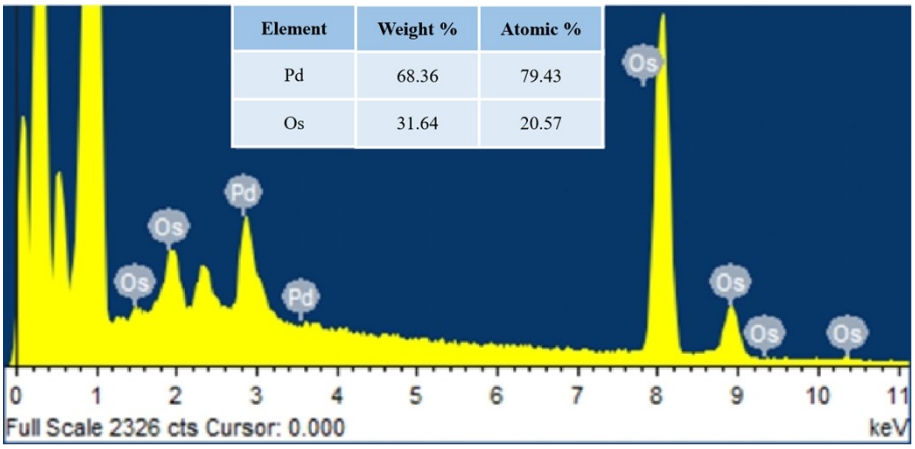

Fig. S6 EDX spectrum of the Pd@PdOs NBs.

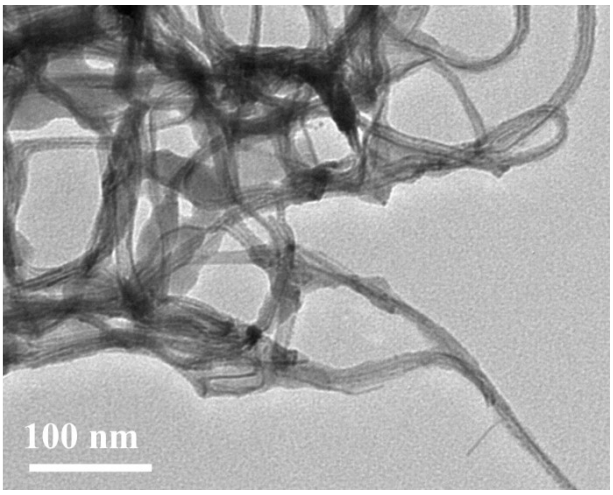

Fig. S7 TEM image of the Pd NBs.

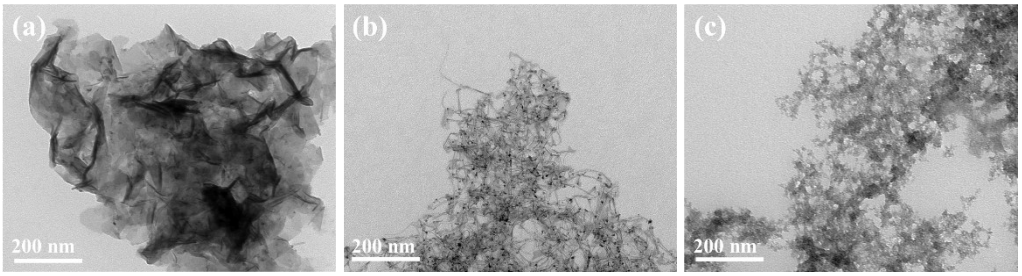

Fig. S8 TEM images of the prepared samples by replacing $Mo(CO)_6$ with (a) $W(CO)_6$, (b) $Cr(CO)_6$, (c) $Fe_2(CO)_9$ under the typical synthesis conditions.

