

Supporting Information

Pd₃Co₁ Alloy Nanocluster on the MWCNT Catalyst for Efficient Formic Acid Electro-Oxidation

Pingping Yang †, Li Zhang †, Xuejiao Wei *, Shiming Dong and Yuejun Ouyang *

College of Chemistry and Materials Engineering, Huaihua University,
Huaihua 418008, China

* Correspondence: wei1348137@163.com (X.W.); oyyj0816@163.com (Y.O.)

† These authors contributed equally to the work.

Table of Contents:

1. Supplementary Figures

Figure S1. XRD patterns of Pd₁Co₁/CNTs (a) and Pd₁Co₃/CNTs (b) catalysts.

Figure S2. TEM and HRTEM images of Pd/CNTs catalyst.

Figure S3 TEM and HRTEM images; HAADF-STEM elements mapping; the corresponding elements Pd and Co of Pd₃Co₁/CNTs (another region).

Figure S4. EDX line-profiles (a-b), spot scanning (c-d) of a Pd₃Co₁ nanoparticle (where Pd is in red and Co in blue) of Pd₃Co₁/CNTs.

Figure S5. EDX-spot scanning and element content ratio (b-c) of a Pd₃Co₁ nanoparticle in Pd₃Co₁/CNTs.

Figure S6. The corresponding particle size distribution of Pd₃Co₁/C catalyst.

Figure S7. TEM and HRTEM images and the corresponding particle size distribution of Pd₁Co₁/CNTs (a-c) and Pd₁Co₃/CNTs (d-f) catalysts.

Figure S8. The corresponding particle size distribution of Pd/CNTs.

Figure S9. TEM and HRTEM images of Pd₃Co₁/C catalyst.

Figure S10 Cyclic voltammograms curve of Pd₃Co₁/C in 0.5 M H₂SO₄+1.0 M HCOOH.

2. Supplementary Tables

Table S1. Elemental composition of the samples obtained from ICP.

Table S2. Pd 3d peaks of Pd₃Co₁/CNTs and Pd/CNTs.

Table S3 A recent literatures survey of the activity of FAOR electrocatalysts.

3. Supplementary References

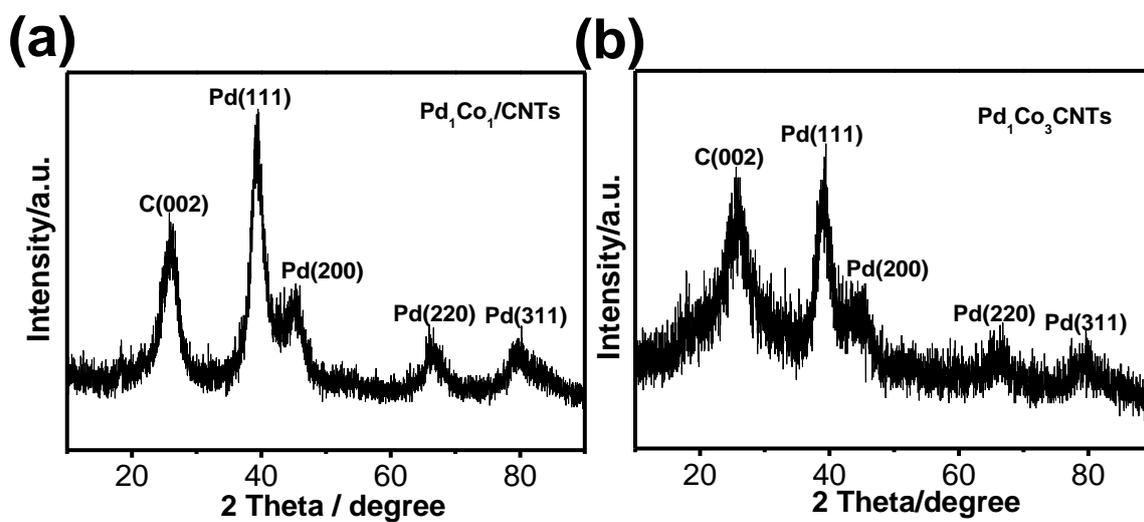


Figure S1. XRD patterns of Pd₁Co₁/CNTs (a) and Pd₁Co₃/CNTs (b) catalysts.

