Electronic Supplementary Material (ESI) for Nanoscale.

PtCuRh Ultrafine Nanowire Catalysts with Alleviated Poisoning Effect for Efficient Ethanol Oxidation

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1. Chemicals

Platinum (II) acetylacetonate ($Pt(acac)_2$, reagent grade, 98%)，palladium(II) acetylacetonate ($Pd(acac)_2$, reagent grade, 99%), rhodium(III) chloride hydrate ($RhCl_3$, reagent grade, 38.1%), iridium(III) 2,4-pentanedionate (reagent grade, >37.5%) and tungsten carbonyl ($W(CO)_6$, reagent grade, 99%) were all purchased from Sigma-Aldrich. Oleylamine (OAm, reagent grade, 80-90%) and 1-octadecene (ODE, reagent grade, 95%) were purchased from Aladdin. Potassium hydroxide (KOH, reagent grade, 99%), copper (II) chloride dihydrate ($CuCl_2 \cdot 2H_2O$, reagent grade, 99%), glucose (analytical pure) hexadecyltrimethylammonium bromide (CTAB, reagent grade, 99%) and absolute ethyl alcohol (reagent grade, >99.5%) were purchased from Sinopharm Chemical Reagent Co. Ltd. (Shanghai, China). All the chemicals were used without further purification.

2. The calculation method of mass activity

Before the electrochemical test, the mixture containing PtCuRh NWs (2 mg), commercial carbon powder (8 mg) and 10 μL Nafion was dispersed into the mixture of isopropanol (1.5 mL) and deionized water (0.49 mL), and then was sonicated to form suspensions (c mg_{Pt}/mL). Because the 5 μL of above homogeneous mixture was dropped on the surface of GCE, we can calculate the mass (m_{Pt}) of Pt dropped on the surface. Then, we conducted electrochemical tests and got the electric current (I). Finally, the mass activity is equal to I/m_{Pt}.

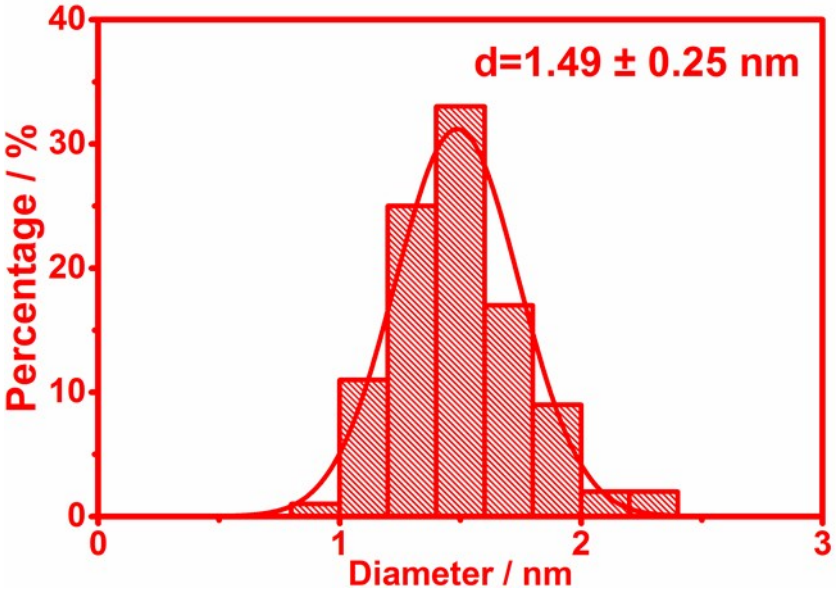

Fig.S1 Diameter distribution of ultrafine PtCu NWs.

