Supporting Information

Re-Dispersion of Pd-based Bimetallic Catalysts by Hydrothermal Treatment for CO Oxidation

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Additional data;

Table S1-S2

Figure S1-S9

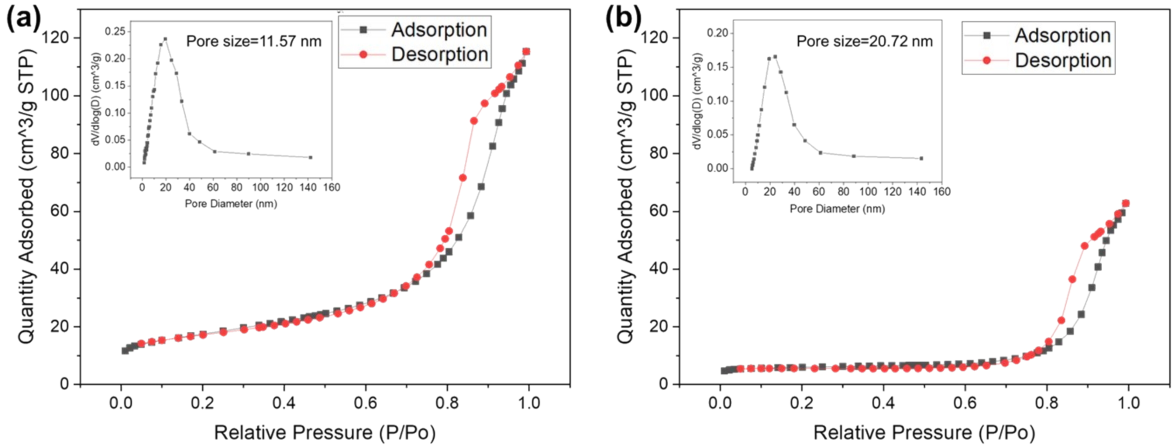

Figure S1. N_2 adsorption-desorption isotherms and pore size distributions of (a) as-made and (b) hydrothermal treated PdFe/CeO_2 catalysts.