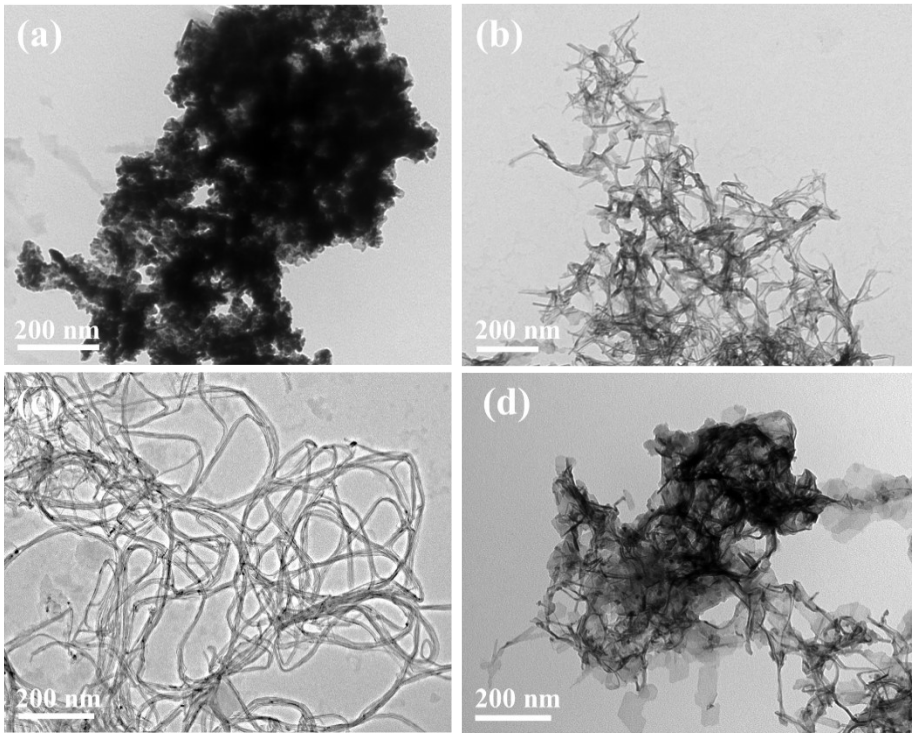

Fig. S9 TEM images of the prepared samples at different PVP contents under the typical synthesis conditions: (a) 0 mg, (b) 200 mg, (c) 600 mg, (d) 1200 mg.

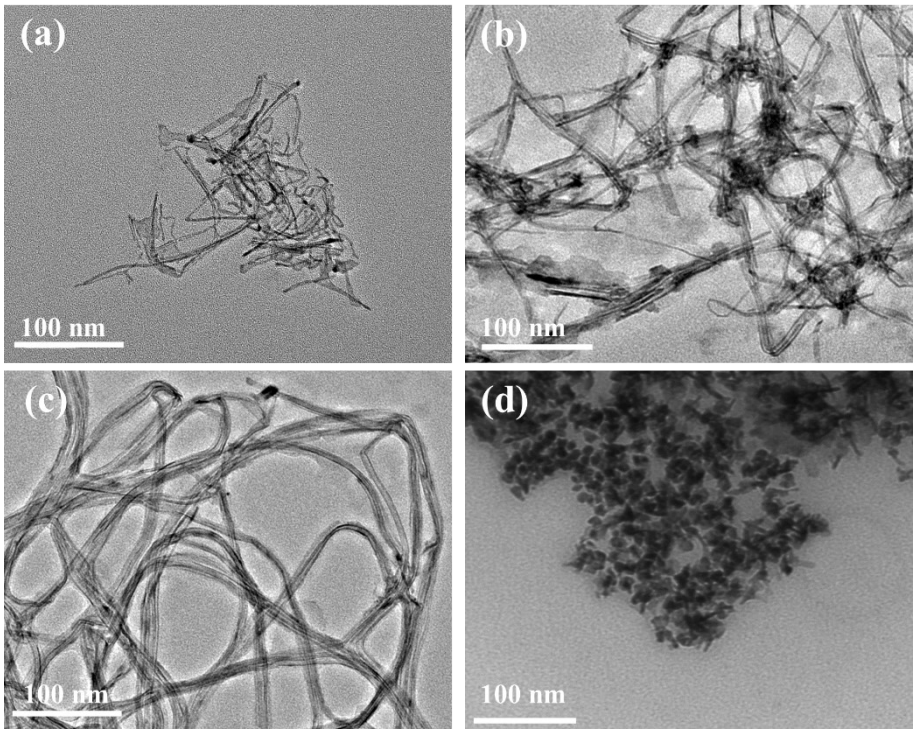

Fig. S10 TEM images of the prepared samples at different AA contents under the typical synthesis conditions: (a) 0 mg, (b) 40 mg, (c) 80 mg, (d) 120 mg.

