Supporting Information

Controlled One-step Synthesis of Pt decorated Octahedral Fe_3O_4 and Its Excellent Catalytic Performance for CO Oxidation

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1. The structural analysis of the catalysts

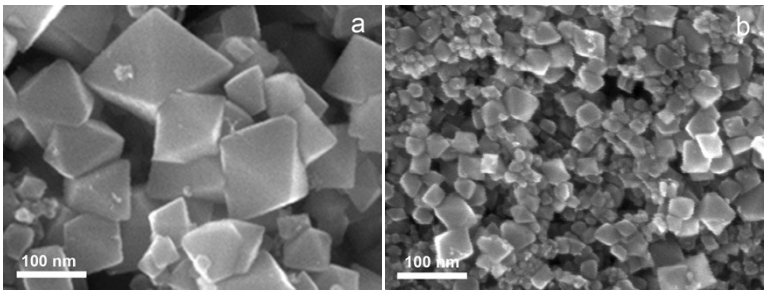

Fig. S1 SEM images of 0.47 wt% Pt/Fe_3O_4 (a) and 2.3 wt% Pt/Fe_3O_4 (b).

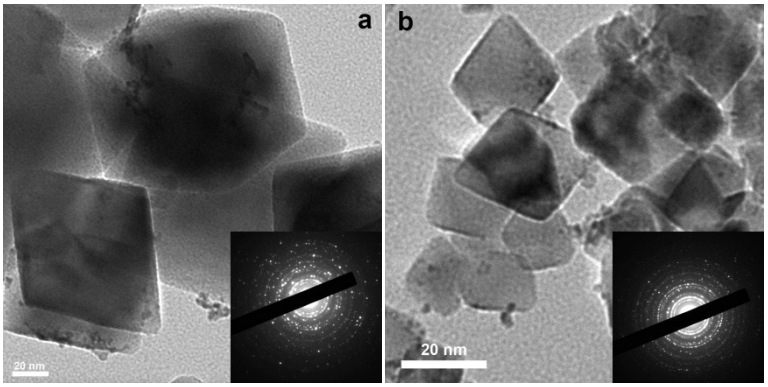

Fig. S2 TEM images of 0.47 wt% Pt/Fe_3O_4 (a) and 2.3 wt% Pt/Fe_3O_4 (b).

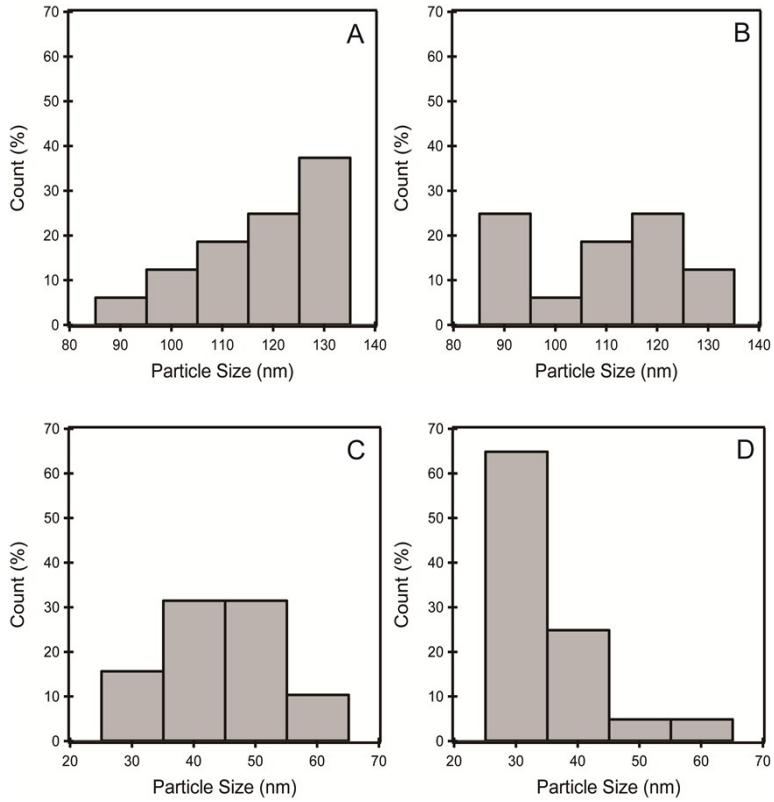

Fig. S3 Particle size distributions of Fe_3O_4 supportand Pt/ Fe_3O_4 catalysts with varied Pt loading amounts: 0 wt% (A), 0.47 wt% (B), 1.4 wt% (C) and 2.3 wt% (D).

