Supporting Information for

Core−Shell Cu@(CuCo-alloy)/Al_2O_3 Catalysts for the Synthesis of Higher Alcohols from Syngas

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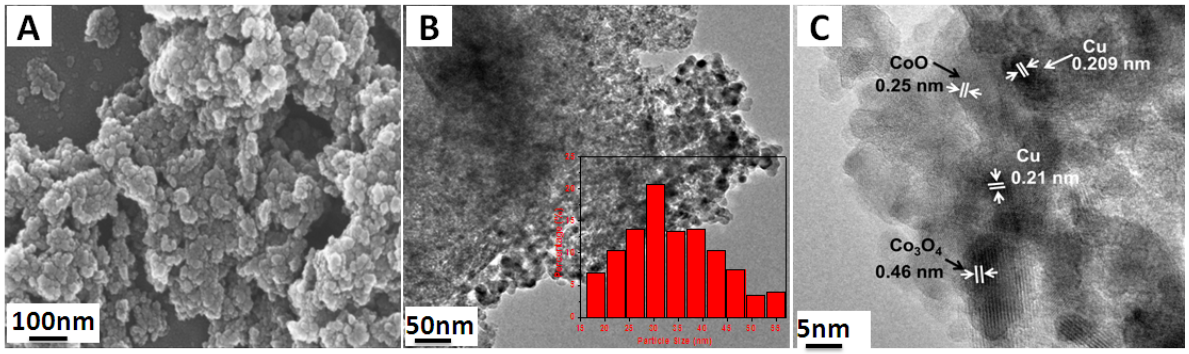

Fig. S1 (A) SEM image and (B, C) HRTEM images of the as-synthesized powdered-CuCo/Al_2O_3 (Cu/Co=1/2) sample. The inset in (B) shows the corresponding particle size distribution.

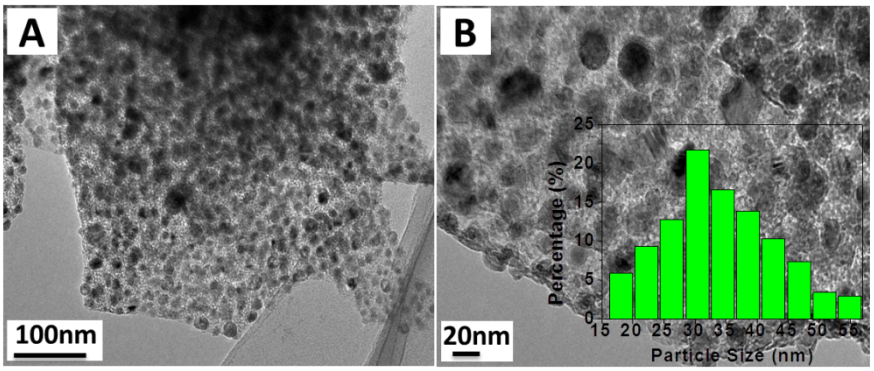

Fig. S2 HRTEM images of the used Cu@(CuCo-alloy)/Al_2O_3 (Cu/Co=1/2) catalyst. The inset shows the corresponding particle size distribution.