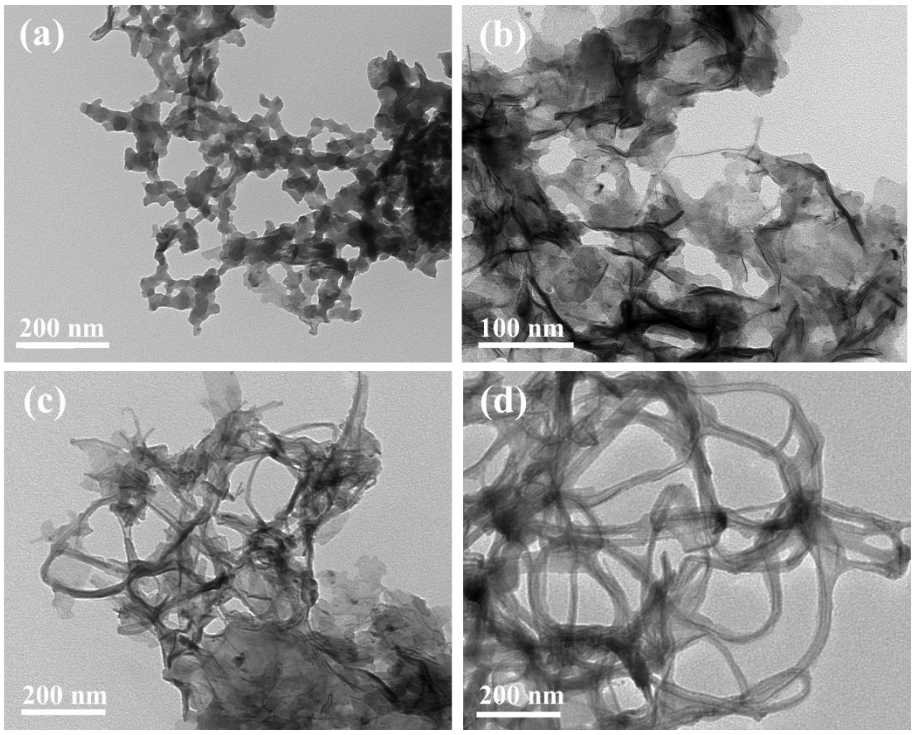

Fig. S11 TEM images of the prepared samples at different reaction times under the typical synthesis conditions: (a) 10 min, (b) 1 h, (c) 2 h, (d) 4 h.