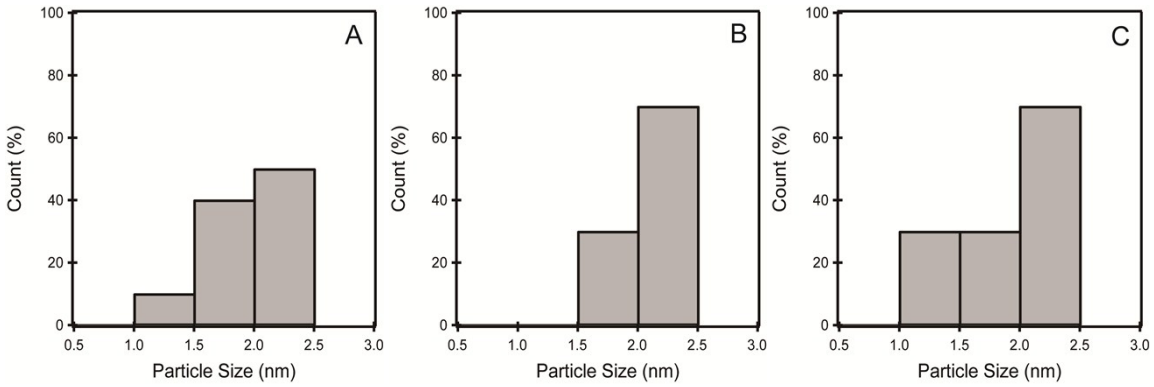

Fig. S4 Particle size distributions of Pt in Pt/ Fe_3O_4 catalysts with varied Pt loading amounts: 0.47 wt% (A), 1.4 wt% (B) and 2.3 wt% (C).

2. The structural characterizations of catalyst after catalytic testing under different conditions.

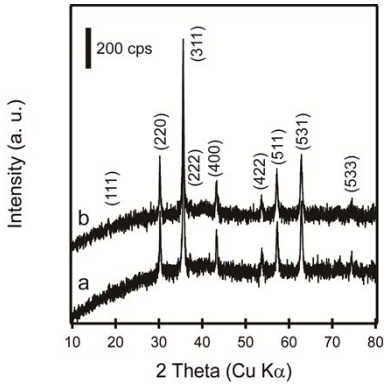

Fig. S5 XRD patterns of 1.4 wt% Pt/Fe_3O_4 catalyst after reaction under dry (a) and moisture (b) conditions.

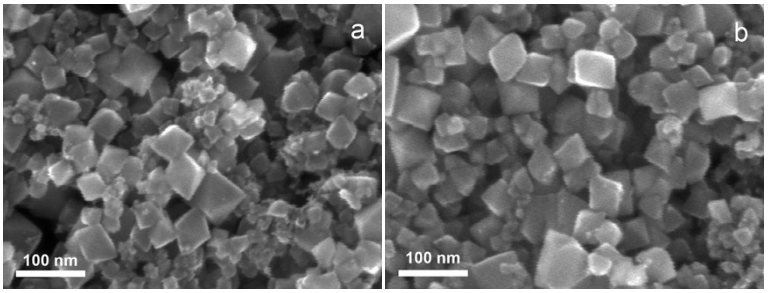

Fig. S6 SEM images of 1.4 wt% Pt/Fe_3O_4 catalyst after reaction under dry (a) and moisture (b) conditions.

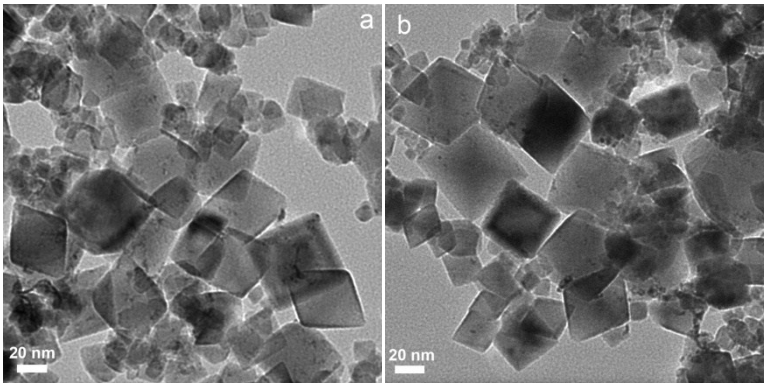

Fig. S7 TEM images of 1.4 wt% Pt/Fe_3O_4 catalyst after reaction under dry (a) and moisture (b) conditions.

