Electronic Supplementary Material (ESI) for Green Chemistry

Electronic Supplementary Information

An Excellent Au/meso-γ-Al_2O_3 Catalyst for Aerobic Selective Oxidation of Alcohols

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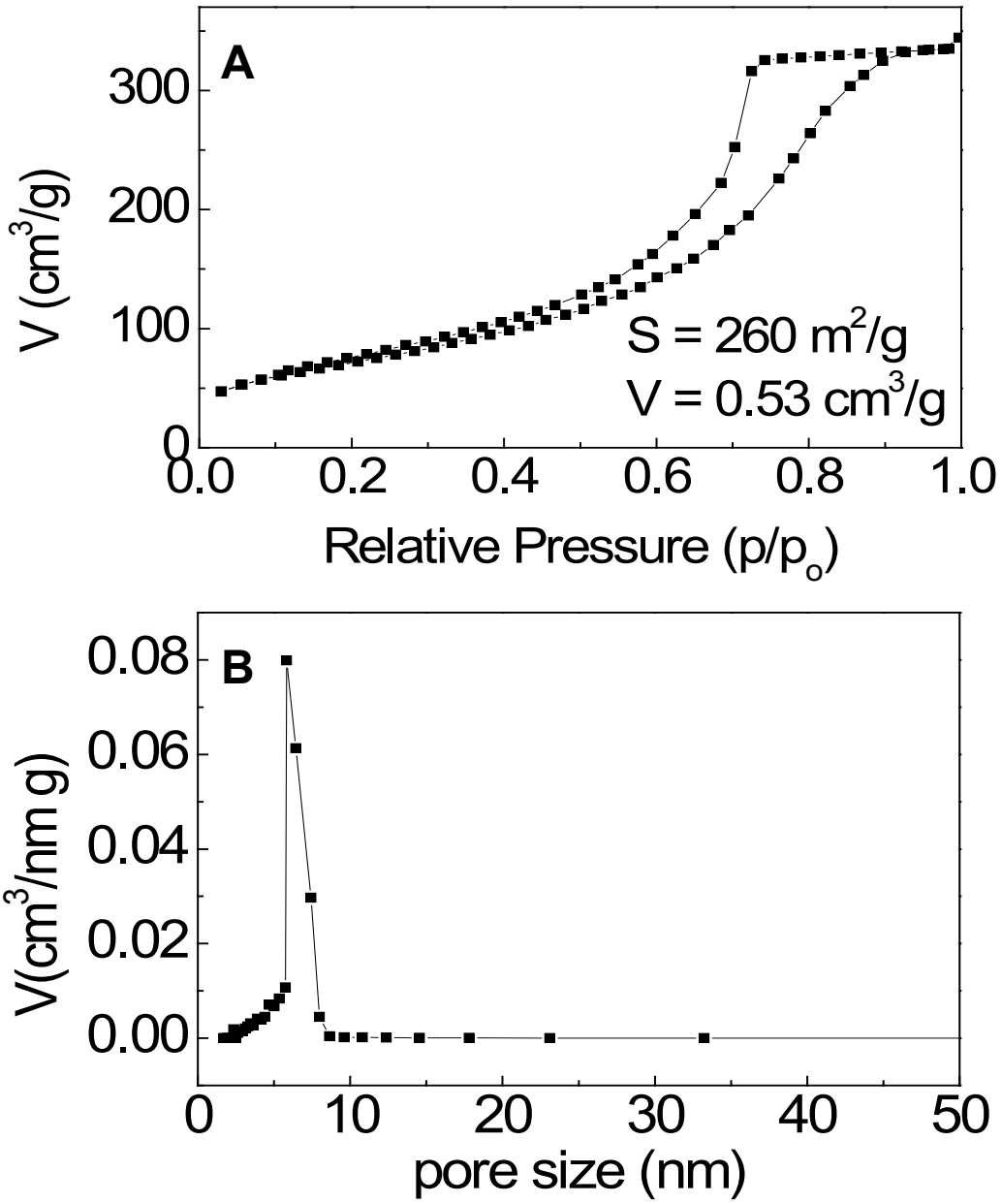

Figure S1. N_2 adsorption/desorption isotherms (A) and pore size distributions (B) of home-made mesoporous γ-Al_2O_3 (denoted as meso-AlO)

