Electronic Supplementary Material (ESI) for Green Chemistry.

Electronic Supplementary Information for

One-Pot Aqueous Synthesis of Ultrathin Trimetallic PdPtCu Nanosheets for the Electrooxidation of Alcohols

Hao Lv,[a] Lizhi Sun,[a] Dongdong Xu,*[a] Steven L. Suib,[b] and Ben Liu*[a]

[a]Jiangsu Key Laboratory of New Power Batteries, Jiangsu Collaborative Innovation Center of Biomedical Functional Materials, School of Chemistry and Materials Science, Nanjing Normal University, Nanjing 210023, China

[b]Department of Chemistry and Institute of Materials Science, University of Connecticut, Storrs, Connecticut 06269, United States

E-mails: ddxu@njnu.edu.cn (D. Xu), ben.liu@njnu.edu.cn (B. Liu)

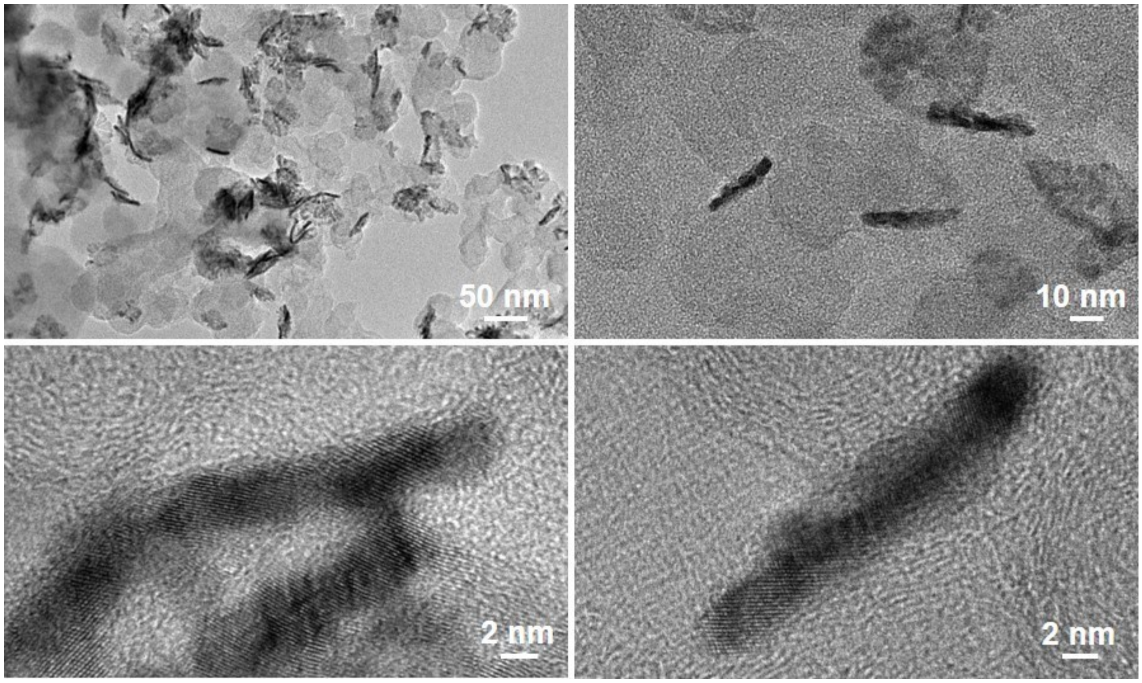

Fig. S1 TEM images of ultrathin PdPtCu nanosheets perpendicularly standing on carbon supports. The results indicated that PdPtCu nanosheets are ultrathin with an average thickness of 3.5 nm.