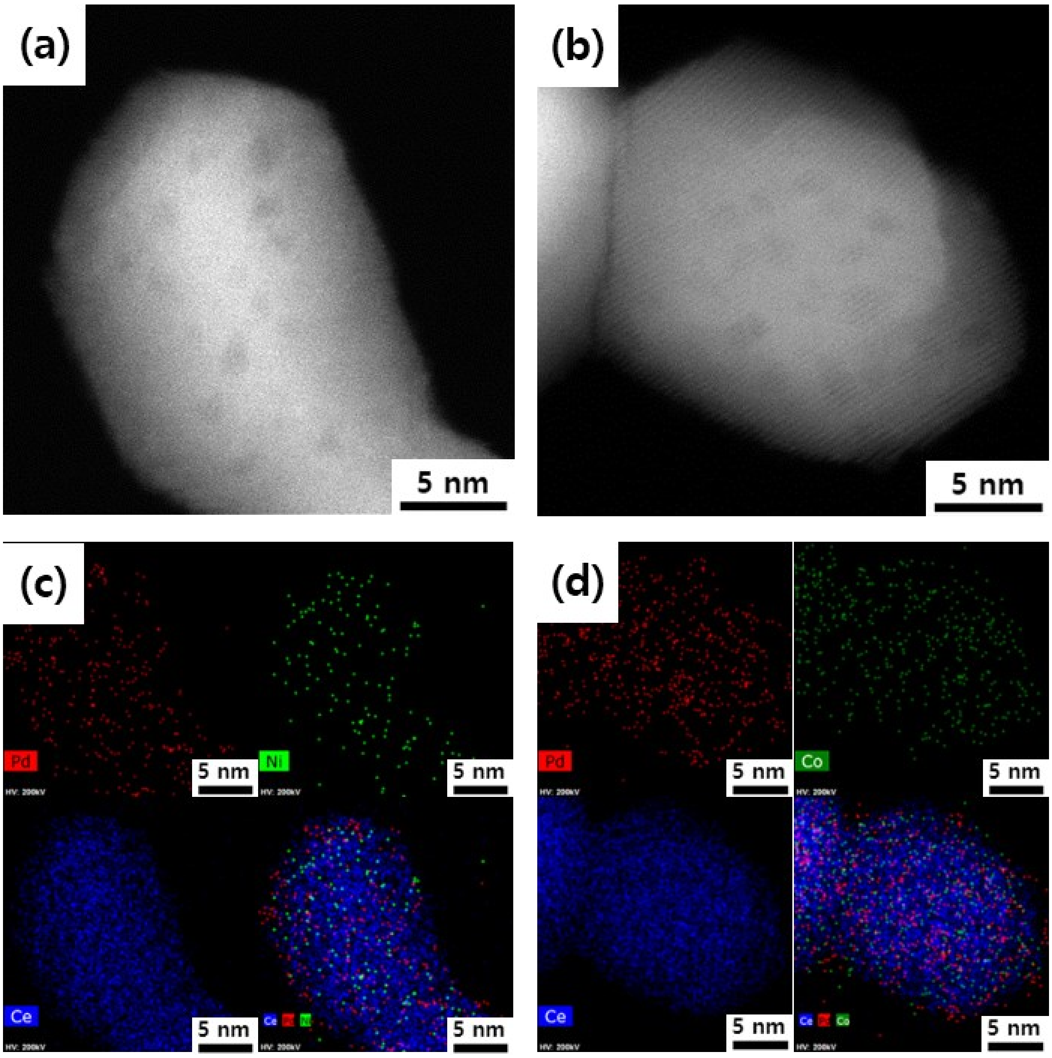

Figure S2. HAADF-STEM images of hydrothermally treated (a) PdNi/CeO_2 and (b) PdCo/CeO_2 catalysts, and EDS mapping images of hydrothermally treated (c) PdNi/CeO_2 and (d) PdCo/CeO_2 catalysts.