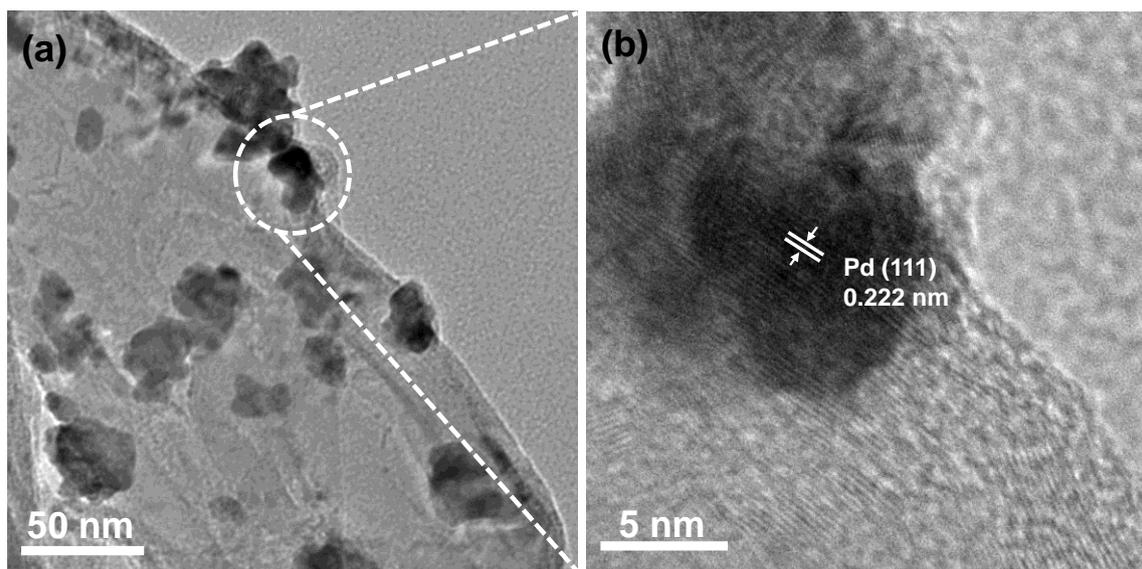


Figure S2. TEM and HRTEM images of Pd/CNTs catalyst.

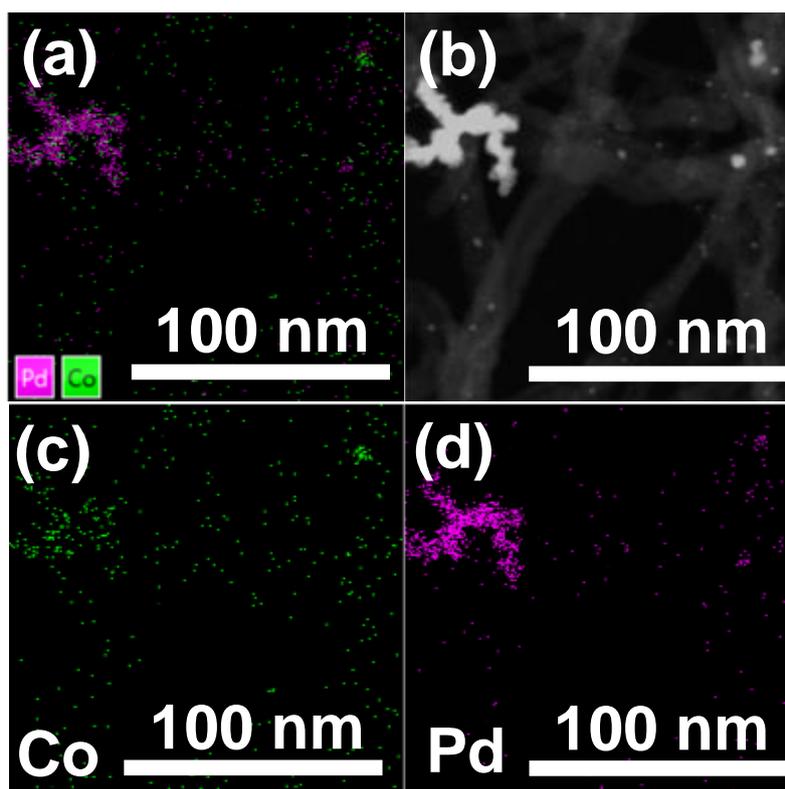


Figure S3. TEM and HRTEM images; HAADF-STEM elements mapping; the corresponding elements Pd and Co of Pd₃Co₁/CNTs (another region).