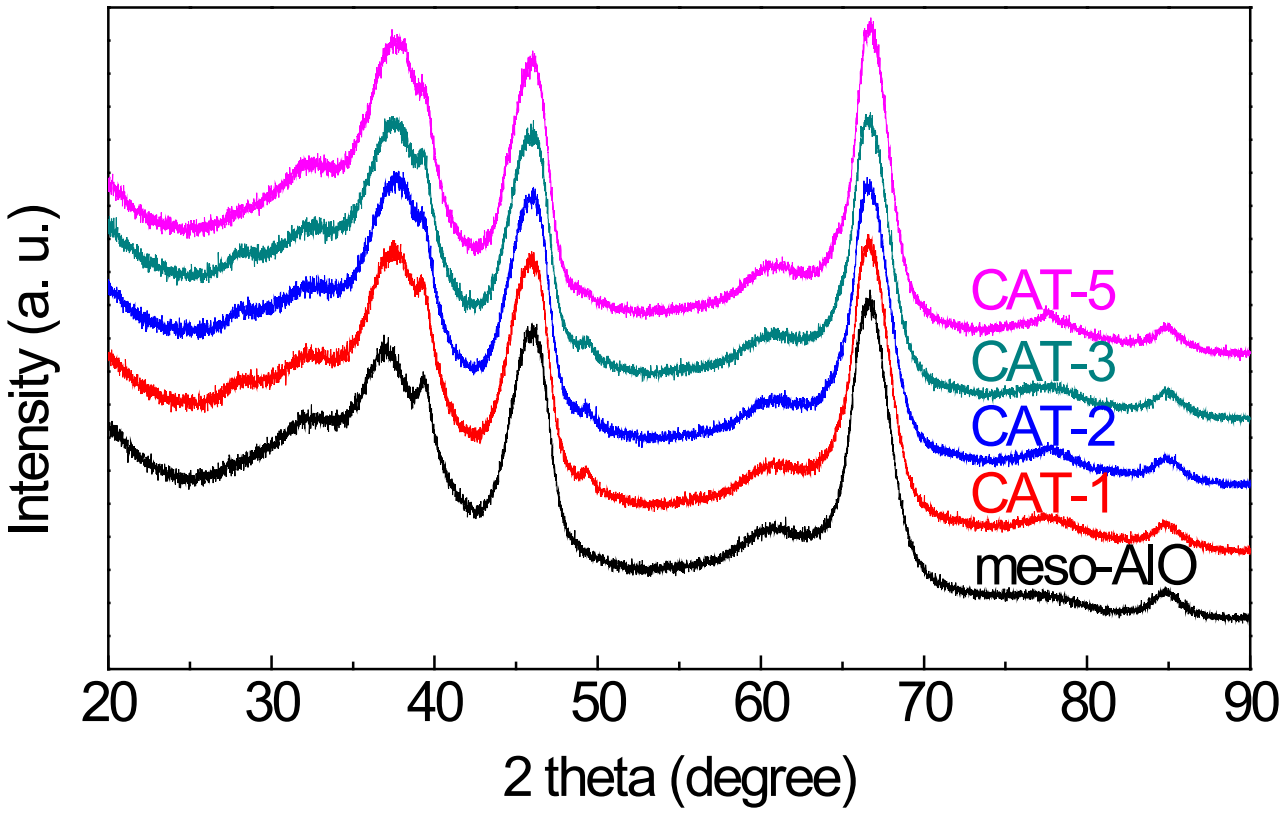

Figure S2. XRD patterns of the home-made meso-AlO and various catalysts with different benzyl alcohol conversion (Home-made meso-AlO; CAT-1 with benzyl alcohol conversion of 99%; CAT-2 with 62%; CAT-3 with 45%; CAT-7 with 25%). The four catalysts are same as in Table 1 in manuscript.