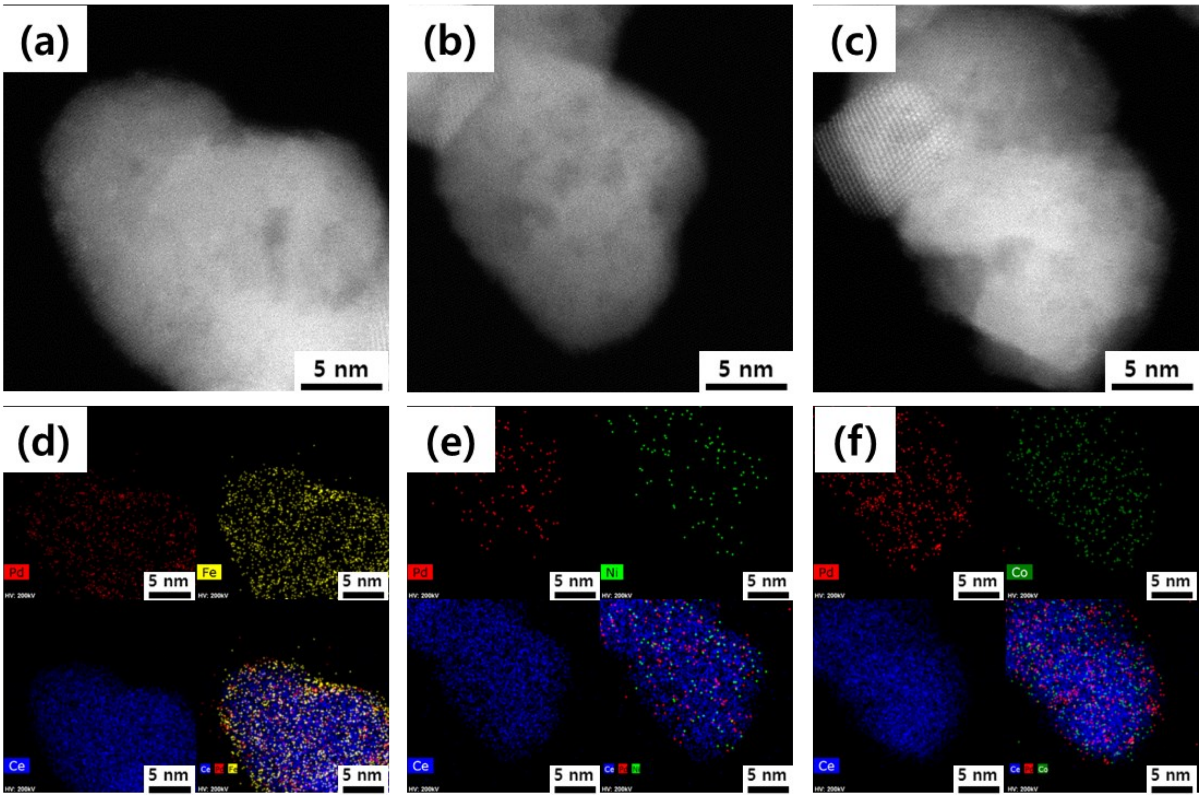

Figure S3. HAADF-STEM images of as-made (a) $PdFe/CeO_2$, (b) $PdNi/CeO_2$, and (c) $PdCo/CeO_2$ catalysts. EDS mapping images of as-made (d) $PdFe/CeO_2$, (e) $PdNi/CeO_2$, and (f) $PdCo/CeO_2$ catalysts.

