Self-Supported Tungsten/Tungsten Dioxide Nanowires Array as an Efficient Electrocatalyst in Hydrogen Evolution Reaction

Zhao Yaoxing,[a,b] Cuncai Lv,[b] Qingli Huang,[c] Zhipeng Huang,[b]* Chi Zhang[b]*

[a] *School of Chemistry and Chemical Engineering, Jiangsu University, Zhenjiang 212013, China.*

[b] *Functional Molecular Materials Research Centre, Scientific Research Academy, and China-Australia Joint Research Center for Functional Materials, Jiangsu University, Zhenjiang, 212013, China.*

[c] *Testing Center, Yangzhou University, Yangzhou, 225009, China.*

*Corresponding author. Zhipeng Huang, Chi Zhang.

E-mail: zphuang@ujs.edu.cn, chizhang@ujs.edu.cn.

Electronic Supplementary Information

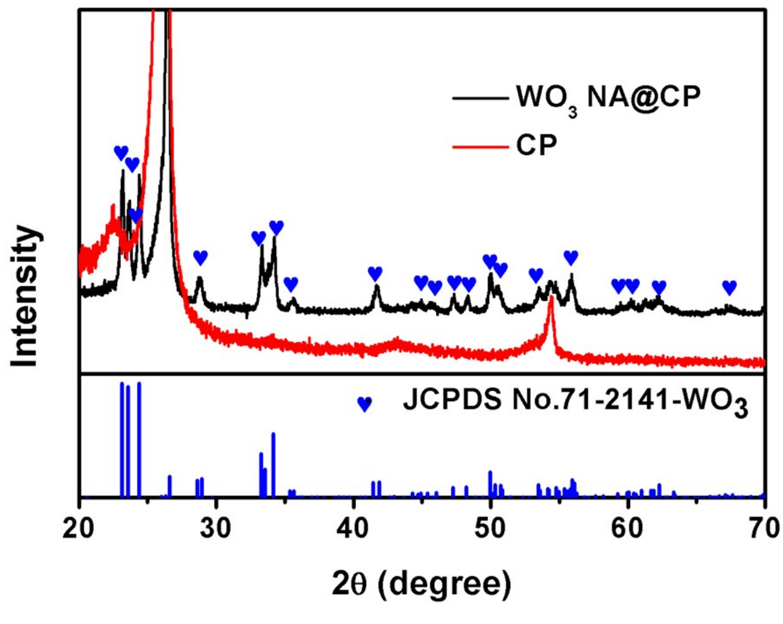

Fig. S1 XRD pattern of WO_3 NA@CP.

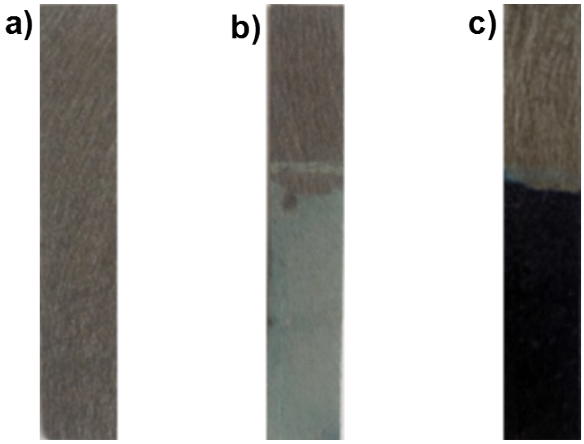

Fig. S2 Optical photograph of (a) pristine CP, (b) WO_3 NA@CP, (C) WO_2/W CSNA@CP