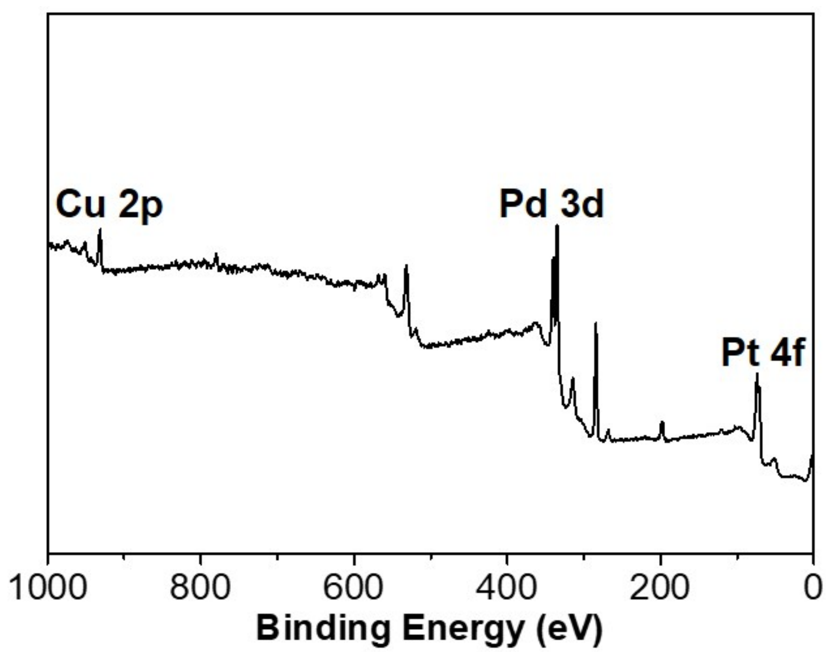

Fig. S2 XPS survey of ultrathin trimetallic PdPtCu nanosheets.