3. The effect of the concentration of O_2 during the CO oxidation process

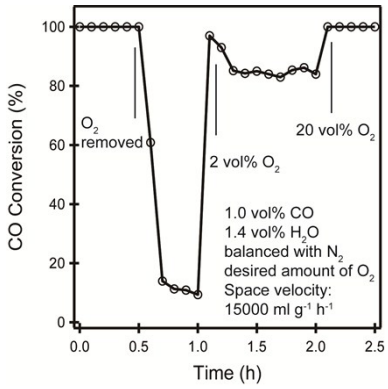

Fig. S8 The effect of O_2 during the CO oxidation reaction.

The catalyst shows relatively high water resistance when the water was introduced into the feed gas. In order to exclude the effect of the water gas shift reaction, the effect of O_2 concentration was employed as shown in Fig. S8. The CO conversion decreases from 100% to 15% in the presence of water, when the O_2 was removed from the feed gas at 25 ^oC. After 2.0 vol% O_2 introduced into the feed gas, the CO conversion increased to 90% and keep at 85% unchanged. Further increases the O_2 concentration, the CO conversion recover to 100% again. This result demonstrates that the effect of WGSR can be ignored during the CO oxidation reaction.

4. The reusability and stability test for 1.4 wt% Pt/Fe_3O_4 catalyst under dry and moisture conditions

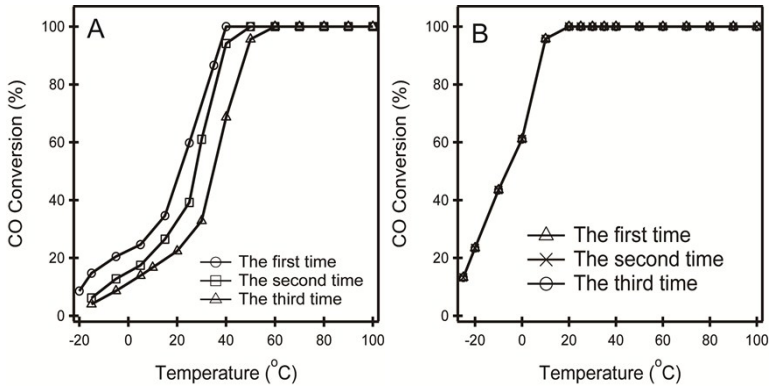

Fig. S9 Catalytic performances of 1.4 wt% Pt/Fe_3O_4 catalyst for CO oxidation under dry (A) (Reaction condition: 1.0 vol% CO, 20.0 vol% O_2 balanced with N_2; Space velocity: 15000 ml g^{-1} h^{-1}) and moisture (B) conditions. (Reaction condition: 1.0 vol% CO, 20.0 vol% O_2, 1.4 vol% H_2O balanced with N_2; Space velocity: 15000 ml g^{-1} h^{-1})

The reusability test for the 1.4 wt% Pt/ Fe_3O_4 catalyst are shown in Fig. S9. A slightly decrease of the catalytic activity could be found under dry condition, while the CO conversion keep unchanged under moisture condition. These results indicate that the 1.4 wt% Pt loaded Fe_3O_4 catalyst is more stable under moisture conditions.

5. The effect of pre-treatment for CO oxidation

The 1.4 wt% Pt/Fe_3O_4 catalyst after pre-treatment at 200 ^oC and 400 ^oC under air atmosphere for 2 h were labeled as Pt/Fe_3O_4-200 and Pt/Fe_3O_4-400. The 1.4 wt% Pt/Fe_3O_4 catalyst after pre-treatment at 200 ^oC and under H_2 atmosphere for 2 h was labeled as Pt/Fe_3O_4-H_2.

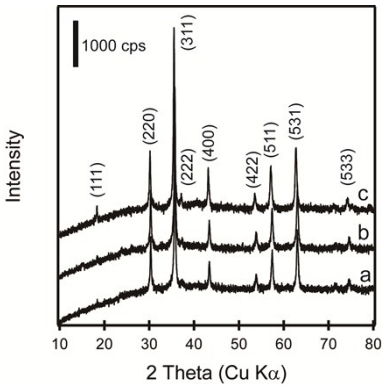

Fig. S10 XRD patterns of Pt/Fe_3O_4-200 (a), Pt/Fe_3O_4-400 (b) and Pt/Fe_3O_4-H_2 (c).