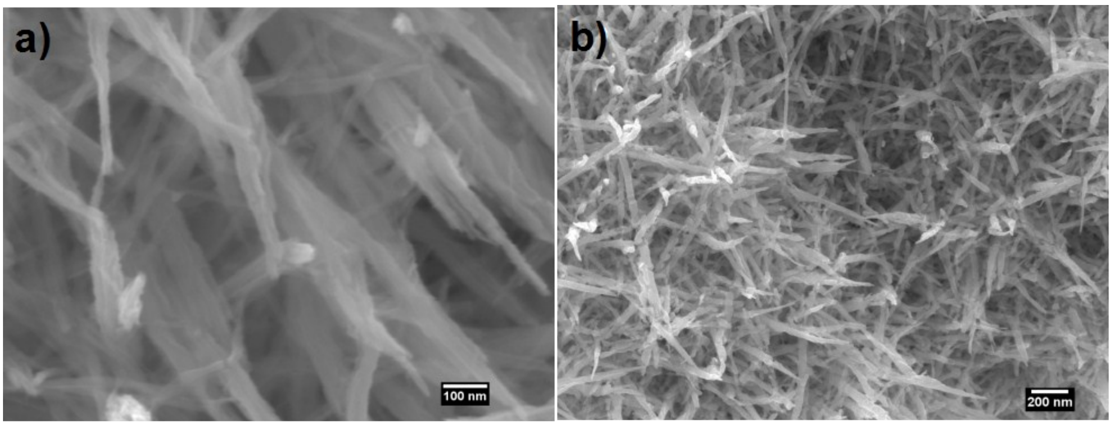

Fig. S3 The SEM image of precursor (a) and WO_3 NA@CP.

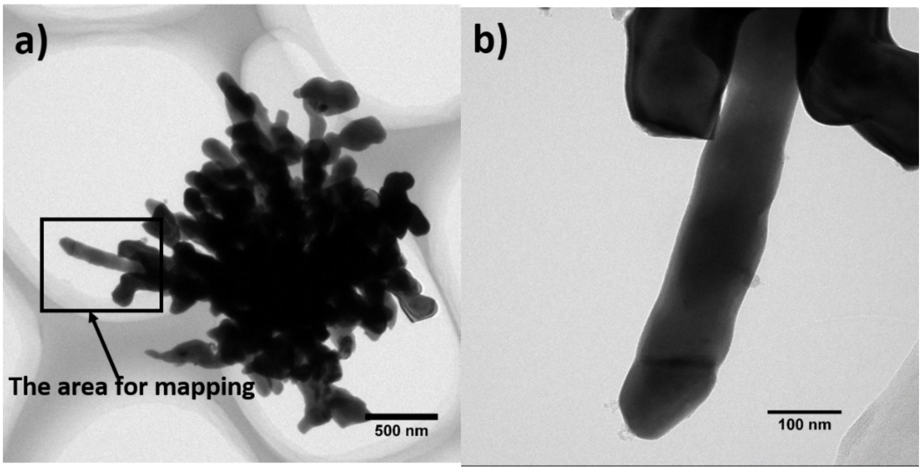

Fig. S4 a) and b) are the TEM images of the W/WO_2 nanorod.

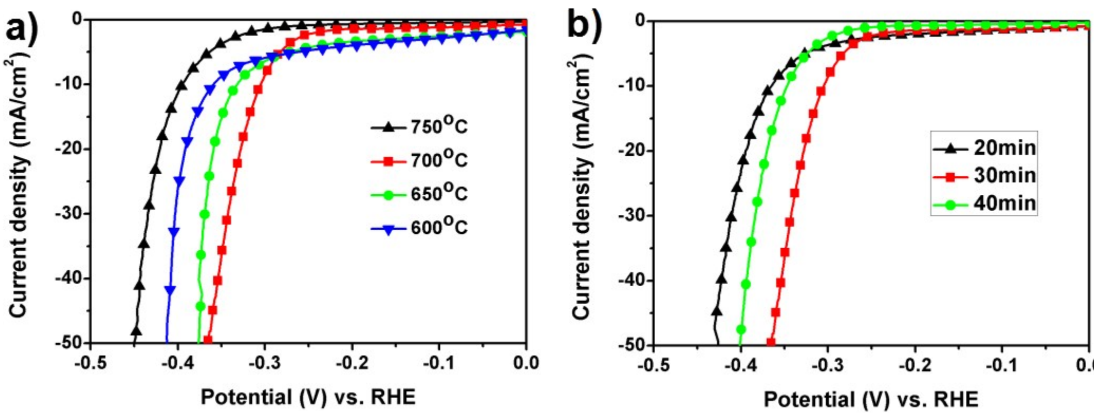

Fig. S5 (a) and (b) show different conditions of annealing, different temperatures and different annealing times are shown for comparison in acidic solution.