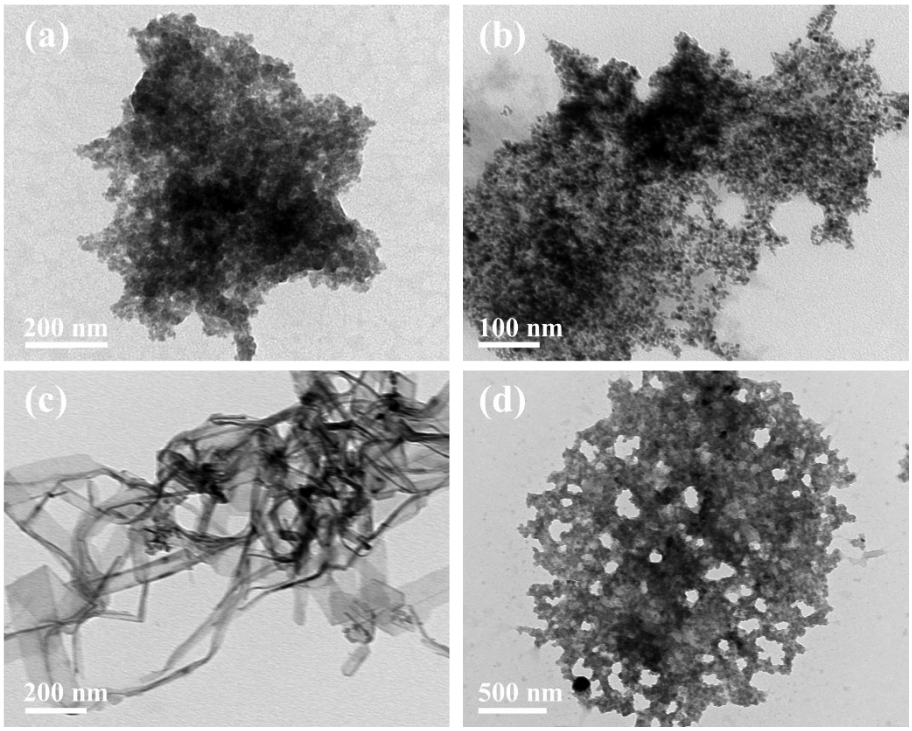

Fig. S12 TEM images of the prepared samples by replacing ethylenediamine with (a) DMF, (b) aniline, (c) DETA (d) ethanol under the typical synthesis conditions.

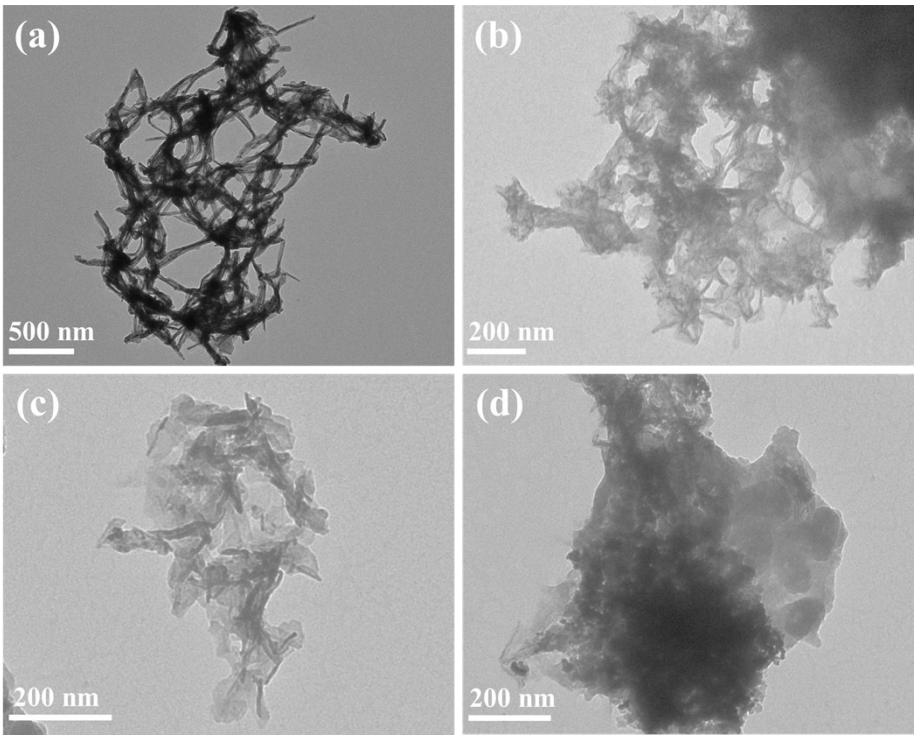

Fig. S13 TEM images of the samples with different ratio of Pd:Os: (a) 1:0, (b) 1:1, (c) 1:2 and (d) 1:4, respectively.

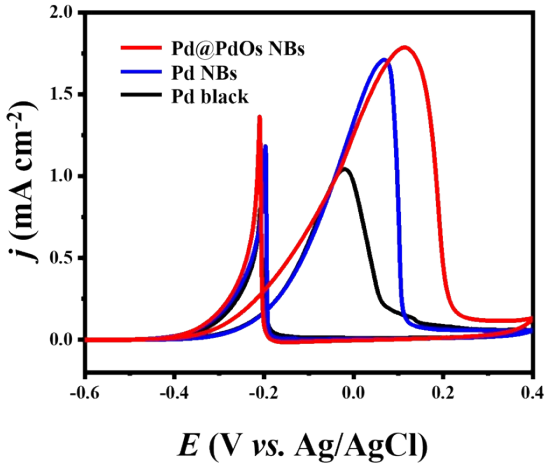

Fig. S14 ECSA-normalized CVs of EGOR for various electrocatalysts at a scan rate of 50 mV s^{-1} in 1 M KOH + 1 M EG solution.

