Supporting Information

Reaction of Methane with MO_x/CeO_2 (M= Fe, Ni, and Cu) Catalysts: In Situ Studies with Time-Resolved X-ray Diffraction

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Table S1. Linear combination fitting (LCF) of XANES spectrum for FeO_x/CeO_2 sample.

	Fe_2O_3 (%)	Fe_3O_4 (%)	R-factor	Chi-square
Fitting results	85.3+/-9.3	14.7+/-9.3	0.0038	0.0447

Table S2. EXAFS fitting of MO_x/CeO_2 (M = Fe, Co, Ni, and Cu) catalysts.

Samples	**Shells**	**Bond length**	**Coordination number**	**σ^2 ($Å^2$)**	**E0 shift (eV)**	**S_0^2**
	Cu-O	1.95+/-0.01	3.5+/-1.2	0.004	1.0	0.85
CuO_x/CeO_2	Cu-Cu	2.84+/-0.01	0.4+/-0.2	0.005		
	Ni-O	2.08+/-0.01	4.2+/-1.0	0.003	-0.4	0.76
NiO_x/CeO_2	Ni-Ni	2.98+/-0.01	9.5+/-2.0	0.006		
	Co-O	1.91+/-0.01	5.9+/-0.6	0.003		
CoO_x/CeO_2	Co-Co	2.86+/-0.01	5.7+/-0.9	0.005	0.7	0.64
	Co-Co	3.37+/-0.01	8.0+/-1.6	0.006		
	Fe-O	1.99+/-0.02	4.2+/-0.8	0.010		
FeO_x/CeO_2	Fe-Fe	3.04+/-0.02	4.7+/-2.2	0.019	0.5	0.71
	Fe-Fe	3.34+/-0.02	4.3+/-2.4	0.019		