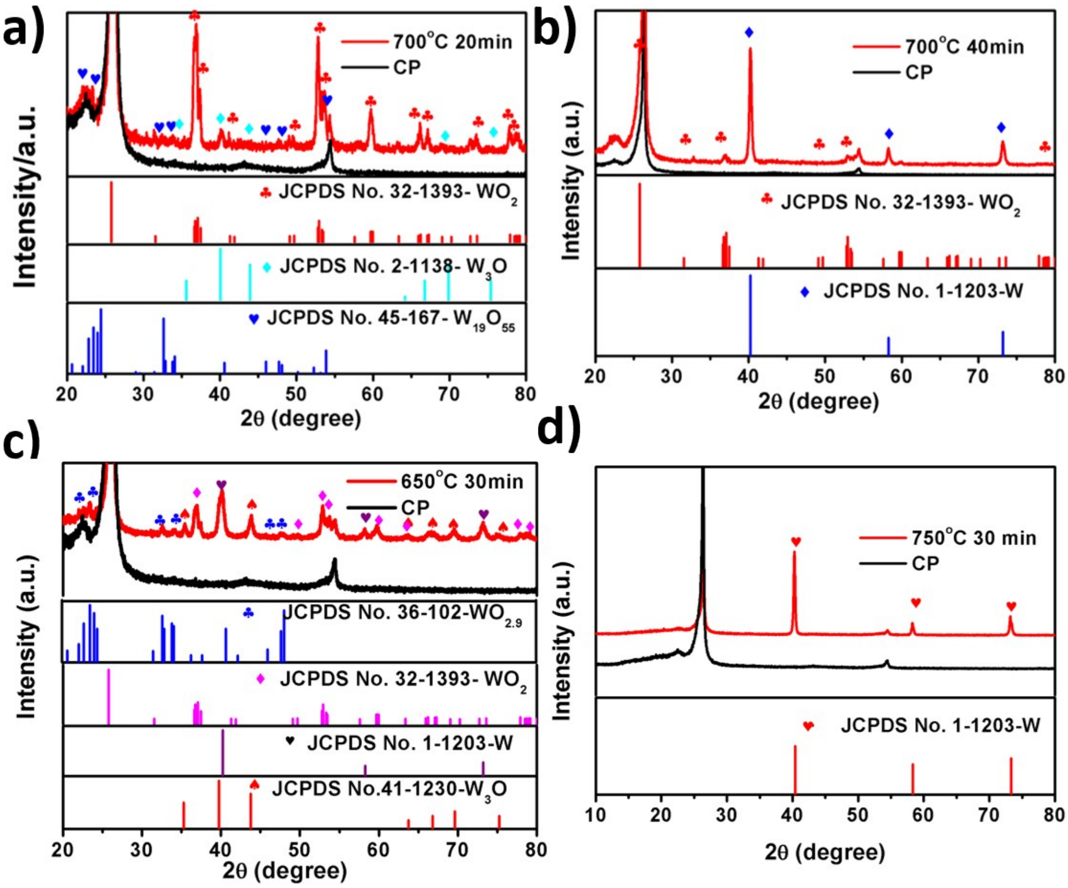

Fig. S6 The XRD patterns of different conditions of annealing.

Table S1 Summary of HER performance of representative tungsten oxides catalysts.

Catalyst	Substrate	Current density (mA/cm^2)	Overpotential(mV)	Tafel slope (mV/dec)	Electrolyte
WO_3/CNT[1]	GCE	3.8	426	104	0.1M H_2SO_4
$WO_3.H_2O$ and WO_3 Nanoplates[2]	GCE	7.5	318	97	1M H_2SO_4
Ta-doped WO_3[3]	GCE	10.72	528	65	1M H_2SO_4
WO_3 nanoparticles[4]	GCE	20	406		1M H_2SO_4
WO_3 Nanorods[5]	GCE	20	396	188	1M H_2SO_4
WO_3/C nanoparticles[6]	GCE	0.7	3	29	0.5M H_2SO_4