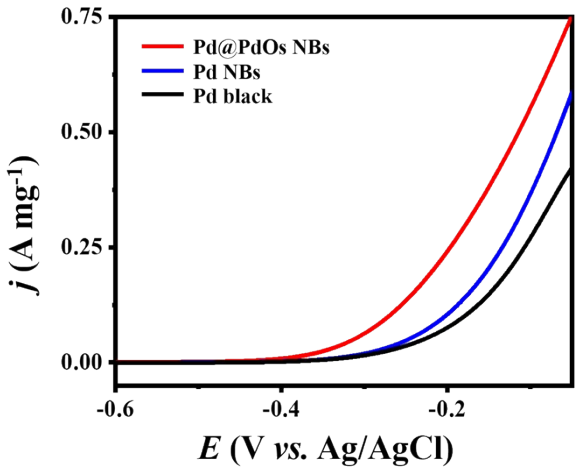

Fig. S15 A partial enlargement of Fig. 3c.

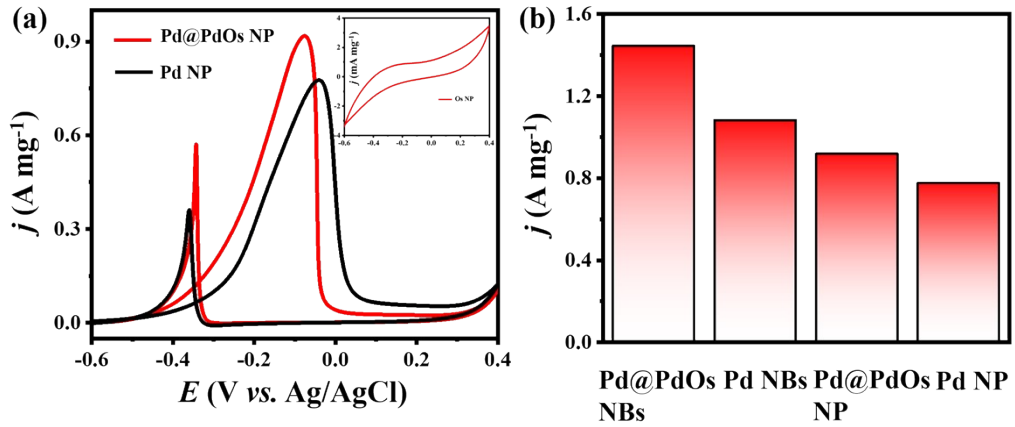

Fig. S16 (a) CVs of Pd@PdOs NP, Pd NP and Os NP. (b) The comparison for MA of various catalysts at a scan rate of 50 mV s^{-1} in 1 M KOH + 1 M EG solution.

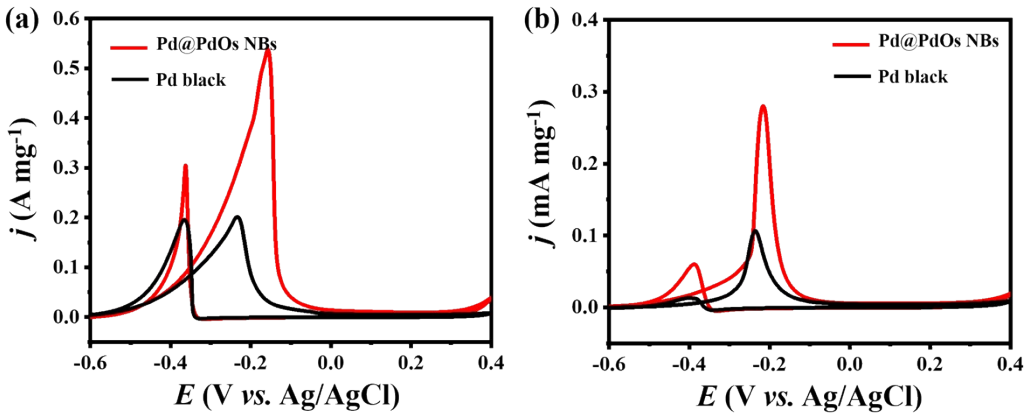

Fig. S17 (a) CVs of Pd@PdOs NBs and Pd black at a scan rate of 50 mV s^{-1} in 1 M KOH + 1 M C_2H_5OH solution. (b) CVs of Pd@PdOs NBs and Pd black at a scan rate of 50 mV s^{-1} in 1 M KOH + 1 M CH_3OH solution.