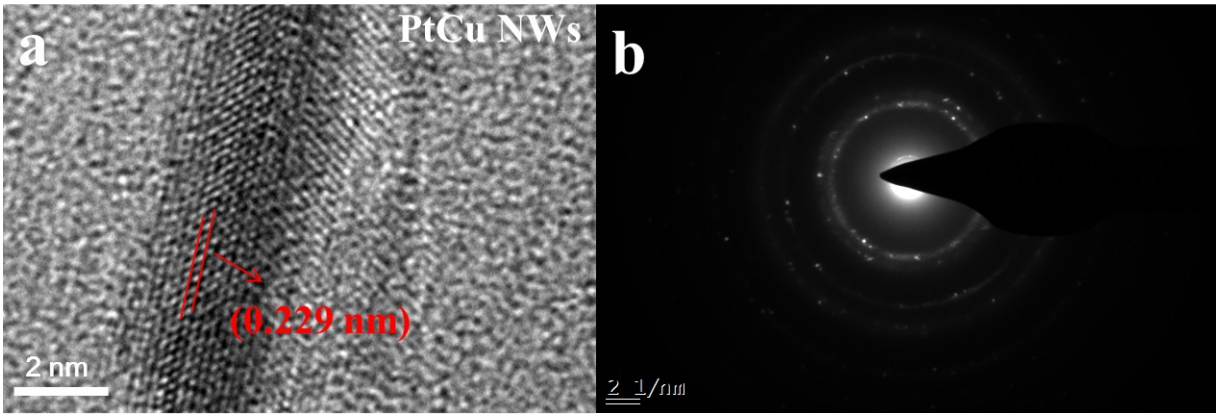

Fig.S2 Images of (a) HAADF-STEM and (b) SAED for ultrafine PtCu NWs.

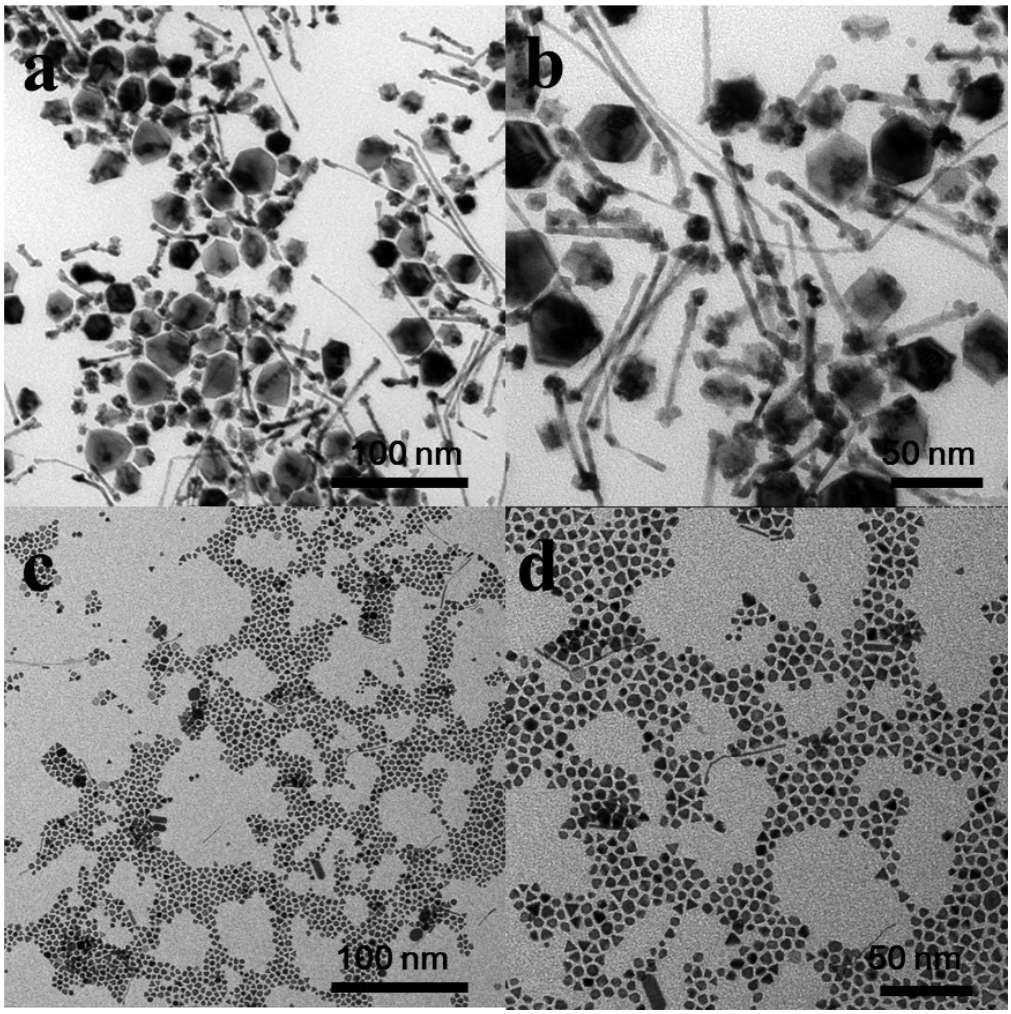

Fig.S3 (a, b) TEM images obtained without $W(CO)_6$, and (c, d) TEM images obtained by changing two steps into one step, when maintaining other conditions for synthesis of ultrafine PtCu NWs invariably.