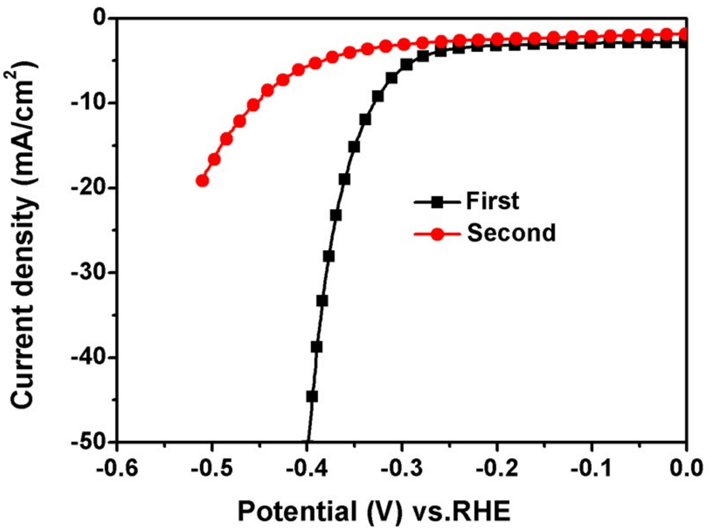

Fig. S7 Polarization curves of the WO_2/W NA@CP in basic solution.

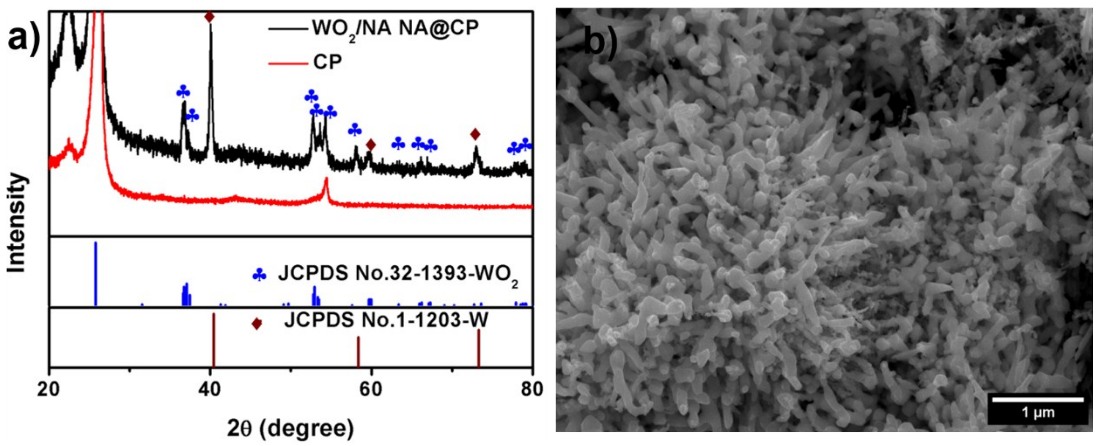

Fig. S8 (a) XRD pattern of WO_2/W NA@CP after it. (b) SEM image of WO_2/W NA@CP after it

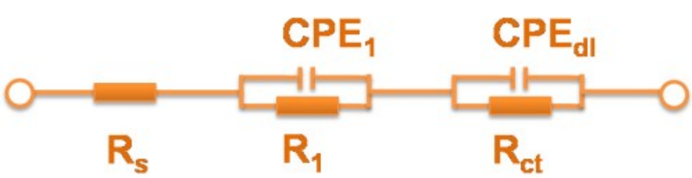

Fig. S9 Equivalent circuit used to fit the EIS data. R_s is the overall series resistance, CPE_1 and R_1 are the constant phase element and resistance describing electron transport at substrate/catalyst interface, respectively, CPE_{dl} is the constant phase element of the catalyst/electrolyte interface, and R_{ct} is the charge transfer resistance at catalyst/electrolyte interface.

Table S2. The fitting results of EIS spectra

Sample	R_s(Ω cm^2)	Q_{ct} (F cm^{-2} S^{n-1}/cm^2)	N_{ct}	R_{ct}(Ω .cm^2)	Q_1 (F cm^{-2} S^{n-1}/cm^2)	N_1	R_1(Ω cm^2)
WO_3 NA@CP	1.45	0.0637	0.651	149.4	$7.539*10^{-6}$	0.804	0.80
WO_2/W CSNA@CP	0.92	0.0647	0.823	14.69	$4.09*10^{-5}$	0.947	1.91

Reference

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