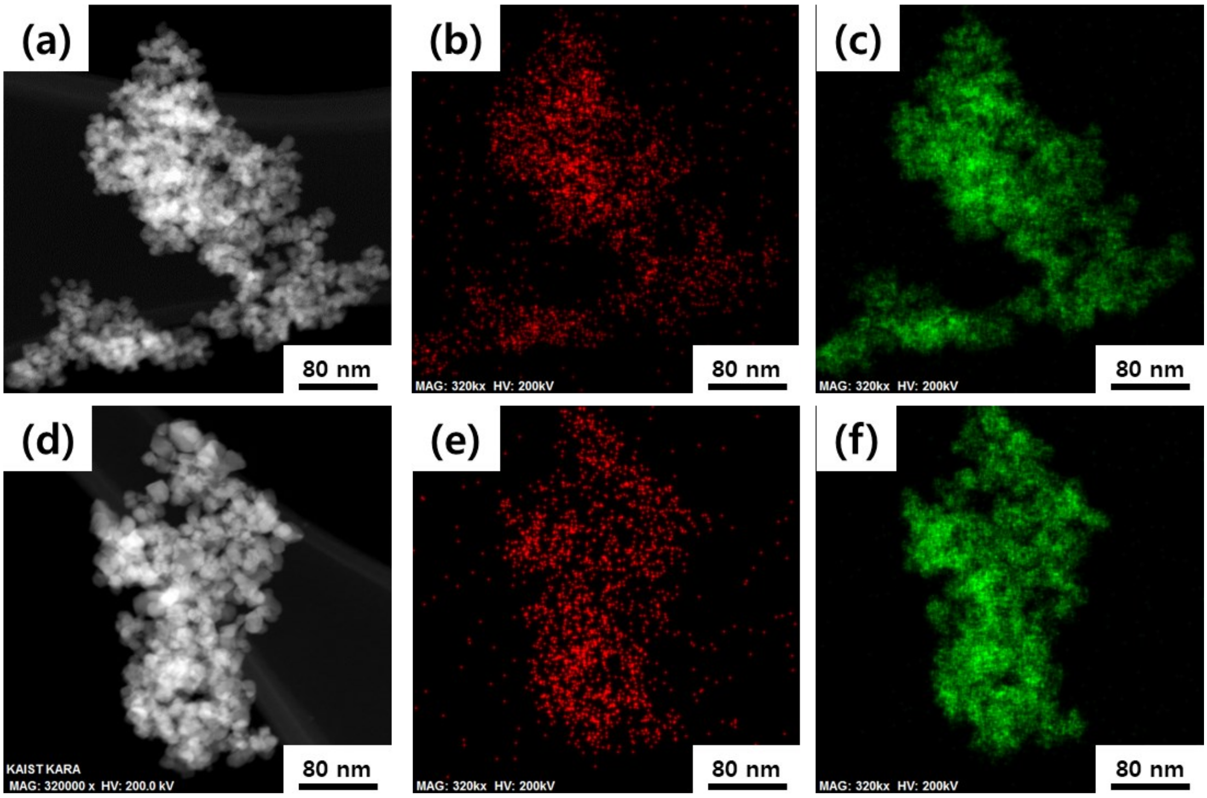

Figure S4. HAADF-STEM images of (a) as-made and (d) hydrothermally treated Pd/CeO_2 catalysts. EDS mapping images of (b, c) as-made and (e, f) hydrothermally treated Pd/CeO_2 catalysts (red: Pd, green: Ce).

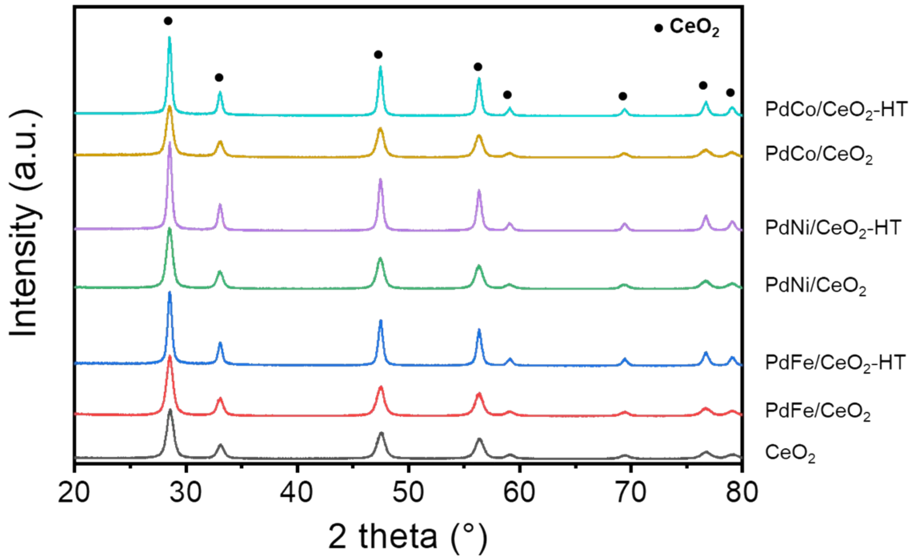

Figure S5. XRD results of as-made and hydrothermally treated Pd based bimetallic catalysts using different transition metals.