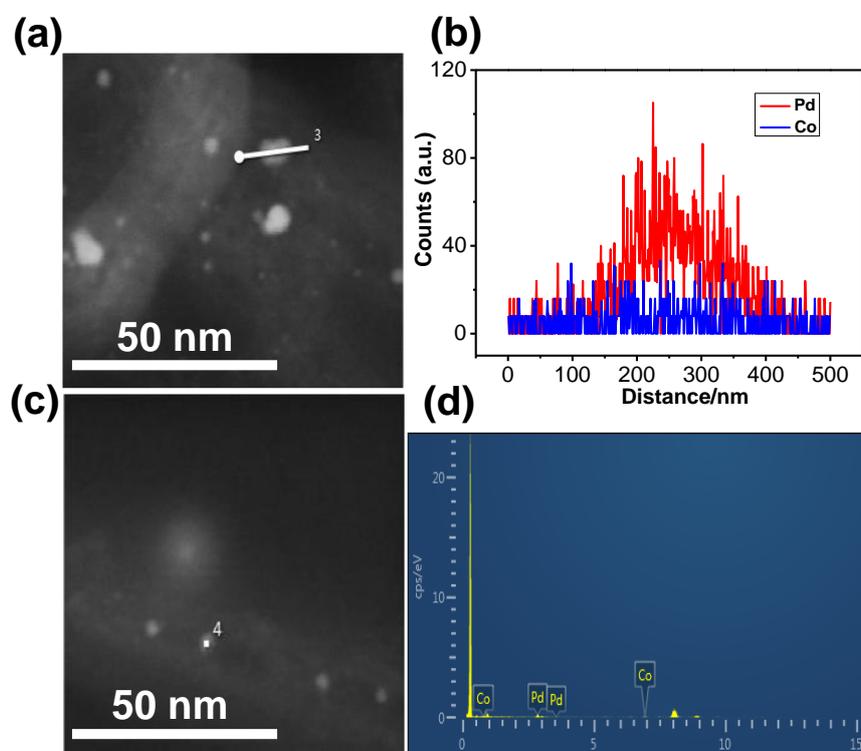


Figure S4. EDX line-profiles (a-b), spot scanning (c-d) of a Pd₃Co₁ nanoparticle

(where Pd is in red and Co in blue) of Pd₃Co₁/CNTs.