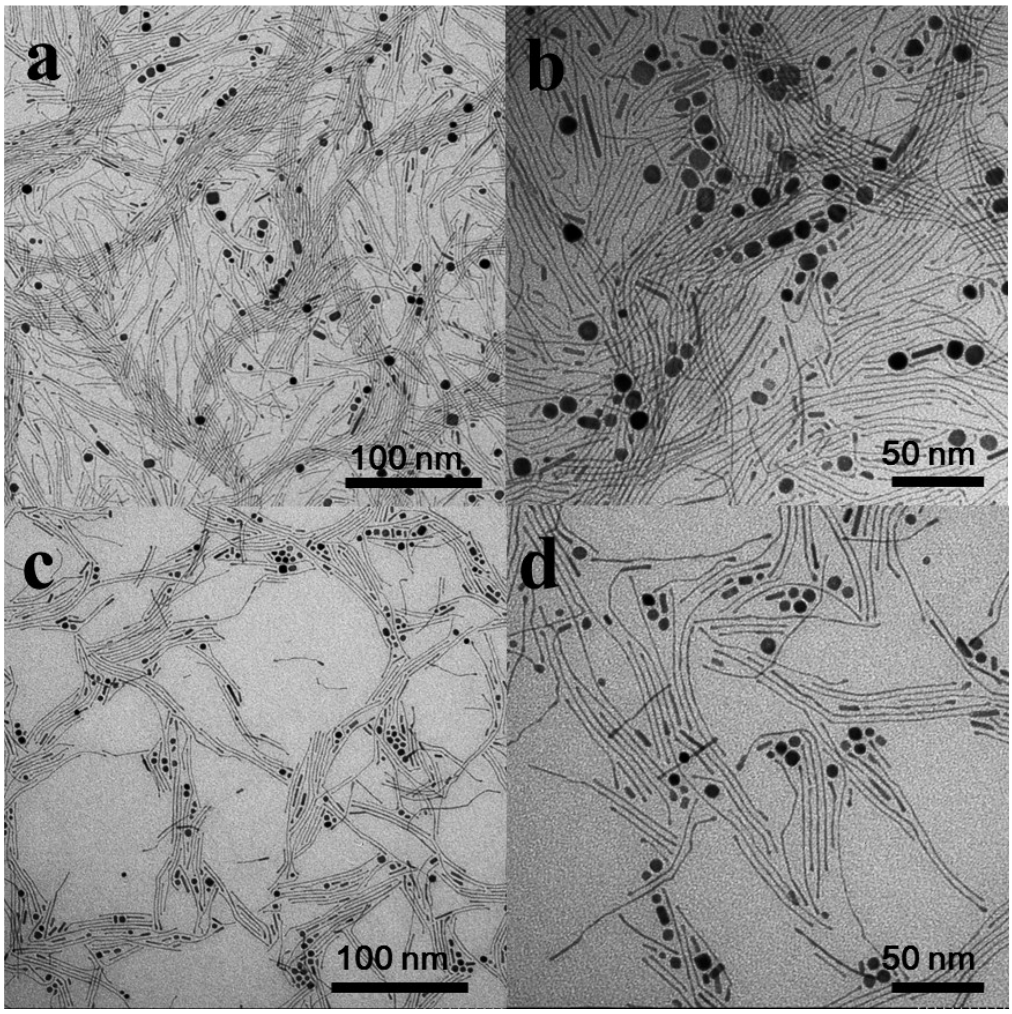

Fig.S4 (a, b) TEM images obtained by changing 4 mL OAm + 1 mL ODE into 5 mL OAm, and (c, d) TEM images obtained by changing 4 mL OAm + 1 mL ODE into 3 mL OAm + 2 ml ODE, when maintaining other conditions for synthesis of ultrafine PtCu NWs invariably.