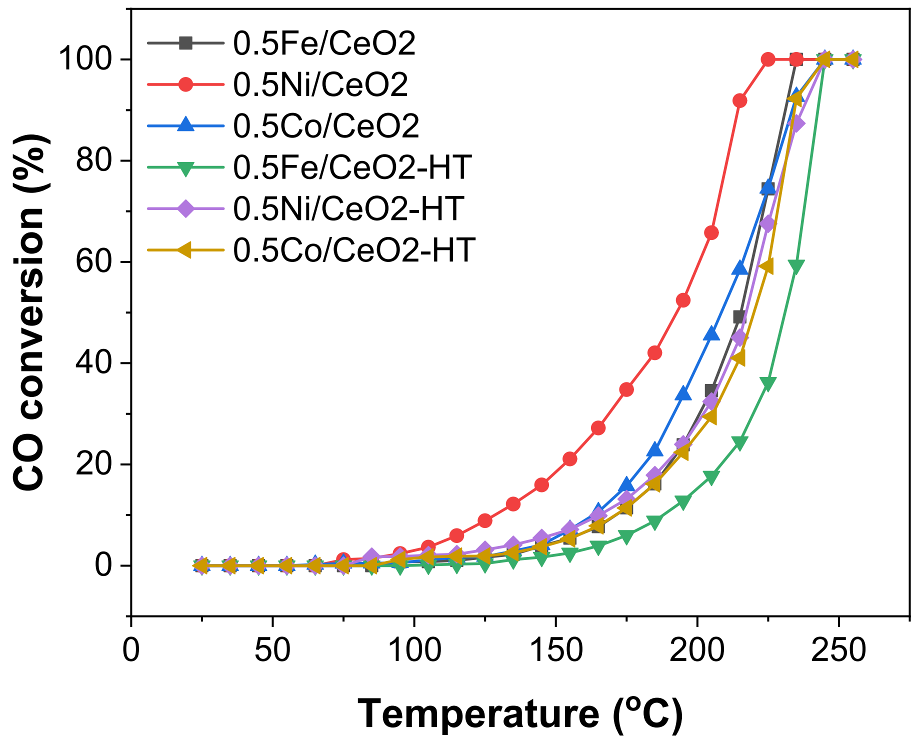

Figure S6. CO oxidation results using as-made and hydrothermally treated transition metal catalysts. (Reaction condition: 50 mg of catalyst, 120,000 ml/hr·g_{cat}, 100 sccm of total feed flow, 1% CO, 1% O_2, and 98% He)

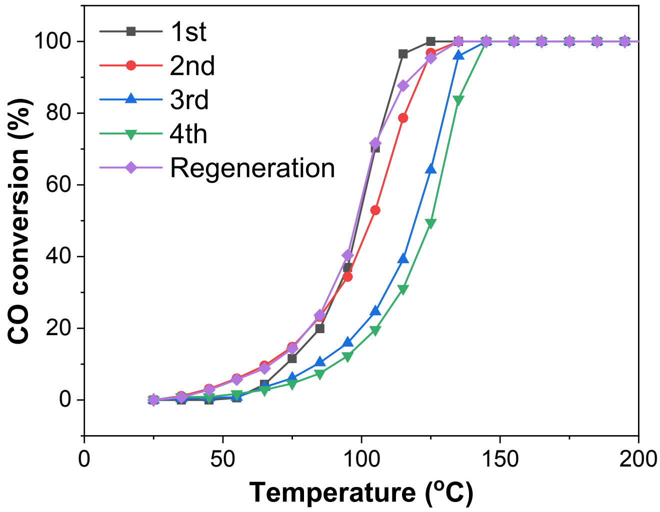

Figure S7. Repeatability and regeneration test using PdFe/CeO_2-HT catalyst.