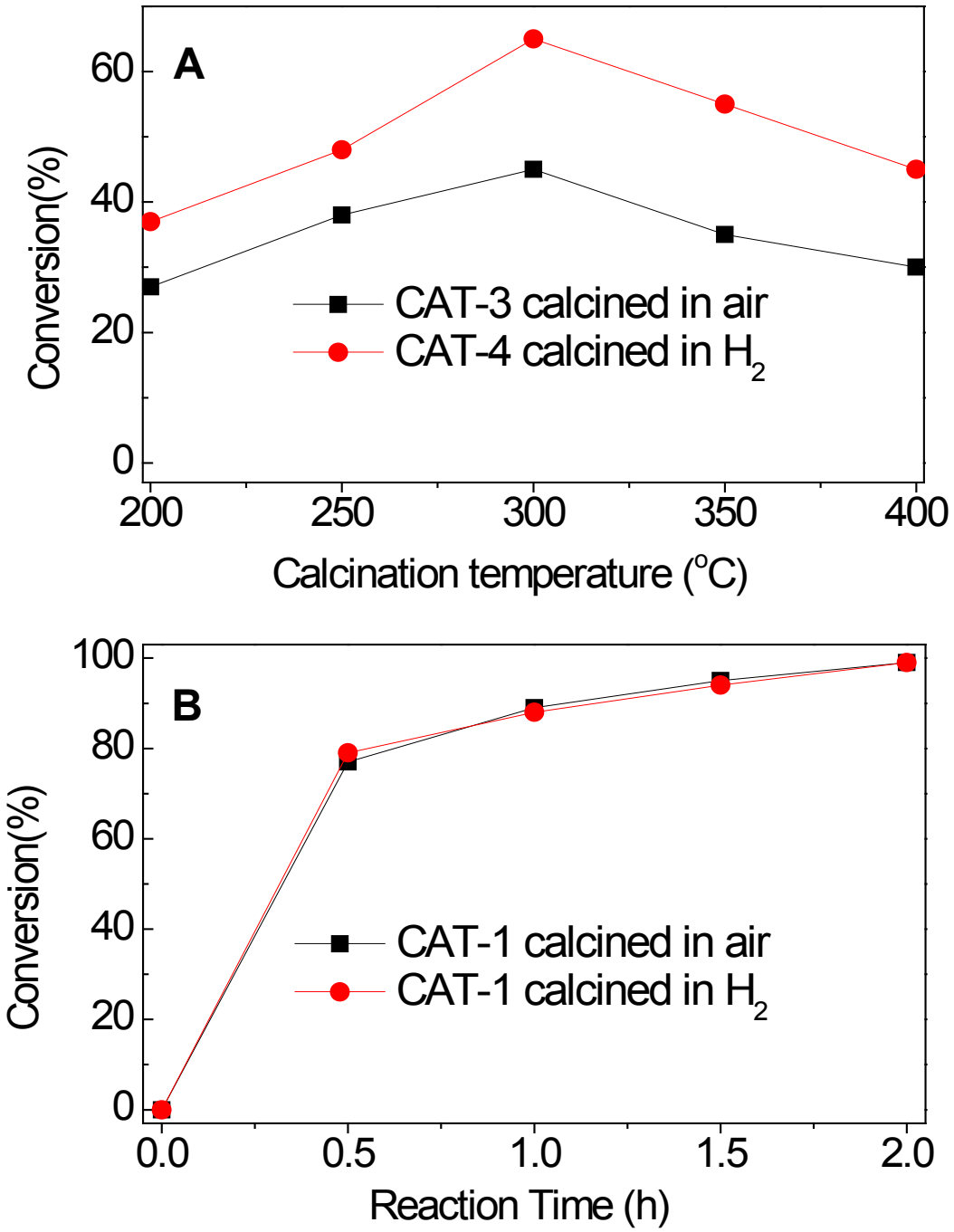

Figure S3. The liquid-phase oxidation of benzyl alcohol catalyzed by several catalysts. (A) The CAT-3 and CAT-4 catalysts are the same samples in Table 1 in manuscript. All the preparations were performed in the absence of natural light; (B) Benzyl alcohol conversion as a function of time over the catalysts CAT-1 and CAT-3 (same as in Table 1 in manuscript), which are calcined in air and H_2 respectively. Reaction conditions: benzyl alcohol of 1 mmol, catalyst of 0.1 g, toluene as solvent of 10 ml, reaction temperature of 80 ^{o}C, O_2 bubbling rate of 20 ml·min^{-1}.