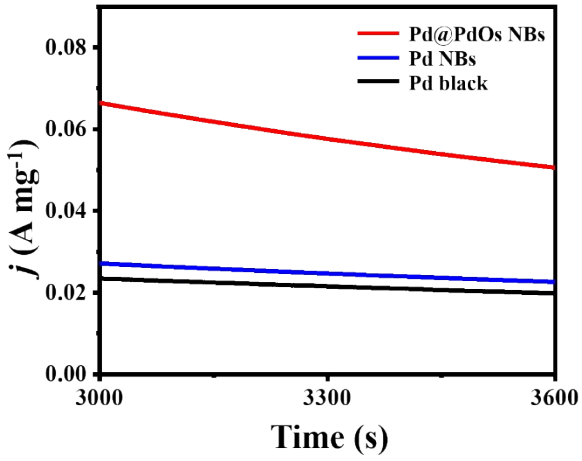

Fig. S18 A partial enlargement of Fig. 4a.

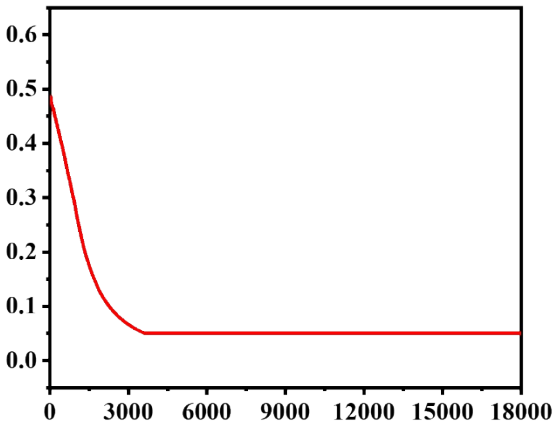

Fig. S19 CA curve of Pd@PdOs NBs recorded at -0.1 V in 1 M KOH electrolyte containing 1 M EG.

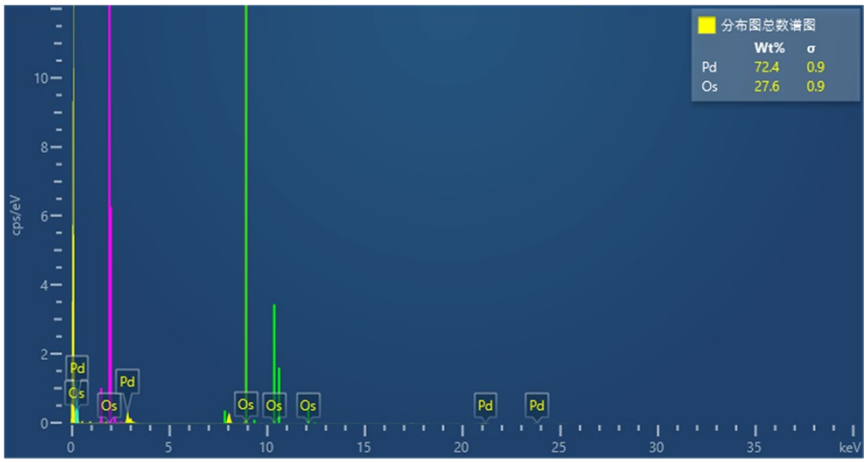

Fig. S20 EDS spectrum of the PdOs NBs after 5h CA test.