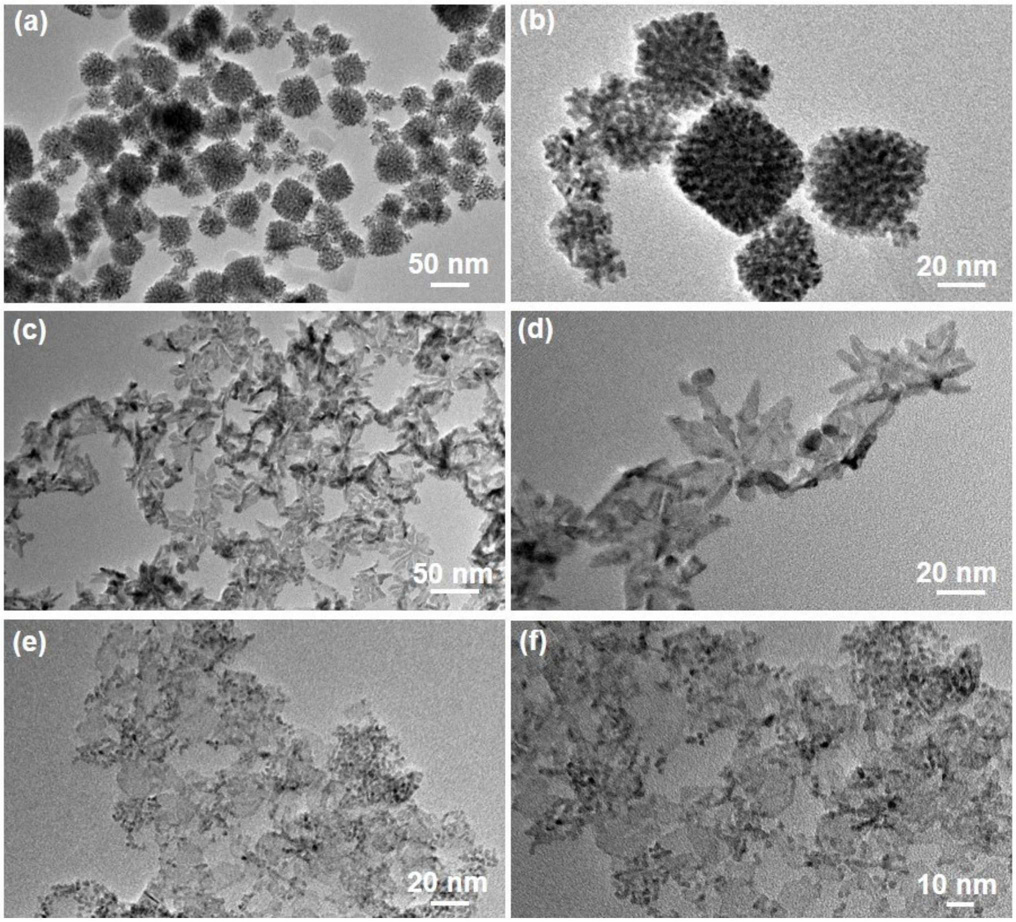

Fig. S3 TEM images of trimetallic PdPtCu nanostructures synthesized with different surfactant of (a, b) C_{16}TAC, (c, d) C_{22}TAB (with the presence of Br^-, instead of Cl^-), and (e, f) using CO as reducing agent. Due to the relatively weak confinement effect of CO to other metals (e.g., Cu), the resultant PdPtCu nanosheets reduced by CO possess some irregular nanostructures on the surface (e and f), further confirming the powerful ability of the synthesis strategy by C_{22}TAC to produce multimetallic nanosheets.

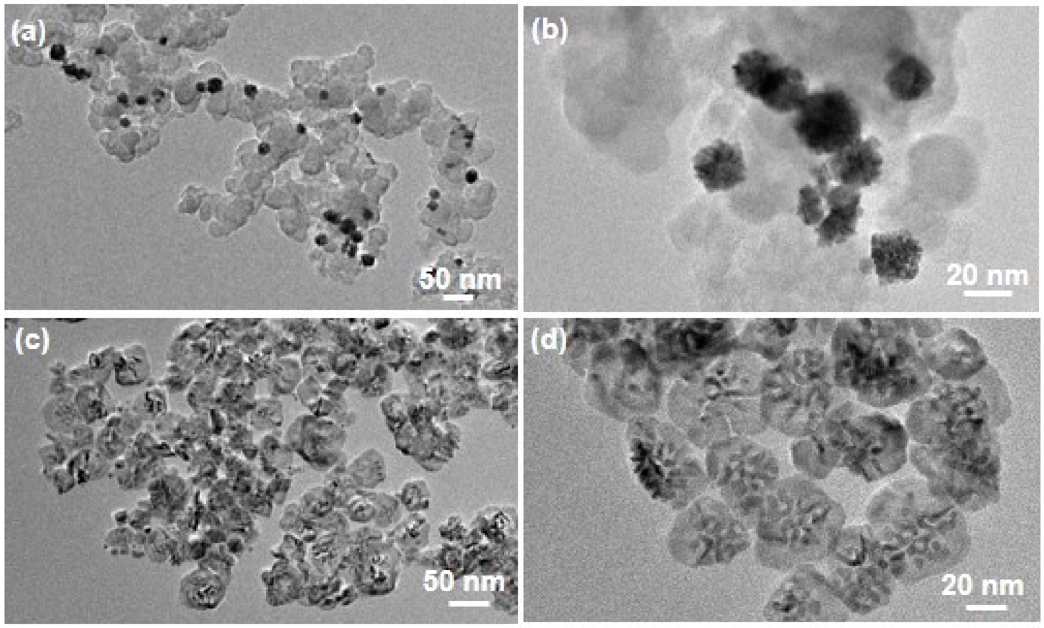

Fig. S4 TEM images of (a, b) 0D PdPtCu nanoparticles synthesized in the absence of surfactant and (c, d) monometallic Pd nanosheets.