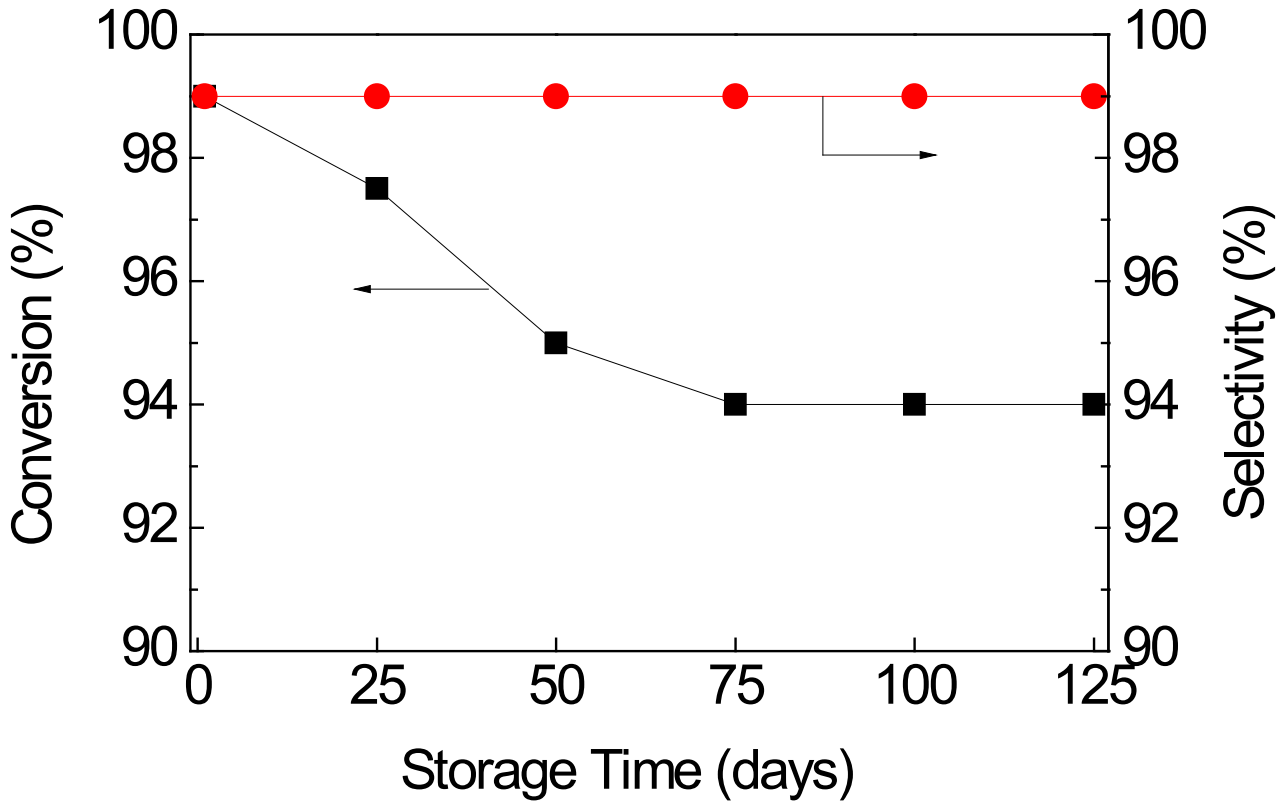

Figure S4. The catalytic activity of the CAT-1 catalyst (same sample in Table 1 in manuscript) as a function of the storage time. Reaction conditions: benzyl alcohol 1 mmol, toluene 10 ml as solvent, CAT-1 0.1 g, reaction temperature 80 ^{o}C, reaction time 2 h, and O_2 bubbling rate 20 ml·min^{-1}.