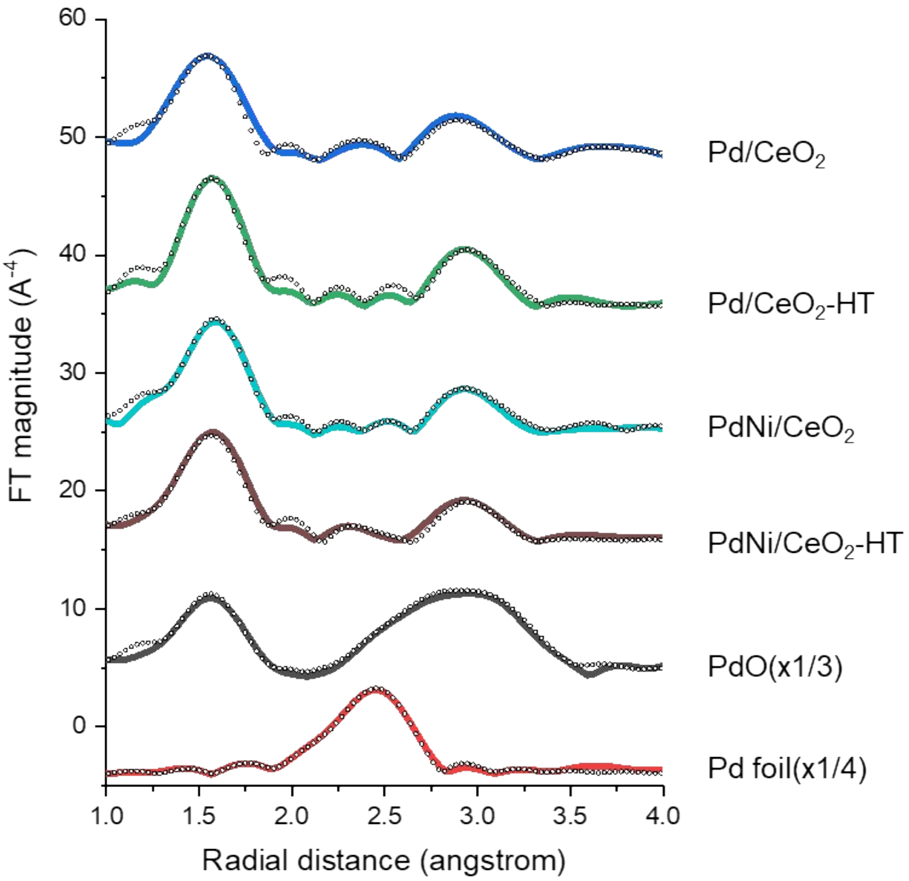

Figure S8. Pd K edge k^3-weighted Fourier transformed EXAFS spectra of PdNi/CeO_2. The dots indicate fitted results, and lines indicate experimental data.

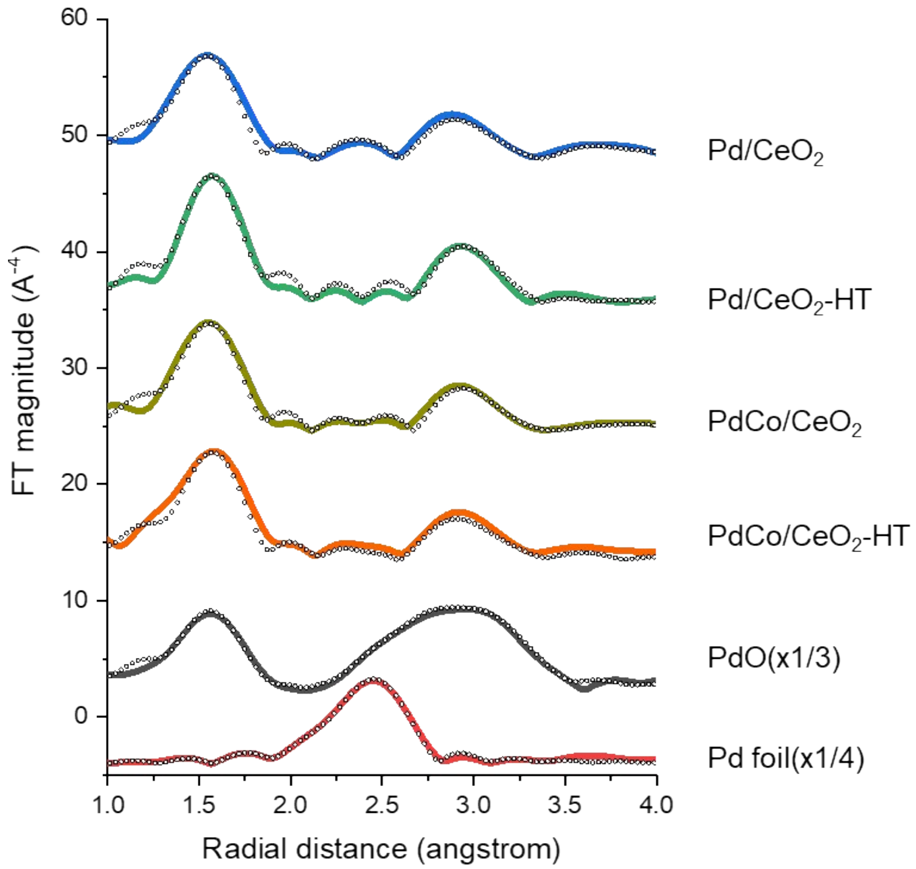

Figure S9. Pd K edge k^3-weighted Fourier transformed EXAFS spectra of PdCo/CeO$_2$. The dots indicate fitted results, and lines indicate experimental data.