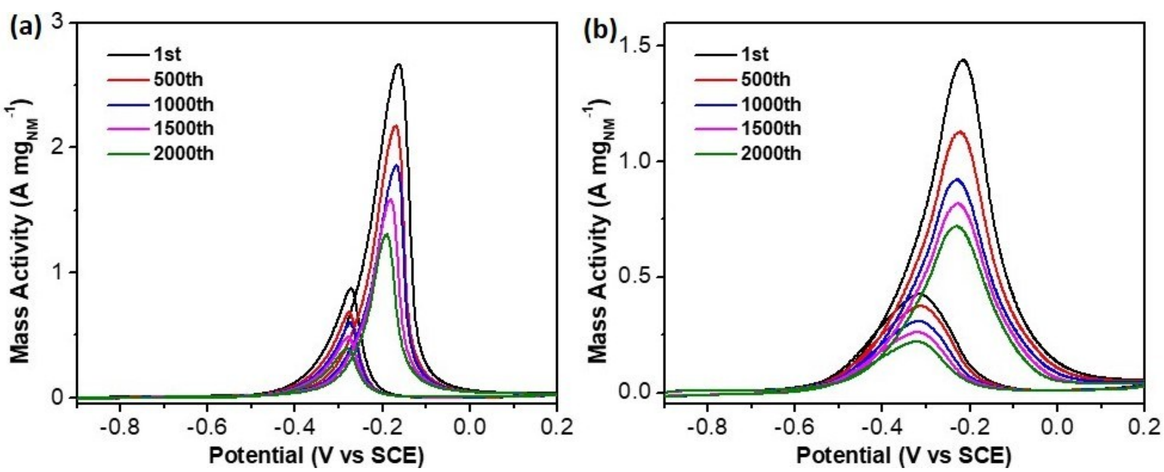

Fig. S5 CV curves of (a) ultrathin PdPtCu nanosheets and (b) commercial Pt nanoparticles with different electrocatalytic cycles.

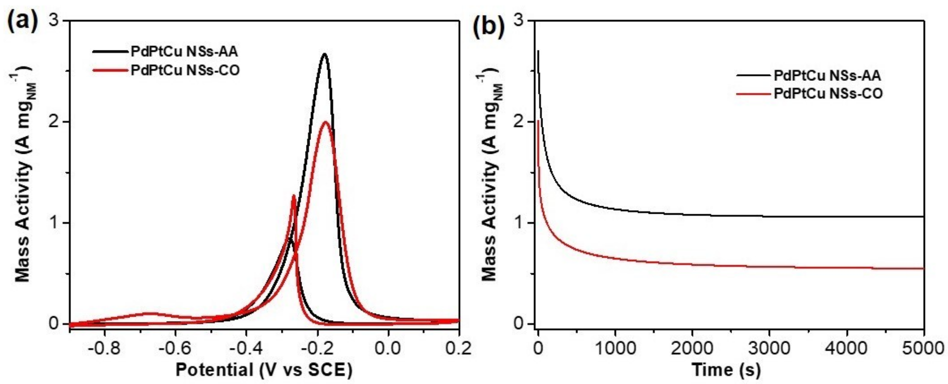

Fig. S6 CV curves (a) and i-t chronoamperometry curves (b) of trimetallic PdPtCu nanosheets reduced by AA and CO, respectively.

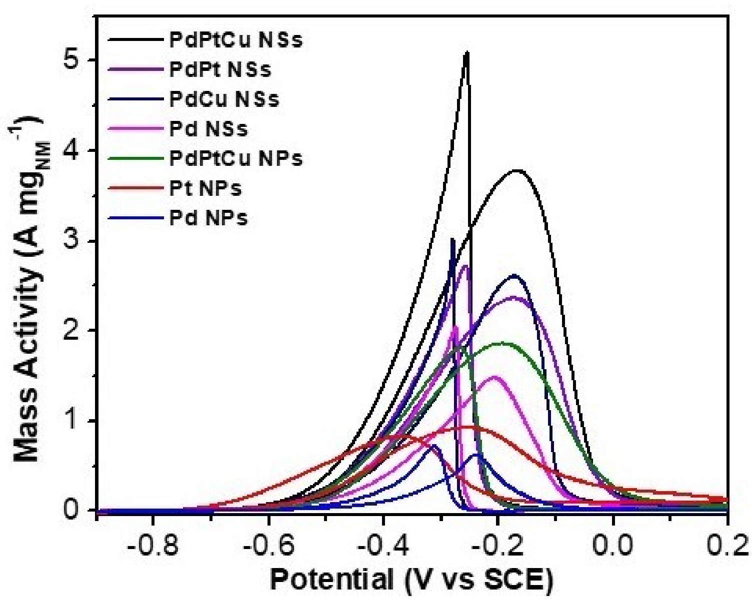

Fig. S7 Ethanol electrooxidation. CV curves of trimetallic PdPtCu nanosheets, bimetallic PdPt and PdCu nanosheets, monometallic Pd nanosheets, PdPtCu nanoparticles, and commercial Pt and Pd nanoparticles obtained in 1.0 M KOH and 1.0 M ethanol at 50 mV s^{-1}.