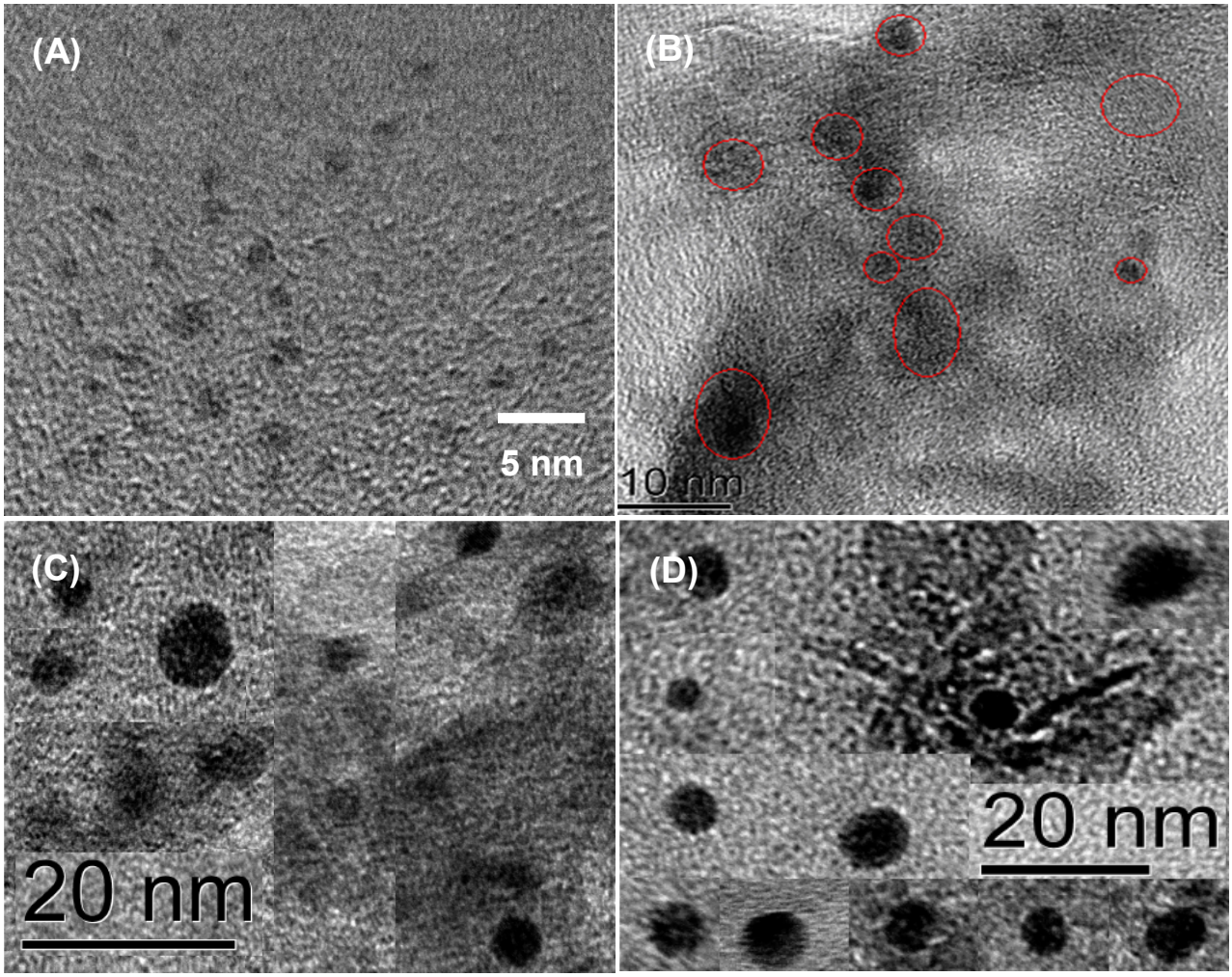

Figure S5. TEM images. (A) CAT-1: benzyl alcohol conversion of 99%; (B) CAT-2: benzyl alcohol conversion of 62%; (C) CAT-3: benzyl alcohol conversion of 45%; (D) CAT-7: benzyl alcohol conversion of 25%. Reaction conditions: benzyl alcohol 1 mmol, toluene 10 ml as solvent, catalyst of 0.1 g, reaction temperature 80 ^{o}C, reaction time 2 h, and O_2 bubbling rate 20 ml·min^{-1}. Note: (1) The four samples are the same as in Table 1 in manuscript; (2) The Figures (C) and (D) were made up from several photos on the same sample with same scale.