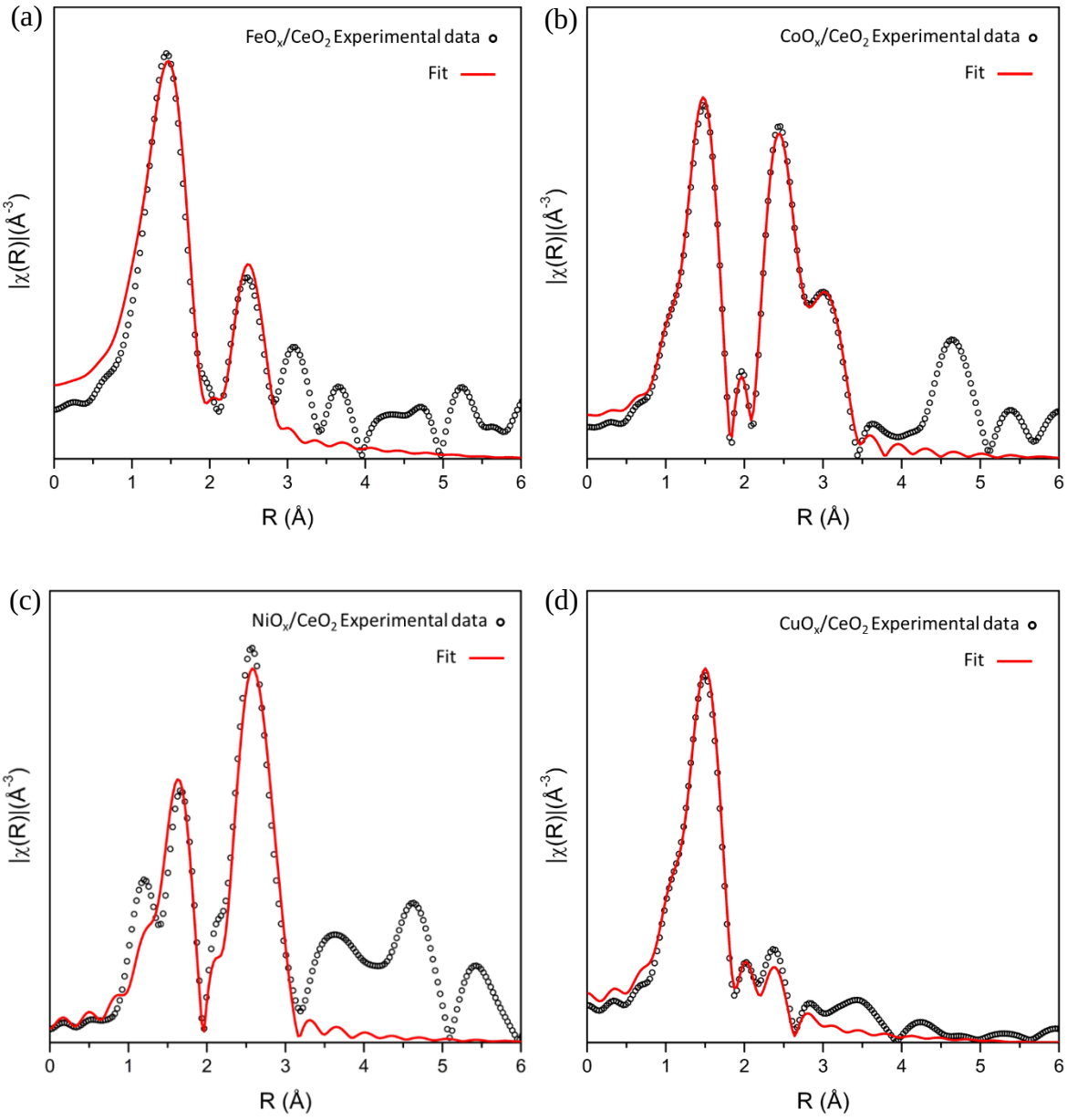

Figure S1. EXAFS fittings of the MO_x/CeO_2 (M = Fe, Co, Ni, and Cu) catalysts from (a) Fe K-edge, (b) Co K-edge, (c) Ni K-edge, (d) Cu K-edge. Red solid lines represent for the calculated fits for (a) Fe_2O_3, (b) Co_3O_4, (c) NiO, (d) CuO while circles in figure are from the experimental results.

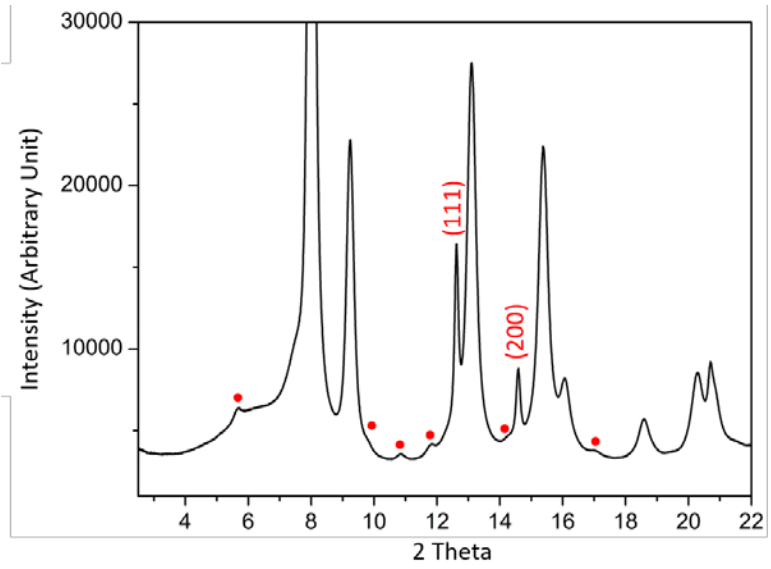

Figure S2. XRD pattern of 10 wt% NiO_x/CeO_2 catalysts at 700 °C during CH_4-TPR reaction. Characteristic peaks of the reduced metallic Ni phase are labelled in red and diffraction peaks marked with the red dots come from the Ce_2O_3 (Ia-3) phase.

Table S3. ICP-OES Results of Metal Phase Composition in the Prepared MO_x/CeO_2 Samples.

Metals	Fe	Co	Ni	Cu
Intended wt%	10	10	10	10
Measured wt%	9.94+/-0.03	10.7+/-0.02	9.69+/-0.01	9.58+/-0.01