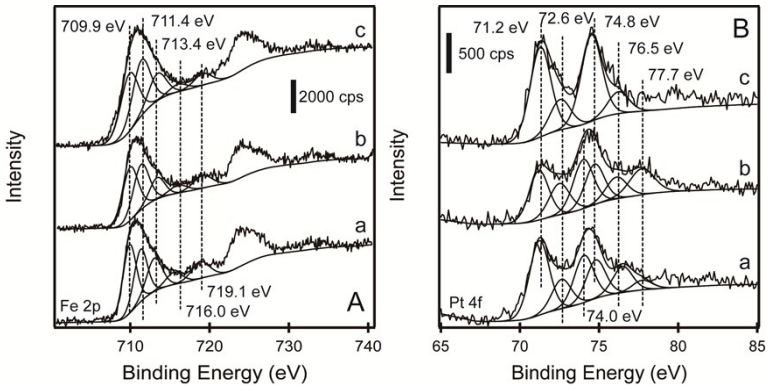

Fig. S11 XPS spectra of Fe 2p (A) and Pt 4f (B) for Pt/Fe_3O_4-200 (a), Pt/Fe_3O_4-400 (b) and Pt/Fe_3O_4-H_2 (c).

Table S1 The composition (%) of the Fe_3O_4 support and 1.4 wt% Pt loaded Pt/Fe_3O_4 catalyst

Sample	Fe		O (%)	Pt		
	Fe^{2+} (%)	Fe^{3+} (%)		Pt^0 (%)	Pt^{2+} (%)	Pt^{4+} (%)
Fe_3O_4	9.0	10.5	80.5	-	-	-
Pt/Fe_3O_4	6.8	10.4	81.3	0.9	0.4	0.2
Pt/Fe_3O_4-200	8.0	10.9	79.4	0.9	0.4	0.4
Pt/Fe_3O_4-400	7.2	9.5	81.6	0.7	0.4	0.6
Pt/Fe_3O_4-H_2	7.4	10.6	80.4	1.3	0.3	-

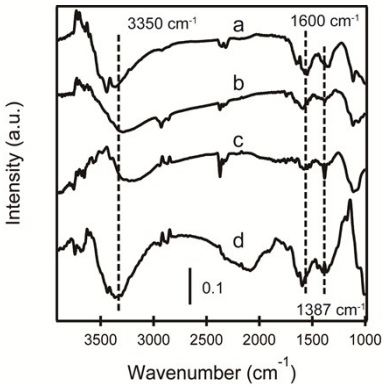

Fig. S12 FT-IR spectra of 1.4 wt% Pt/Fe_3O_4 catalyst (a) and Pt/Fe_3O_4-200 (b), Pt/Fe_3O_4-400 (c) and Pt/Fe_3O_4-H_2 (d).

The FT-IR spectra of 1.4 wt% Pt loaded catalyst pre-treated under different conditions were shown in Fig. S12. The broad and strong band at 2800-3800 cm^{-1} can be assigned as the stretching vibration of OH groups and adsorbed water on Fe_3O_4, and the less strong band centered at 1600 cm^{-1} can be ascribed to the deformation vibration of OH groups on carboxyl species. [1-3] In addition, the carbonate-type species appeared at 1387 cm^{-1}. The intensities of all these bands concerned with –OH groups decrease after that pre-treated at higher temperature, indicating the removal of physisorbed water and dehydroxylation. However, the intensity of these bands show slightly increases when the catalyst pretreated under H_2 atmosphere at 200 ^oC. This may attributed to the formation of H_2O which can be easily absorbed on the surface of the catalyst during the reduction process. This result is in agreement with the XPS analysis.

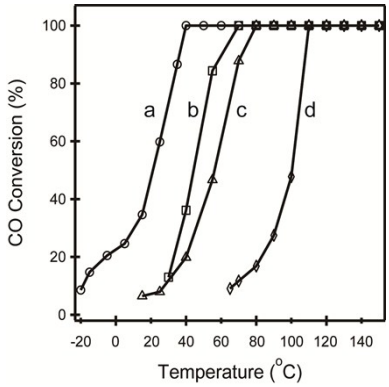

Fig. S13 Catalytic activities of 1.4 wt% Pt/Fe_3O_4 catalyst (a) and Pt/Fe_3O_4-200 (b), Pt/Fe_3O_4-400 (c) and Pt/Fe_3O_4-H_2 (d) under dry condition.