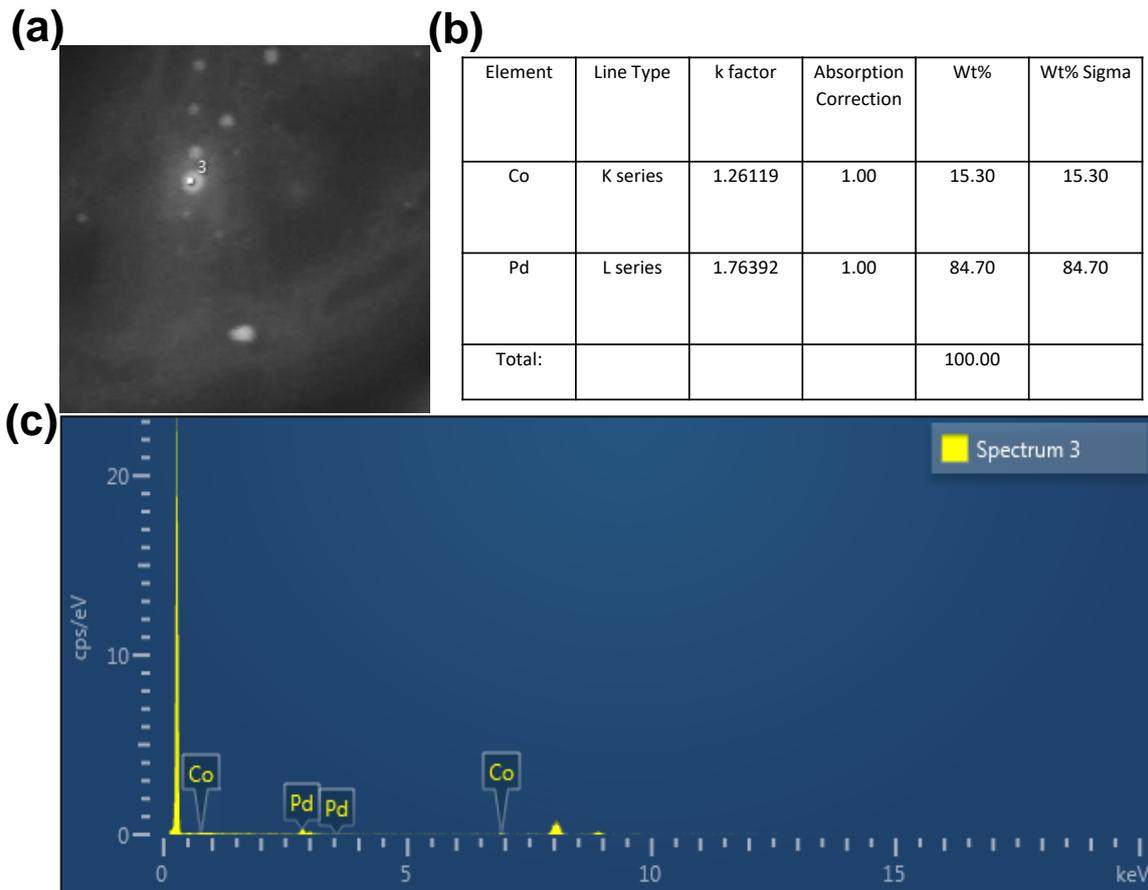


Figure S5. EDX-spot scanning (a) and element content ratio (b-c) of a Pd₃Co₁ nanoparticle in Pd₃Co₁/CNTs.

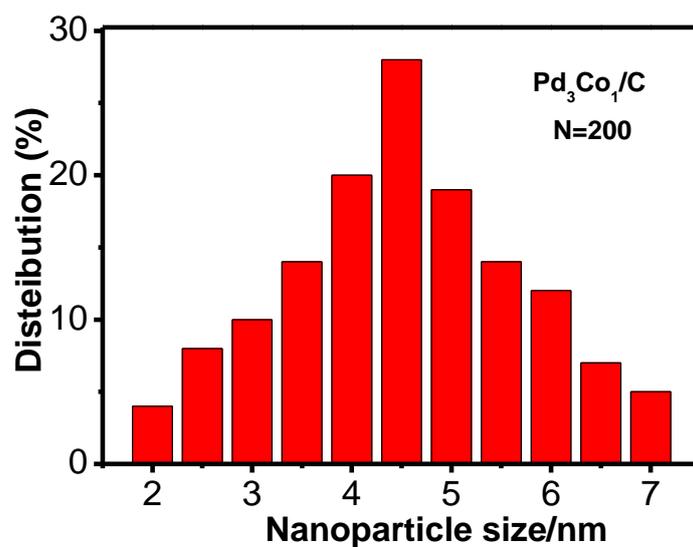


Figure S6. The corresponding particle size distribution of Pd₃Co₁/C catalyst.