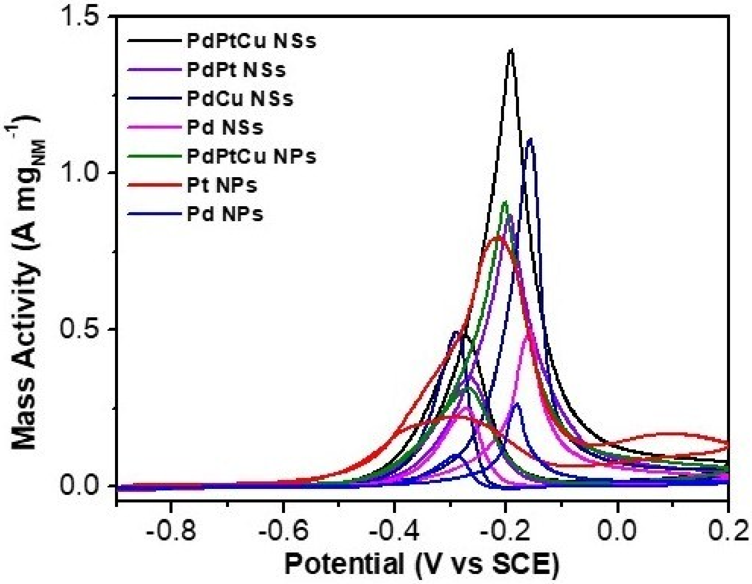

Fig. S8 Glycerol electrooxidation. CV curves of trimetallic PdPtCu nanosheets, bimetallic PdPt and PdCu nanosheets, monometallic Pd nanosheets, PdPtCu nanoparticles, and commercial Pt and Pd nanoparticles obtained in 1.0 M KOH and 0.1 M glycerol at 50 mV s^{-1}.

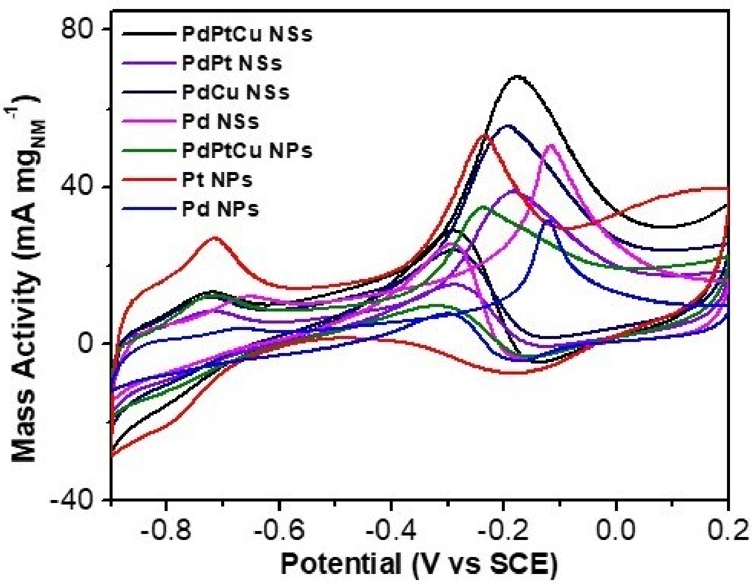

Fig. S9 Glucose electrooxidation. CV curves of trimetallic PdPtCu nanosheets, bimetallic PdPt and PdCu nanosheets, monometallic Pd nanosheets, PdPtCu nanoparticles, and commercial Pt and Pd nanoparticles obtained in 0.1 M NaOH and 0.01 M glucose at 50 mV s^{-1}.