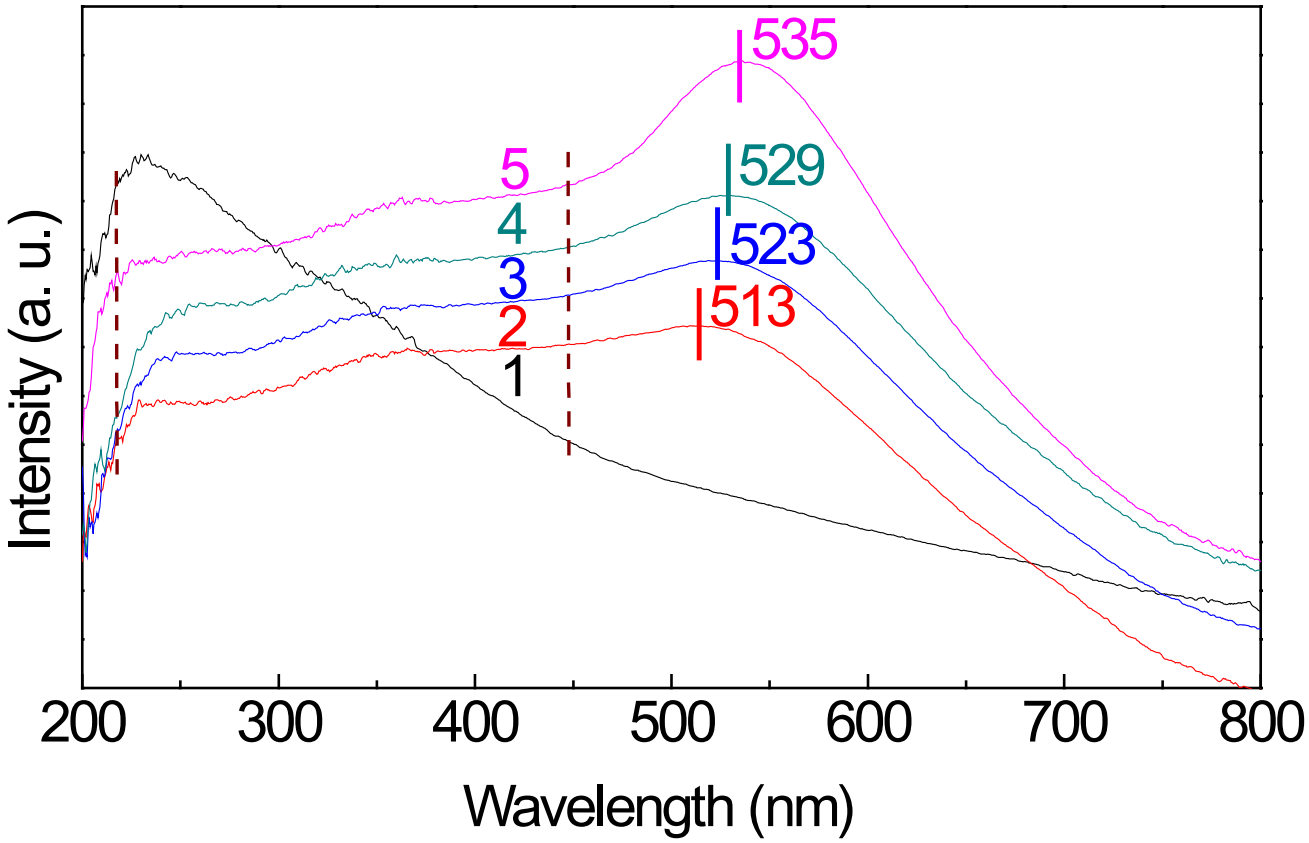

Figure S6. Uv-vis spectra of various catalysts. (1) the freshly prepared CAT-1 before calcination; (2) CAT-1 with benzyl alcohol conversion of 99%; (3) CAT-2 with 62%; (4) CAT-3 with 45%; (5) CAT-7 with 25%. The four catalysts are same as in Table 1 in manuscript.

