Supporting Information

Synthesis of Bimetallic Au-Ag/CMK-3 Catalysts and Their Catalytic Activity for the Oxidation of Amino Alcohol

Xiangzhan Meng,[a,b] Ruiyi Yan,[b] Shouwei Zuo,[d] Yongqiang Zhang,[a,b] Zengxi Li[a,*], and Hui Wang[b,c,*]

[a] School of Chemical Sciences, University of Chinese Academy of Sciences, Beijing 100049, P.R. China

[b] Beijing Key Laboratory of Ionic Liquids Clean Process, CAS Key Laboratory of Green Process and Engineering, State Key Laboratory of Multiphase Complex Systems, Institute of Process Engineering, Chinese Academy of Sciences, Beijing 100190, P.R. China

[c] Innovation Academy for Green Manufacture, Chinese Academy of Sciences, Beijing 100190, P.R. China

[d] Beijing Synchrotron Radiation Facility, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, P. R. China

[*]Corresponding authors: lizengxi@ucas.ac.cn (Z. Li), huiwang@ipe.ac.cn (H. Wang)

Characterizations

The specific surface area (S_{BET}), pore volume, and average pore size were measured at 77 K from the N_2 adsorption-desorption isotherm on a Micromeritics ASAP 2460 apparatus. The powder X-ray diffraction (XRD) patterns were recorded on a Rigaku RINT 2500 diffractometer using monochromated Cu Kα radiation (λ =1.54060 Å) at 30 kV and 15 mA. X-ray photoelectron spectra (XPS) were recorded on a PHI-5400 spectrometer with an Al Kα source. The binding energy scale was calibrated relative to the C 1s peak (285.0 eV) of contaminant carbon. The transmission electron microscopy (TEM) images were collected using a JEOL JEM-2100F operated at 200 kV. Samples were deposited on the TEM grids after dispersion in ethanol. The atomically resolved high-angle annular dark field scanning transmission electron microscopy (HAADF-STEM) images were taken on a JEM-ARM300F instrument operated at 80 kV. The Au loading in the catalysts was determined by inductively coupled plasma optical emission spectroscopy (ICP-OES) using an IRIS Intrepid II XSP (Thermofisher, USA). The total Ag/Au ratio was obtained by Oxford Aztec energy dispersive X-ray spectroscopy (EDS) system.

X-ray absorption fine structure (XAFS) measurements for the Au L_3-edge were performed in the transmission and fluorescence modes at room temperature with the XAFS station of the 1W1B beamline of Beijing Synchrotron Radiation Facility (BSRF, Beijing, China). XAFS data were analyzed using IFEFFIT software package [1]. Temperature-programmed desorption of hydrogen (H_2-TPD) experiments were performed on a Micromeritics Autochem 2920 (Micromeritics, USA) equipped with a TILON LC-D200 mass spectroscopy system in real-time as the detector. The loading of each sample was 126 ± 2 mg and the catalysts were treated in the reactor in a gas mixture of H_2 and Ar (1:9, v/v) at 323 K for 60 min. Subsequently, Ar was flowed into the reactor at 323 K for 30 min to remove physisorbed and/or weakly bound species. After flushing with Ar until a stable baseline was obtained, the temperature was raised to 1073 K with a heating rate of 10 K min^{-1} and the H_2 desorption profiles were measured online by fixing the *m/z* signal at 2. ^{1}H NMR spectra were recorded on a

Bruker AVANCE III HD NMR spectrometer operating at 600 MHz.

All the samples were characterized by the above methods after preparation without handling, unless otherwise noted.

Textural properties of 10Ag90Au/CMK-3 with different total metal loadings

Table S1. Textural properties of 10Ag90Au/CMK-3 with different total metal loadings.