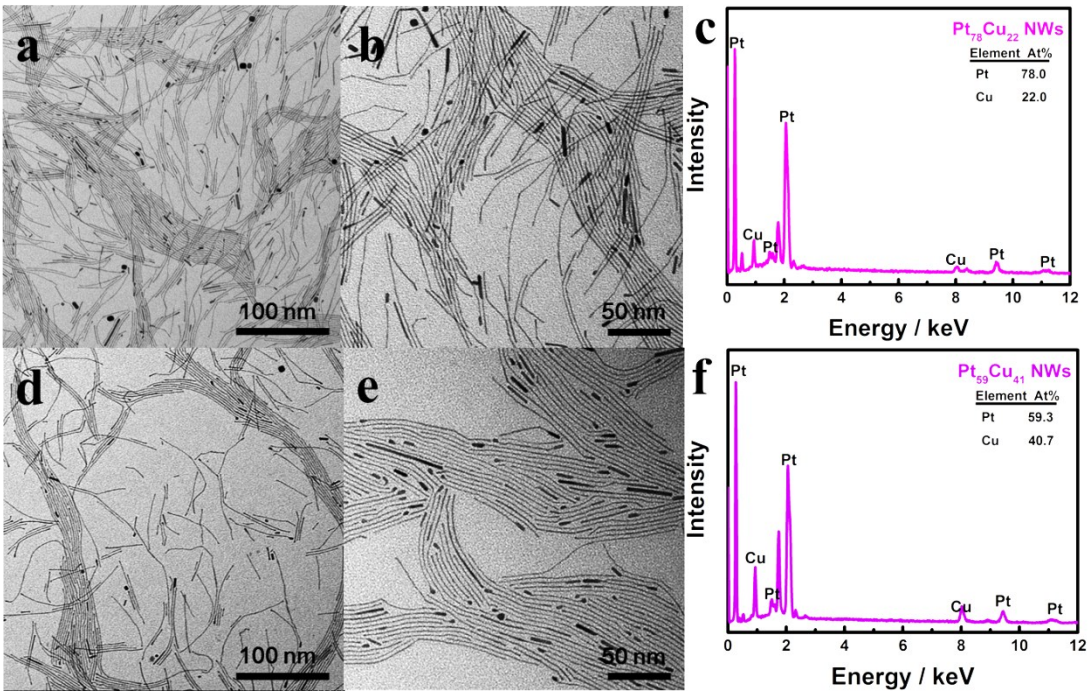

Fig.S5 TEM images of ultrafine PtCu NWs with adjustable atomic ratio of Pt/Cu by only changing the amount of $CuCl_2.2H_2O$ from 5 mg to 2.5 mg (a, b) and 7.5 mg (d, e), and (c, f) corresponding TEM-EDS images.

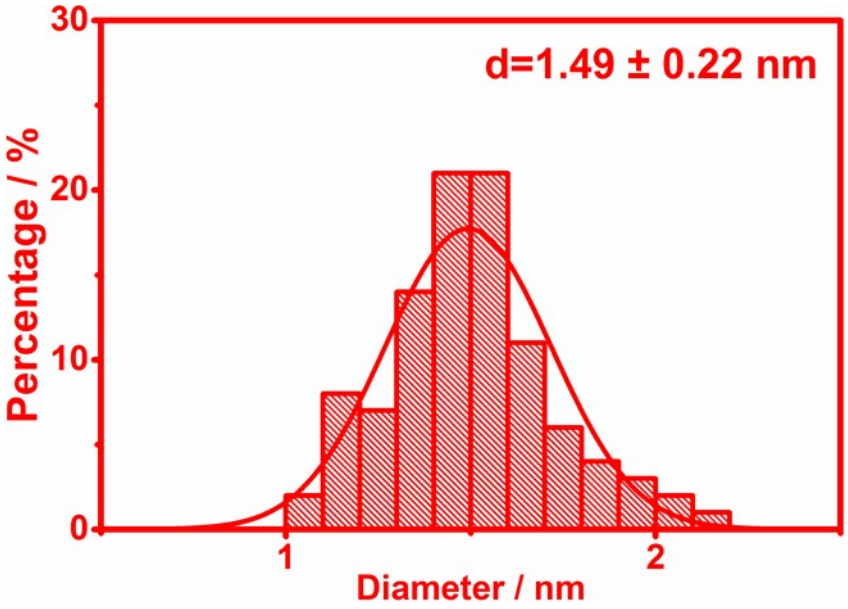

Fig.S6 Diameter distribution of ultrafine PtCuRh NWs.