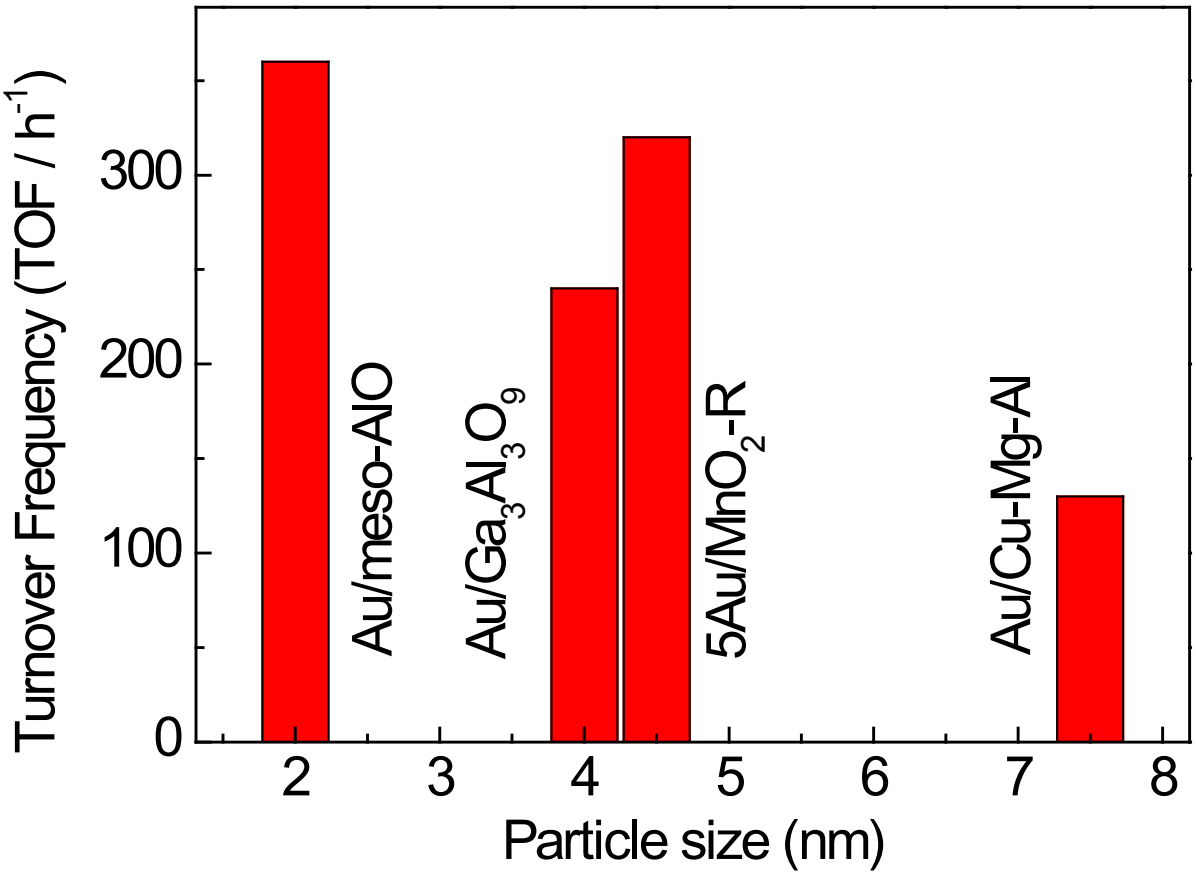

Figure S7. Turnover frequency (TOF) as a function of the gold particle size over various catalysts. Reaction conditions for the catalysts: ***(1) Au/meso-AlO*** (~2 nm): benzyl alcohol of 1 mmol, catalyst of 0.1 g with gold loading of 1 wt%, toluene as solvent of 10 ml, O_2 bubbling rate of 20 ml·min^{-1}. At 80 ^{o}C and 90 ^{o}C, TOF is 297 and 360 h^{-1}, respectively, but for simplicity, only TOF at 90 ^{o}C is shown in this figure. ***(2) Au/Ga$_3$Al$_3$O$_9$*** (~4 nm) [S1]: benzyl alcohol of 1 mmol, catalyst of 0.1 g with gold loading of 1 wt%, toluene as solvent of 10 ml, O_2 bubbling rate of 20 ml·min^{-1}, and reaction temperature of 80 ^{o}C. ***(3) 5Au/MnO$_2$-R*** (~4.5 nm) [S2]: 120 ^{o}C, 0.3 MPa, 0.2 g catalyst and 200 mmol benzyl alcohol. ***(4) Au/Cu-Mg-Al*** (~7.5 nm) [S3]: 90 ^{o}C, 50 ml/min O_2, 50 mg catalyst, 2 ml mesitylene. Substrate/Au molar ratio is 397.