Loading (wt%)	**S_{BET} ($m^2 g^{-1}$)**	**Pore volume ($cm^3 g^{-1}$)**	**Pore diameter (nm)**
0	1190	1.41	5.16
1	1156	1.40	5.19
3	1064	1.31	5.21

H_2-TPD of 10Ag90Au/ZrO_2 and ZrO_2

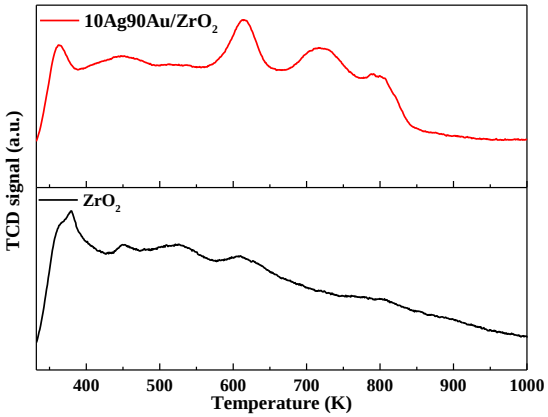

Figure S1. H_2-TPD profiles of the prepared 10Ag90Au/ZrO_2 catalyst and ZrO_2 support.

H_2-TPD of the prepared catalysts recorded by TCD detector

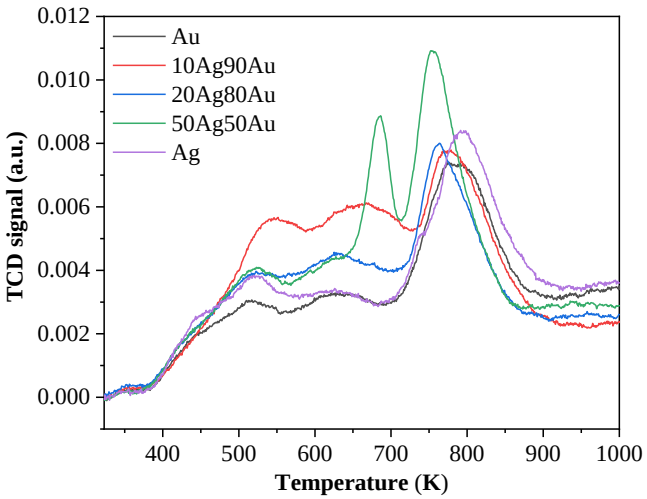

Figure S2. H_2-TPD profiles of the prepared catalysts (the catalyst support sign was not included in the legends for simplicity).

Table S2. Comparison of integral peak areas of H_2-TPD profiles shown in Figure S2 and the calculated results of desorption amount of H_2 based on H_2-TPD-MS of the prepared catalysts shown in Table 2 (the catalyst support sign was not included in the legends for simplicity).

Catalysts	**Integral peak area**	**Desorption amount of H_2 shown in Table 2 (μmol/g)**
Au/CMK-3	0.97	0
10Ag90Au/CMK-3	1.88	2.97
20Ag80Au/CMK-3	1.36	2.61
50Ag50Au/CMK-3	1.59	2.70
Ag/CMK-3	1.14	0

More HADDF-STEM images of 10Ag90Au/CMK-3

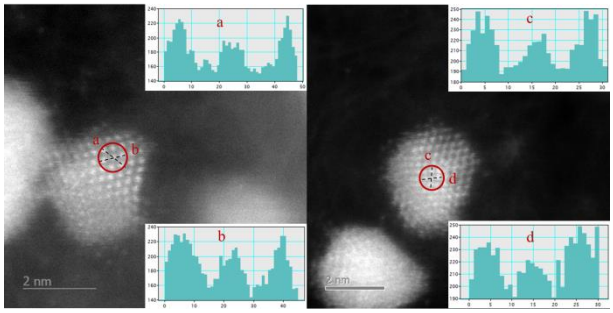

Figure S3. Typical HADDF-STEM images of Au-Ag alloy nanoparticles of 10Ag90Au/CMK-3 (surface isolated atomic sites on fcc (111) were marked with red cycles, and inserted graphs of a, b, c, and d showed the integrated pixel intensity along the black lines of a, b, c, and d, respectively.)