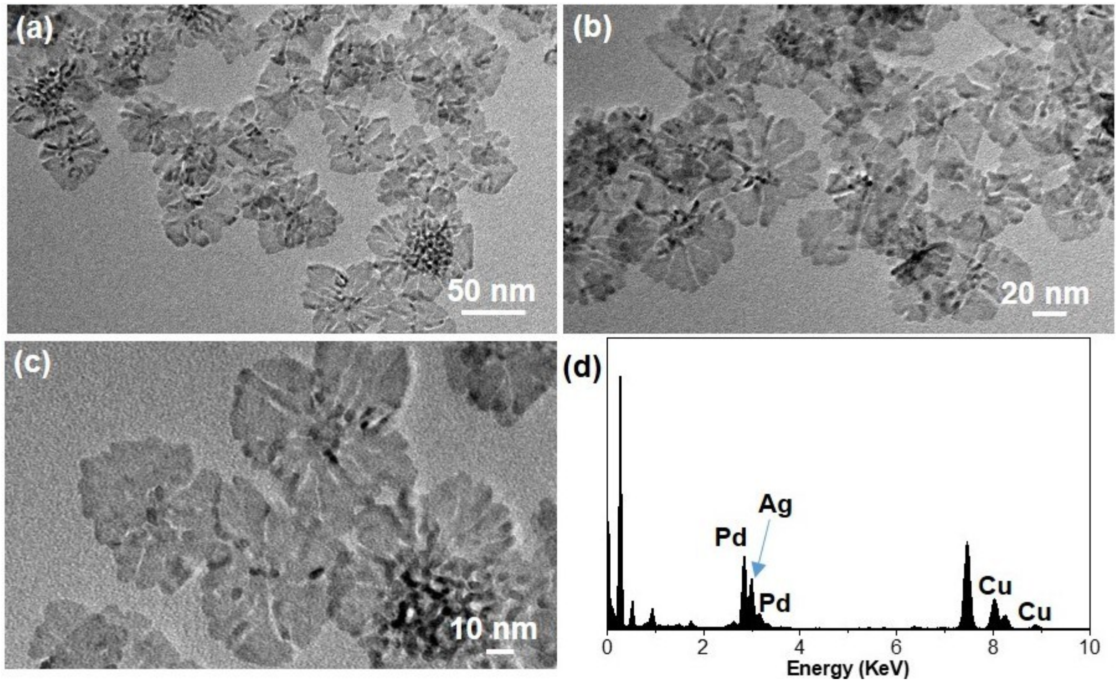

Fig. S10 (a-c) TEM images and (d) corresponding EDX of ultrathin trimetallic PdAgCu nanosheets.

Table S1. Summarization of methanol electrochemical performance of PdPtCu nanosheets in alkaline solution.

Electrocatalyst	Electrolyte		Peak current from CV (A mg_{NM}^{-1})	Reference
	Methanol	KOH	50 mV s^{-1}	
PdPtCu NSs	1.0 M	1.0 M	2.67	This work
PtPdBi nanoparticles	1.0 M	1.0 M	2.133	Catalysts, 2017, 7, 208
Pt/Ni(OH)$_2$/rGO	1.0 M	1.0 M	1.07	Nat. Commun. 2015, 6, 10035
PdRuP	1.0 M	1.0 M	1.26	Int. J. Hydrogen Energy, 2017, 42, 11229
Pd/PTCDIIL/GO	1.0 M	1.0 M	0.616	Electrochim. Acta 2013, 109, 276
Pd@PtNi	1.0 M	1.0 M	1.614	ACS Appl. Nano Mater. 2018, 1, 3226
Pt/NiFe-LDH/RGO	1.0 M	1.0 M	0.949	J. Electroanalyt. Chem., 2018, 818, 198
PdAu/C	1.0 M	1.0 M	0.951	J. Mater. Chem. A, 2013, 1, 9157
PtAuRu/RGO/GC	1.0 M	1.0 M	1.606	J. Mater. Chem. A, 2013, 1, 7255
PtAu/PDA-RGO	1.0 M	1.0 M	0.645	Electrochim. Acta, 2015, 153, 175
Pt/RGO/TiO$_2$/CF	1.0 M	1.0 M	0.364	J. Solid State Electrochem., 2014, 18, 515
Pt$_{50}$Pd$_{50}$	1.0 M	1.0 M	0.336	Chem. Commun., 2016, 52, 12737
Pd/ZnO/GNs	1.0 M	1.0 M	0.818	Langmuir, 2015, 31, 2576
PdCu /RGO	1.0 M	1.0 M	1.153	J. Power Sources, 2015, 228, 160
PdCu/VrGO	1.0 M	1.0 M	0.763	J. Power Sources, 2015, 278, 725
N-Pt/RGO/CF	1.0 M	1.0 M	1.073	Int. J. Hydrogen Energy, 2013, 38, 6368