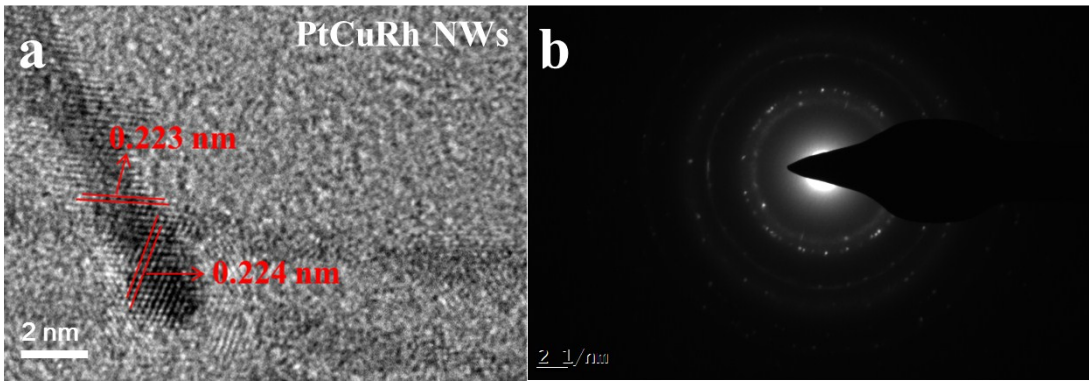

Fig.S7 Images of (a) HAADF-STEM and (b) SAED for ultrafine PtCuRh NWs.

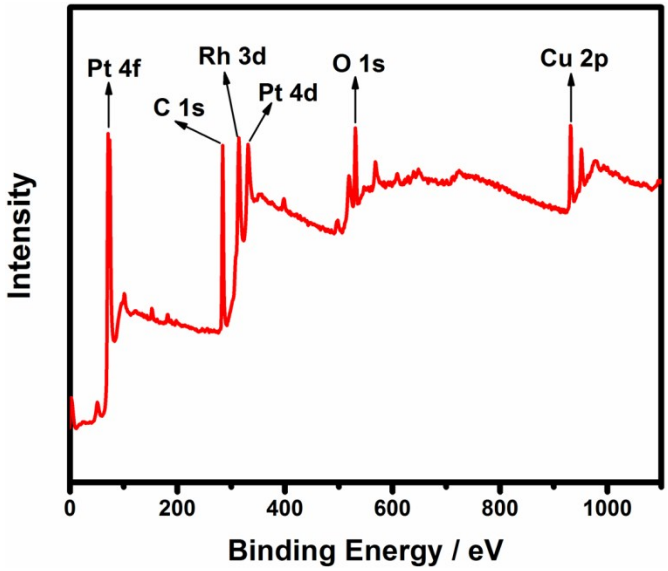

Fig.S8 The XPS full spectra of PtCuRh NWs.

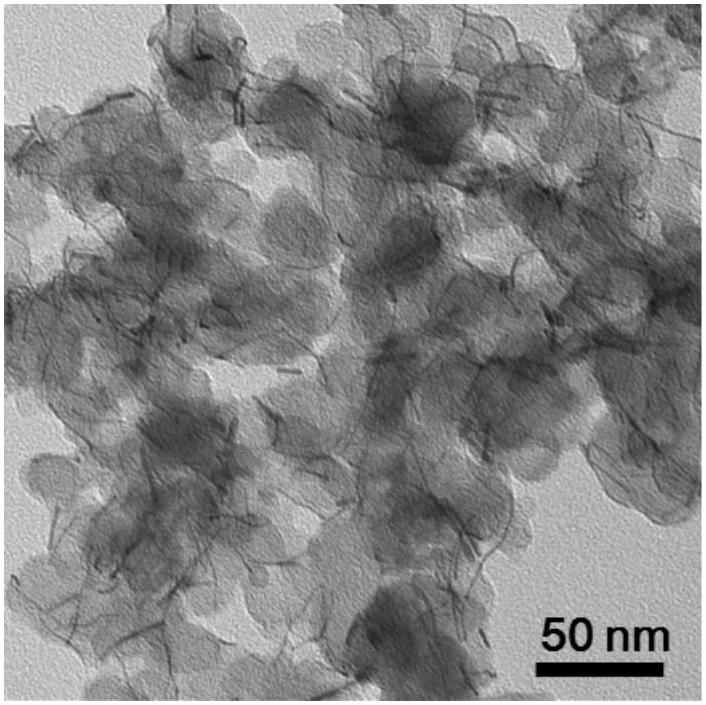

Fig.S9 Representative TEM image of carbon-supported ultrafine PtCuRh NWs.