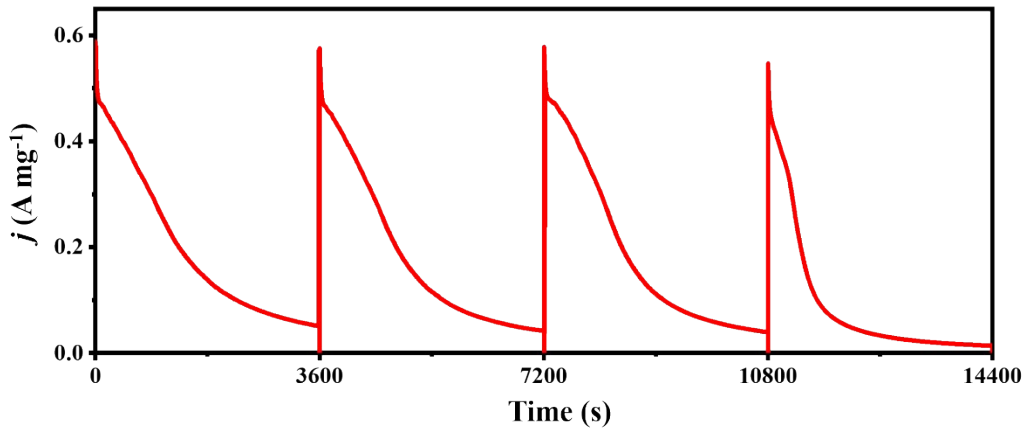

Fig. S21 Long-term curves of Pd@PdOs NBs recorded at -0.1 V vs. Ag/AgCl in 1 M KOH + 1 M EG solution.

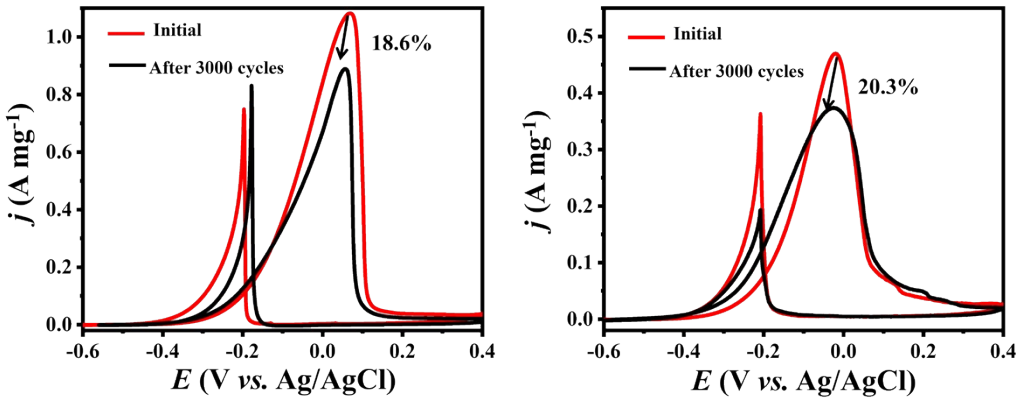

Fig. S22 CV curves of Pd NBs and Pd black before and after 3000 cycles.

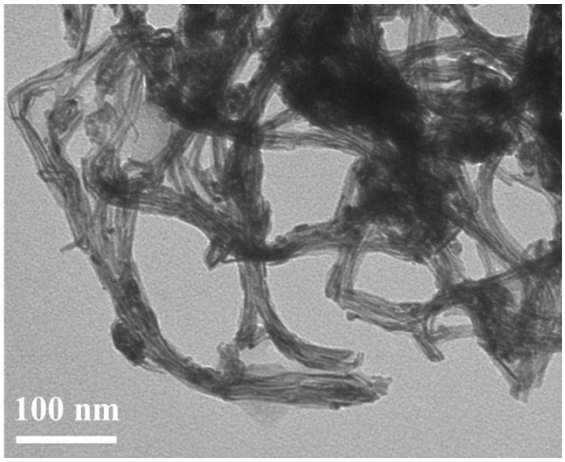

Fig. S23 TEM image of the Pd@PdOs NBs after the 3000 CV test.

Table S1. Comparison with other Pd-based catalysts for EGOR.

Catalysts	Electrolyte	MA (A mg^{-1}_{Pd})	Reference
Pd@PdOs NBs	1 M KOH + 1 M EG	1.45	This work
Pd-$Ni(OH)_2$	1 M KOH + 1 M EG	0.8	[1]
$PtNi_{0.56}Pd_{1.42}$ NWs	0.1 M $HClO_4$ + 0.5 M EG	0.54	[2]
Pd/FNO-2.5	0.5 M KOH + 1 M EG	0.38	[3]
0.5%Ga@10%PdAgCo	1 M KOH + 1 M EG	0.298	[4]
PdP (2:1)/GE	1 M KOH + 1 M EG	0.264	[5]
PdCu/PT-SG	1 M KOH + 1 M EG	1.07	[6]

References

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