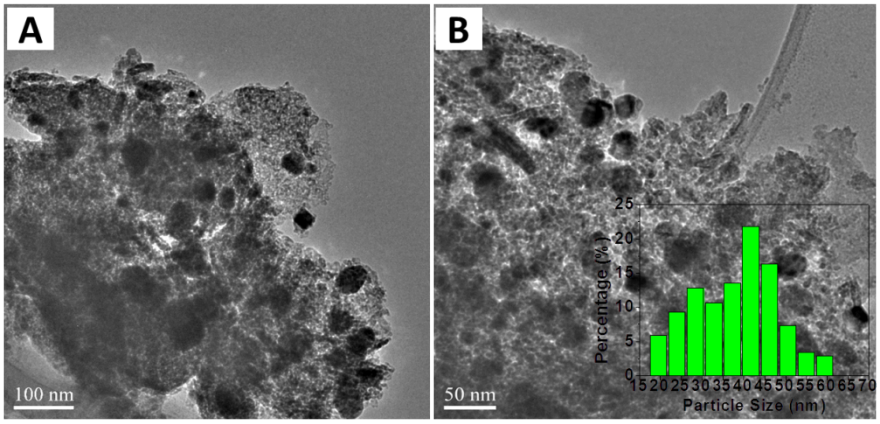

Fig. S3 HRTEM images of the used powdered-CuCo/Al_2O_3 (Cu/Co=1/2) catalyst. The inset shows the corresponding particle size distribution.

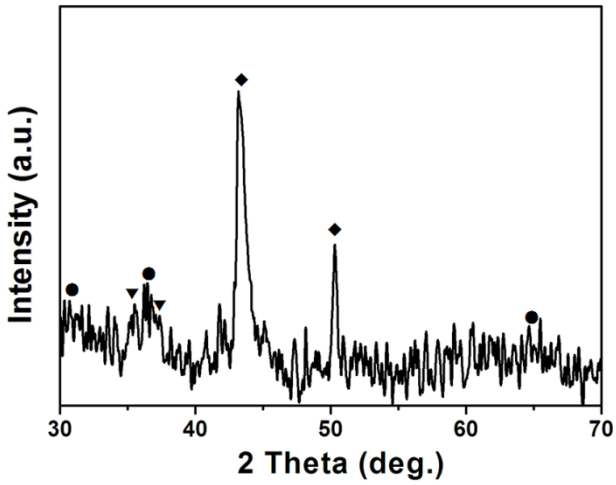

Fig. S4 XRD pattern of the used Cu@(CuCo-alloy)/Al_2O_3 (Co/Cu=1/2) catalyst. Crystalline phase: (♦) CuCo alloy, (▼) CuO, (●) Co_3O_4.

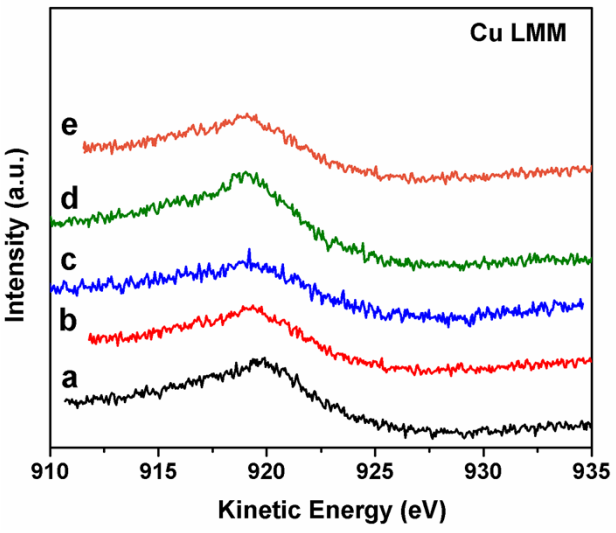

Fig. S5 Cu LMM XAES spectra of Cu/Al_2O_3 and Cu@(CuCo-alloy)/Al_2O_3 samples with various Cu/Co ratios: (a) Cu/Al_2O_3, (b) Cu/Co=5/1, (c) Cu/Co=2/1, (d) Cu/Co=1/2, (e) Cu/Co=1/5.