(Feed gas: 1.0 vol% CO, 20.0 vol% O_2 balanced with N_2; WHSV=15,000 ml/g/h)

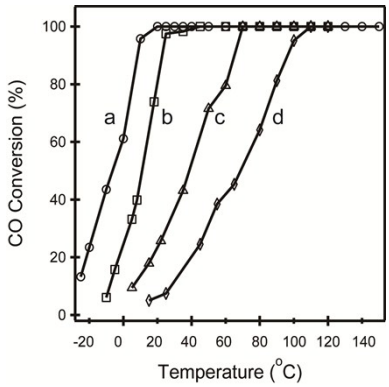

Fig. S14 Catalytic activities of 1.4 wt% Pt/Fe_3O_4 catalyst (a) and Pt/Fe_3O_4-200 (b), Pt/Fe_3O_4-400 (c) and Pt/Fe_3O_4-H_2 (d) under moisture condition.

(Feed gas: 1.0 vol% CO, 20.0 vol% O_2, 1.4 vol% H_2O balanced with N_2; WHSV=15,000 ml/g/h)

The catalytic performance clearly indicate that the catalyst without pre-treatment shows the higher catalytic activity for CO oxidation whatever under dry or moisture conditions.

5. The comparison of the present work with others

Table S2 Comparison of the catalyst performance over different noble-metal supported catalysts for CO oxidation reported previously

Catalysts	Noble metal loading (wt %)	CO/H_2O concentration (vol %)	Space velocity (ml $h^{-1}g_{cat}^{-1}$)	Temperature of 100% CO conversion (^oC)	Note
Pd/FeO_x	5.4	1.0/0.0	15,000	10	Ref 4
Pd/FeO_x	9.1	1.0/0.0	15,000	-20	Ref 4
Pt/Al_2O_3	0.4	1.0/0.0	15,000	150	Ref 5
Pt/SiO_2	2	1.0/0.0	15,000	> 100	Ref 6
Pt/TiO_2	1.0	1.0/0.0	15,000	27	Ref 6
Pt/NiO	1.0	0.5/1.8	120000	100	Ref.7
Pt/ZnO	1.0	0.5/1.8	120000	50	Ref.7
Pt/Al_2O_3	1.0	0.5/1.8	120000	80	Ref.7
Ir/FeO_x	1.2	1.0/0.0	18,000	40-70	Ref. 8
Pt_1/FeOx	2.5	1.0/0	18,750	~ 80	Ref. 9
Pt/Fe_3O_4	2.25	1.0/0	44,400	100	Ref. 10
Fe_3O_4	0	1.0/0.0	15,000	120	This work
Pt/Fe_3O_4	0.47	1.0/0.0	15,000	80	This work
Pt/Fe_3O_4	1.4	1.0/0.0	15,000	40	This work
Pt/Fe_3O_4	2.3	1.0/0.0	15,000	0	This work
Pt/Fe_3O_4-200	1.4	1.0/0.0	15,000	60	This work
Pt/Fe_3O_4-400	1.4	1.0/0.0	15,000	80	This work
Pt/Fe_3O_4-H_2	1.6	1.0/0.0	15,000	100	This work
Pt/Fe_3O_4	1.4	1.0/1.4	15,000	20	This work
Pt/Fe_3O_4-200	1.4	1.0/1.4	15,000	40	This work
Pt/Fe_3O_4-400	1.4	1.0/1.4	15,000	70	This work
Pt/Fe_3O_4-H_2	1.6	1.0/1.4	15,000	110	This work

6. The hysteresis loops of the Fe_3O_4 nanoparticles

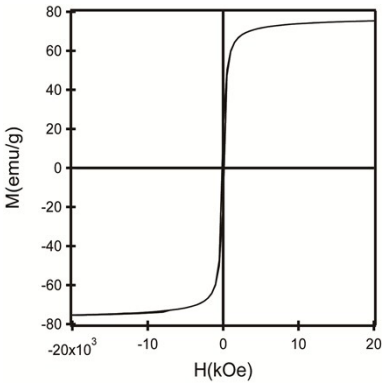

Fig. S15 Hysteresis loops of as prepared octahedral Fe_3O_4 nanoparticles measured at 300K.

Reference:

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