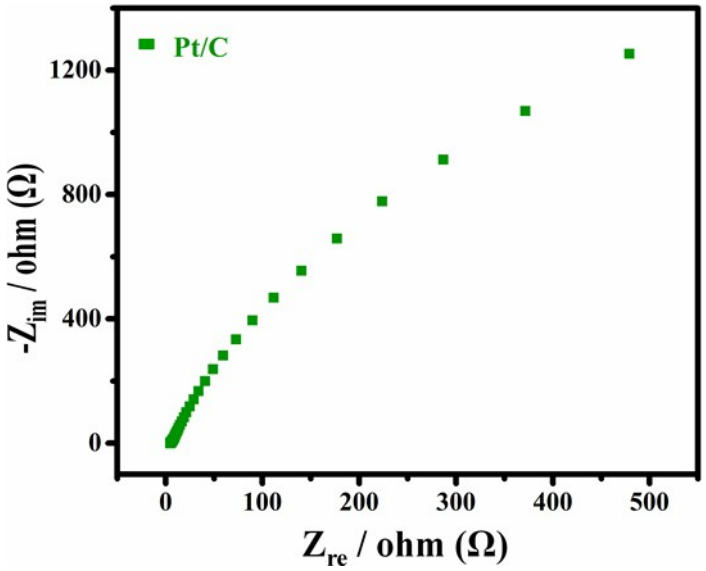

Fig.S10 Nyquist plots of commercial Pt/C in 1 M KOH and 1 M ethanol solution.

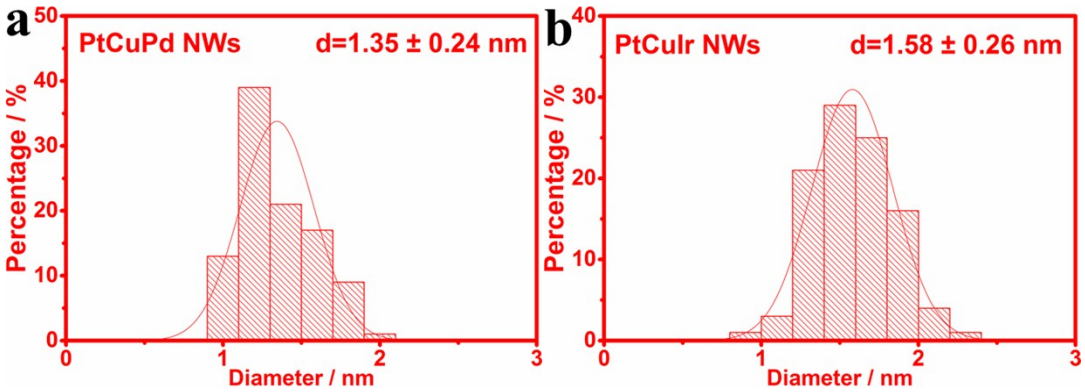

Fig.S11 Diameter distribution of ultrafine PtCuPd and PtCuIr NWs.

Table S1 Electrocatalytic activity comparison of PtCuRh NWs with different electrocatalysts reported.

Catalysts	Activity/J_m (A/mg)	Electrolyte	References
PtCuRh NWs	2.01	1.0 M KOH + 1.0 M ethanol	**This work**
PtCu NWs	1.49	1.0 M KOH + 1.0 M ethanol	**This work**
H-PdSnNi Catalyst	1.96	1.0 M KOH + 1.0 M ethanol	Electrochim Acta.2018, 259, 1145-1153
Pd_1Ag_3 Hollow Nanoflowers	1.62	1.0 M KOH + 1.0 M ethanol	Chem-Eur J. 2016, 22, 16642-16647
Pd@Pt Hexapod	0.52	0.5 M H_2SO_4 + 0.5 M methanol	Nanoscale 2017, 9, 11077-1084.
N-doped porous carbon encapsulated bimetallic PdCo	1.25	1.0 M KOH + 1.0 M ethanol	J. Mater. Chem. A. 2017, 5, 10876-10884
PtRhNi nanoparticles	1.07	0.5 M KOH + 0.5 M ethanol	Chemelectrochem. 2015, 2, 903-908