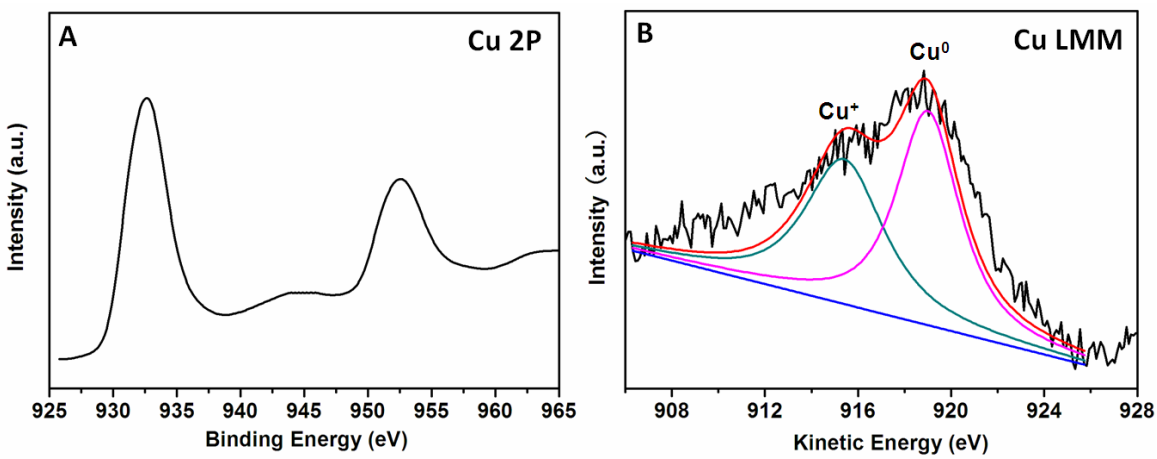

Fig. S6 Cu XPS spectra of the used Cu@(CuCo-alloy)/Al_2O_3 (Co/Cu=1/2) catalyst.

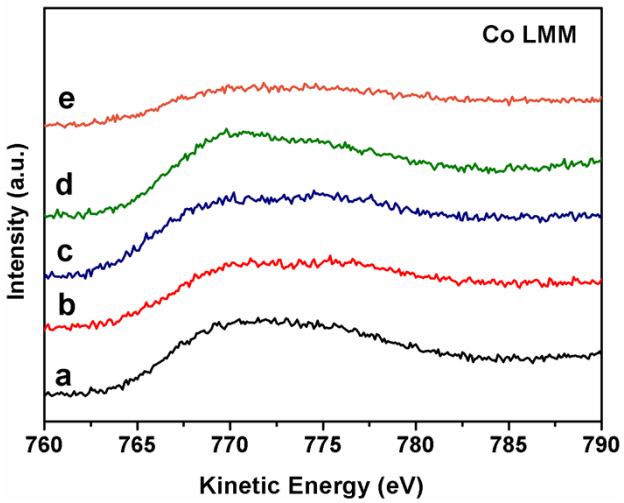

Fig. S7 Co LMM XAES spectra of Co/Al_2O_3 and Cu@(CuCo-alloy)/Al_2O_3 samples with various Cu/Co ratios: (a) Co/Al_2O_3, (b) Cu/Co=1/5, (c) Cu/Co=1/2, (d) Cu/Co=2/1, (e) Cu/Co=5/1.

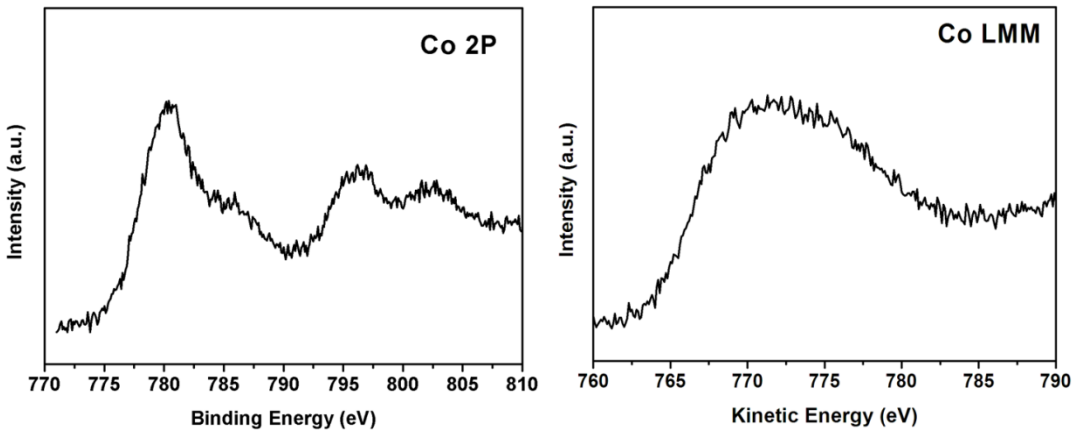

Fig. S8 Co XPS spectrum of the used Cu@(CuCo-alloy)/Al_2O_3 (Co/Cu=1/2) catalyst.