Kinetic data

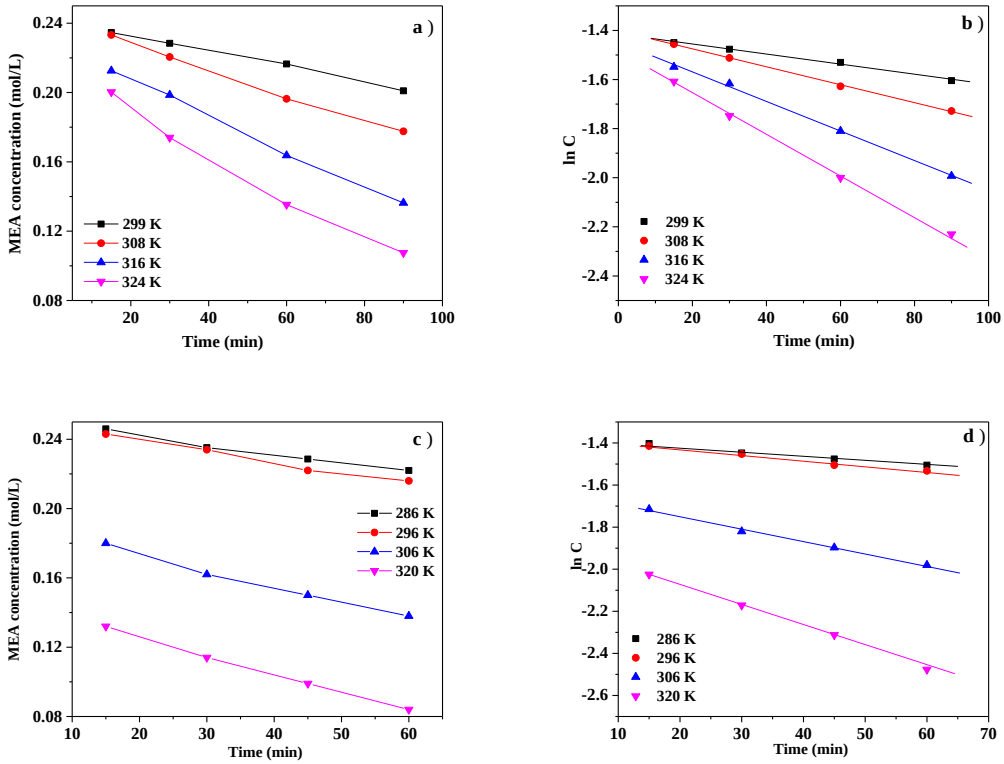

Figure S4. a) Change of C_{MEA} with reaction time at different temperatures over Au/CMK-3; b) change of ln(C_{MEA}) with reaction time at different temperatures over Au/CMK-3; c) change of C_{MEA} with reaction time at different temperatures over 10Ag90Au/CMK-3; d) change of ln(C_{MEA}) with reaction time at different temperatures over 10Ag90Au/CMK-3.

Table S3. Linear regression results of the data in Figure S4 b) and d).

Catalyst	Temperature (K)	Regressive equation	R^2
Au/CMK-3	299	y=-0.00204x-1.41576	0.989
	308	y=-0.00365x-1.40293	0.998
	316	y=-0.00602x-1.44827	0.997
	324	y=-0.00827x-1.49378	0.998
10Au90Au/CMK-3	286	y=-0.002x-1.38581	0.980
	296	y=-0.00342x-1.35066	0.980
	306	y=-0.00583x-1.63463	0.993
	320	y=-0.00998x-1.87226	0.999

References

1. Newville, M., IFEFFIT: interactive XAFS analysis and FEFF fitting. *J. synchrotron radiat.* **2001,** 8, (2), 322-324.