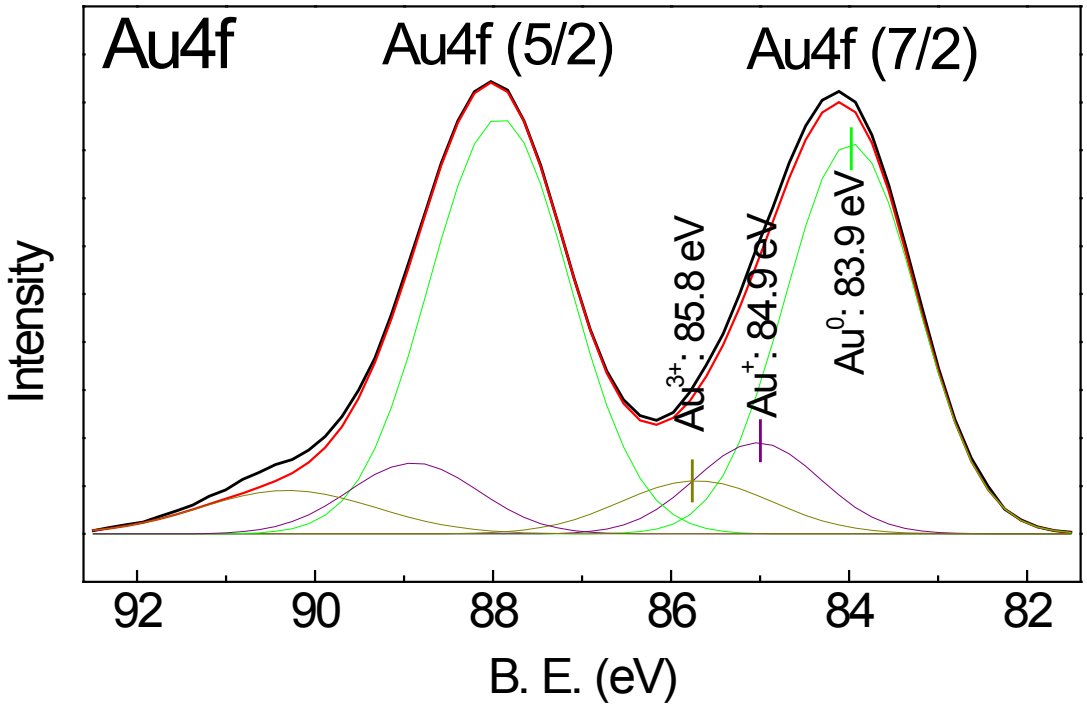

Figure S8. Representative XPS spectra of CAT-1 in Au 4f region. The CAT-1 is the same sample in Table 1 in manuscript.

Table S1. Liquid-phase oxidation of various alcohols, catalyzed by CAT-1. [a]

Substrate	Product	Reaction time (h)	Conversion (%)	Selectivity (%)
1-phenylethanol	Acetophenone	2	99	99
2-phenylethanol	phenylacetaldehyde	3	30	99
1-octanol	Octanal	3	37	98
2-octanol	2-octanone	3	20	98
cyclopropanemethanol	Cyclopropanecarboxaldehyde	2	60	98
cyclohexanol	Cyclohexanone	2	58	98
crotyl alcohol	Crotonaldehyde	2	94	99

[a] The catalyst-preparation conditions: light-free DPU, DPU time of 4.5 h, DPU temperature of 90 ^{o}C, urea/Au molar ratio of 100, and calcination in air at 300 ^{o}C for 4h if not specified. The catalyst-test conditions: Alcohol of 1 mmol, reaction temperature of 80 ^{o}C, O_2 bubbling rate of 20 ml/min.

Reference

[S1] F. Z. Su, Y. M. Liu, L. C. Wang, Y. Cao, H. Y. He and K. N. Fan, *Angew. Chem. Int. Ed.*, 2008, **47**, 334.

[S2] L. C. Wang, L. He, Q. Liu, Y. M. Liu, M. Chen, Y. Cao, H. Y. He and K. N. Fan, *Appl. Catal. A: Gen.*, 2008, **344**, 150.

[S3] P. Haider and A. Baiker, *J. Catal.*, 2007, **248**, 175;