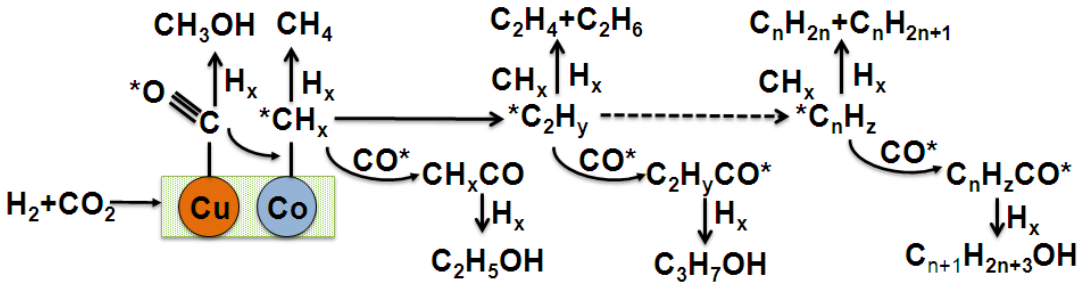

Fig. S9 Reaction pathway for CO hydrogenation over CuCo-based catalyst.[1-3]

Table S1. The nominal and determined metal contents in the Cu@(CuCo-alloy)/Al_2O_3 samples with various Cu/Co ratios and the powdered-CuCo/Al_2O_3 (Cu/Co=1/2) sample

Catalyst	Nominal ratio (Cu/Co)	Determined ratio (Cu/Co)	Metal content (wt.%)	
			Cu	Co
Co/Al_2O_3	–	–	–	29.6
Cu/Co (5/1)	5/1	4.81/1.00	52.8	7.7
Cu/Co (2/1)	2/1	1.96/1.00	49.7	23.6
Cu/Co (1/2)	1/2	1.00/2.63	24.1	39.8
Cu/Co (1/5)	1/5	1.00/4.63	11.3	49.5
Cu/Al_2O_3	–	–	30.9	–
powdered-$CuCo/Al_2O_3$(1/2)	1/2	1.00/2.28	20.6	42.8

Table S2. Cu, Co $2p_{3/2}$ and Cu, Co LMM peak maximum and Modified Auger parameter (α')

	Cu/Al_2O_3	Cu/Co (5/1)	Cu/Co (2/1)	Cu/Co (1/2)	Cu/Co (1/5)	Co/Al_2O_3	Used Cu/Co (1/2)
Cu $2p_{3/2}$ peak Maximum E_b/eV	931.9	932	932.1	932.2	932.4	–	932.3
Cu LMM Auger peak Maximum E_k/eV	919.4	919.3	919.18	919.03	918.8	–	918.9
Modified Auger parameter (α')/eV	1851.3	1851.3	1851.28	1851.23	1851.2	–	1851.2
Co $2p_{3/2}$ peak Maximum E_b/eV	–	781.2	780.0	780.1	780.3	780.9	780.5
Co LMM Auger peak Maximum E_k/eV	–	770.9	770.8	771.0	771.1	771.3	771.1
Modified Auger parameter (α')/eV	–	1552.1	1550.9	1551.0	1551.3	1552.2	1551.6

References:

1 J. J. Spivey and A. Egbebi, *Chem. Soc. Rev.*, 2007, **36**, 1514.

2 V. Subramani and S. K. Gangwal, *Energy Fuels*, 2008, **22**, 814.

3 K. Fang, D. Li, M. Lin, M. Xiang, W. Wei and Y. Sun, *Catal. Today*, 2009, **147**, 133.