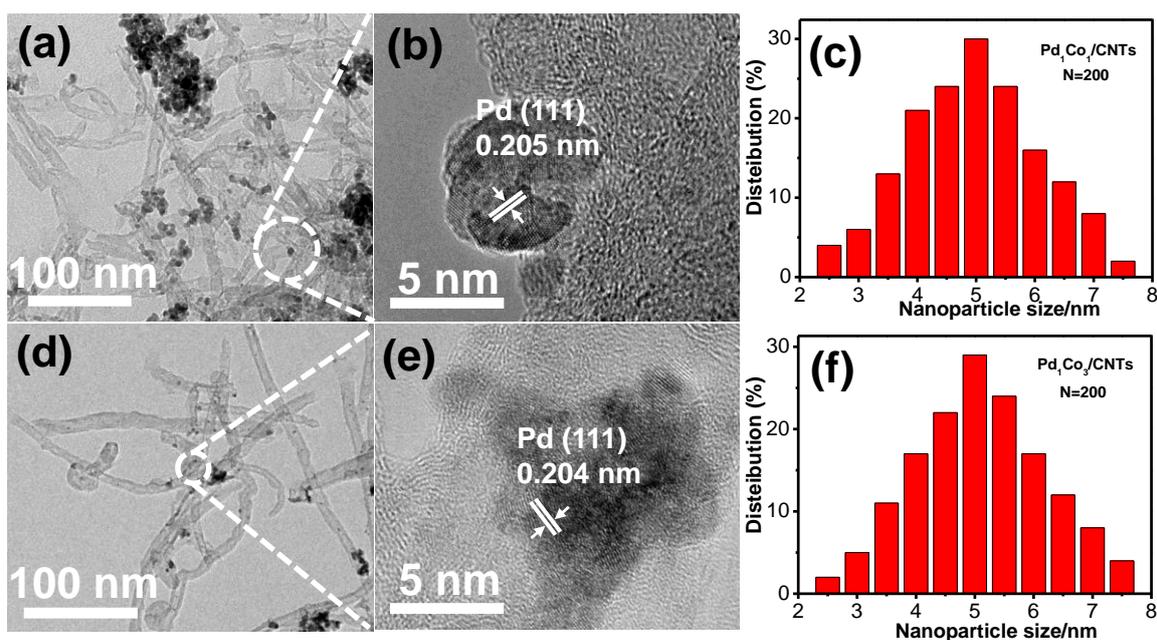


Figure S7. TEM and HRTEM images and the corresponding particle size distribution of Pd₁Co₁/CNTs (a-c) and Pd₁Co₃/CNTs (d-f) catalysts.

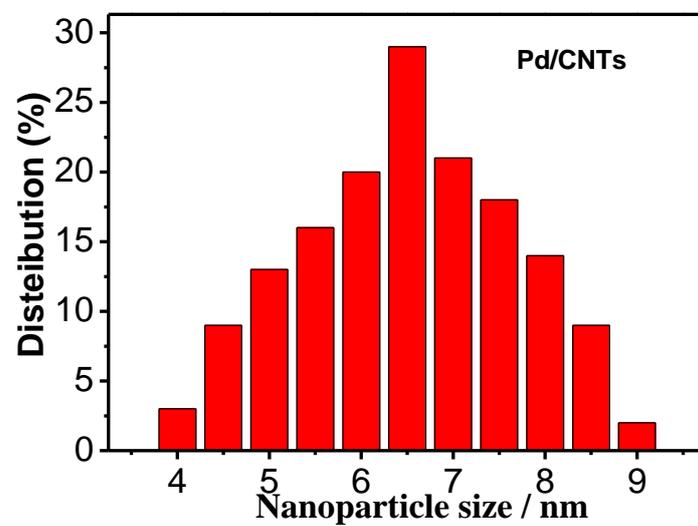


Figure S8. The corresponding particle size distribution of Pd/CNTs.