Table S1. EXAFS fitting data of as-made and hydrothermally treated $PdNi/CeO_2$ and $PdCo/CeO_2$ catalysts.

Sample	Path	Coordination number (R)	Interatomic distance (Å)
Pd-Ni	Pd-O	2.7±0.2	2.01±0.03
	Pd-Ni	0.0±0.0	2.59±0.02
	Pd-Pd	0.3±0.0	2.74±0.02
	Pd-O-Ce	1.7±0.2	3.22±0.04
	Pd-O-Pd	0.4±0.3	3.48±0.03
Pd-Ni HT	Pd-O	2.5±0.4	1.99±0.03
	Pd-Ni	1.1±0.1	2.59±0.02
	Pd-Pd	0.0±0.0	2.74±0.01
	Pd-O-Ce	1.9±0.3	3.21±0.03
	Pd-O-Pd	0.3±0.2	3.49±0.03
Pd-Co	Pd-O	2.6±0.2	1.99±0.03
	Pd-Co	0.0±0.0	2.60±0.02
	Pd-Pd	0.1±0.0	2.74±0.02
	Pd-O-Ce	1.8±0.3	3.22±0.04
	Pd-O-Pd	0.3±0.2	3.49±0.02
Pd-Co HT	Pd-O	2.3±0.4	1.99±0.02
	Pd-Co	0.9±0.2	2.60±0.01
	Pd-Pd	0.0±0.0	2.74±0.01
	Pd-O-Ce	2.0±0.2	3.21±0.02
	Pd-O-Pd	0.4±0.2	3.49±0.02

Table S2. Short summary of activity comparison (T_{50} and T_{100}) with literature values for CO oxidation. T_{50} indicates the temperature at which the CO conversion reaches 50%, and T_{100} indicates the temperature at which the CO conversion reaches 100%.

Entry	Catalyst	Metal loading (%)	Reaction condition	T_{50} (°C)	T_{100} (°C)	Reference
1	$PdFe/CeO_2$-HT	0.5	1% CO, 1% O_2 SV = 120,000 mL/g_{cat}·h	100	125	This study
2	Pd/MgO	2	1% CO, 1% O_2 SV = 116,640 mL/g_{cat}·h	193	226	Catalysis Communications, 2014, 46, 213–218
	Pd/TiO_2	2		295	318	
	Pd/SiO_2	2		275	317	
3	$PdO/Ce_{1-x}Pd_xO_{2-\delta}$	1.68	0.95 % CO, 1.75% O_2 SV = 12,000 mL/g_{cat}·h	120	160	J. Phys. Chem. C, 2011, 115, 19789–19796
	$Ce_{1-x}Pd_xO_{2-\delta}$	1.58		180	220	
	PdO/CeO_2	0.2		185	220	
4	Pd/CeO_2	1	0.45% CO,10% O_2 GHSV = 480,000 h^{-1}	97	150	Appl. Catal. B: Environmental, 2013, 132– 133, 511– 518
	Pd/TiO_2	1		121	>200	
	Pd/Al_2O_3	1		143	160	
5	P-Pd/SBA-15	2	1% CO, 20% O_2 SV = 24,000 mL/g_{cat}·h	201	206	Appl. Catal. B: Environmental, 2011, 106, 672–680
	H-Pd/SBA-15-1%	1		138	140	
	H-Pd/SBA-15-2%	2		133	135	
	H-Pd/SBA-15-5%	5		120	127	
6	Pd/Al_2O_3	2.5	1.9% CO,1.3% O_2 SV = 232,500 mL/g_{cat}·h	217	-	ACS Catal. 2013, 3, 846−855
	$Pd/La-Al_2O_3$			197	-	