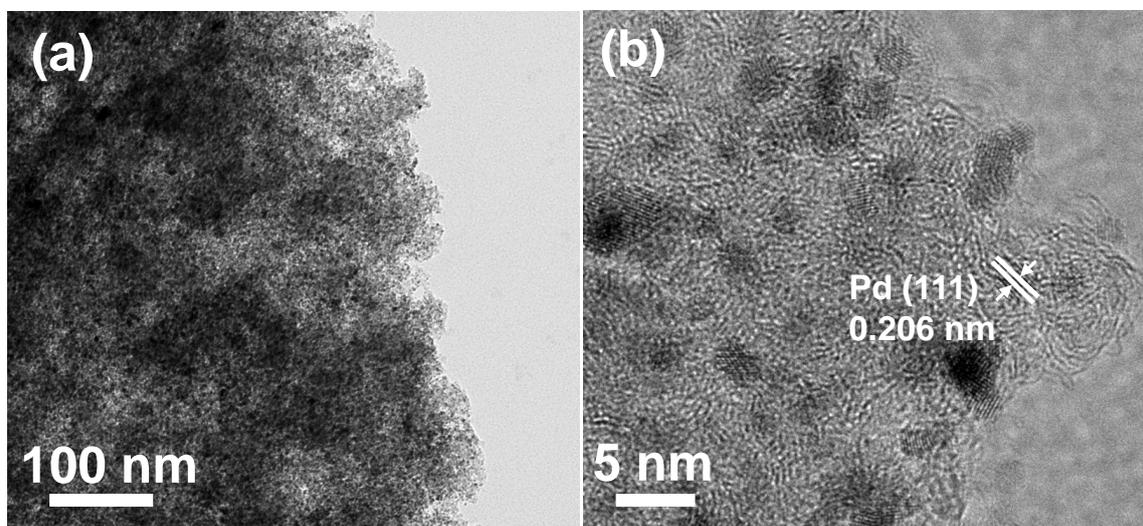


Figure S9. TEM and HRTEM images of Pd₃Co₁/C catalyst.

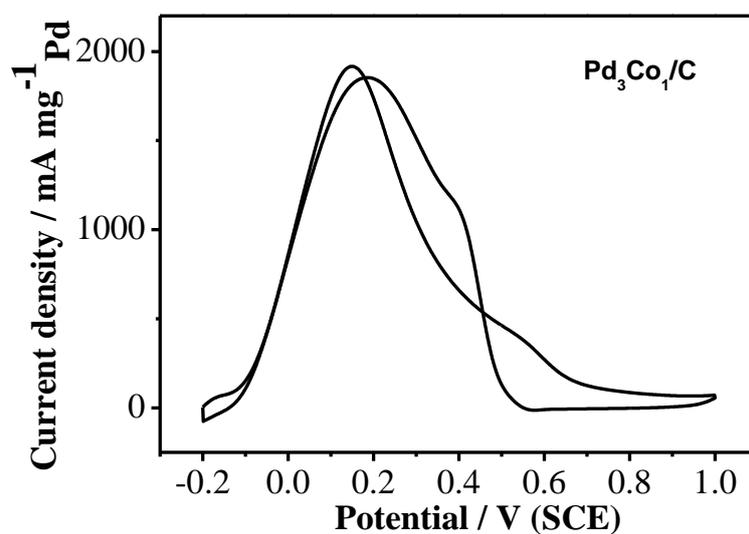


Figure S10 Cyclic voltammograms curve of Pd₃Co₁/C in 0.5 M H₂SO₄+1.0 M HCOOH.

Table S1. Elemental composition of the samples obtained from ICP.

Elements Catalysts	Pd(wt.%)	Co(wt.%)	Atomic ratios
Pd ₃ Co ₁ /CNTs	19.1	6.35	3:1
Pd ₁ Co ₁ /CNTs	18.3	17.9	1:1
Pd ₁ Co ₃ /CNTs	18.6	55.1	1:3
Pd/CNTs	17.5	-	-

Table S2. Pd 3d peaks of Pd₃Co₁/CNTs and Pd/CNTs.

Catalysts	Pd ⁰ 3d _{5/2} (eV)	Pd ⁰ 3d _{3/2} (eV)	Pd ²⁺ 3d _{5/2} (eV)	Pd ²⁺ 3d _{3/2} (eV)
Pd ₃ Co ₁ /CNTs	335.8	336.8	340.7	341.3
Pd/CNTs	335.5	336.2	340.6	341.1

Table S3 a recent literatures survey of the activity of FAOR electrocatalysts.

Catalysts	Mass activity (mA mg ⁻¹ Pt)	References
Pd ₃ Co ₁ /CNTs	2410.1	This work
PdCo nanodots	1362.1	[22]
PdCu nanochains	1108.2	[26]
PdCu clusters	1289.0	[57]
coral-like PdCu	1050.0	[61]
Pd ₆ Co nanocrystals	430.8	[62]
PdCu nanoparticles	194.5	[63]
(3D) porous PdSn	553.4	[64]
PdCu porous network	517.0	[65]
Pd-Fe nanoparticles	1000.0	[66]
PdCu/CNTs	252.0	[67]