Supplementary information

# Insight into the chemical adsorption properties of CO molecules on supported Au or Cu and hybridized Au-CuO nanoparticles

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# Supplementary information

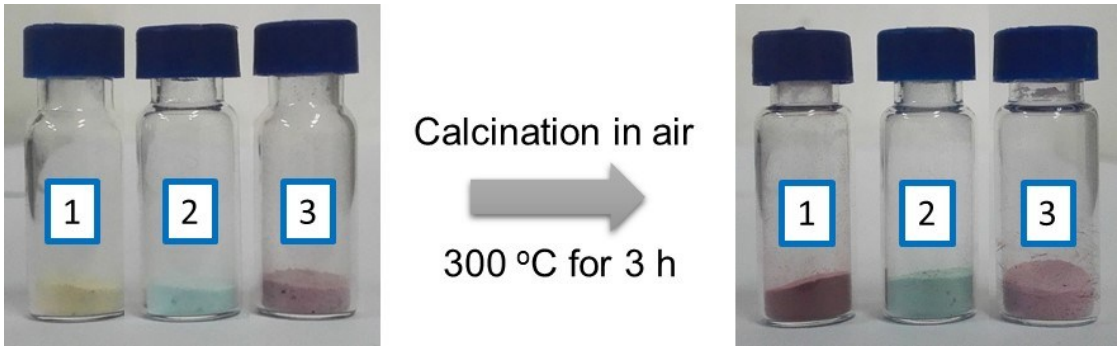


**Figure S1.** Photos displaying the distinctive colors of samples before and after calcination process.

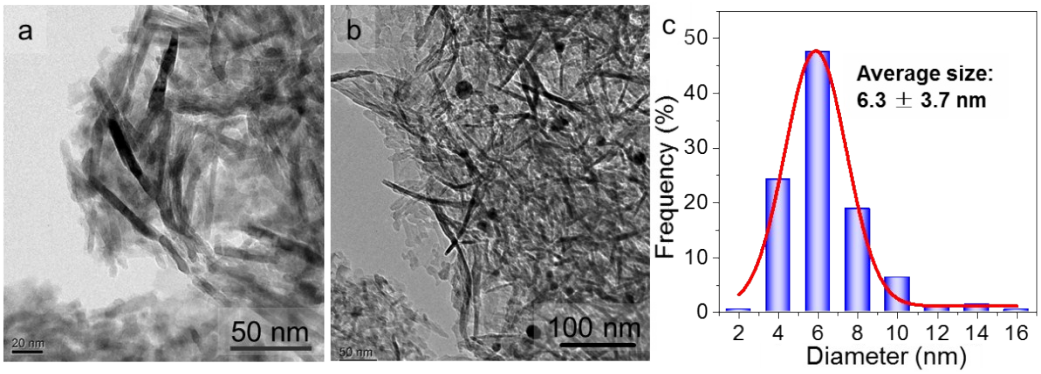


**Figure S2**. TEM images of CuO/AO (a), Au/AO (b), and size distribution of gold nanoparticles in Au/AO (c).

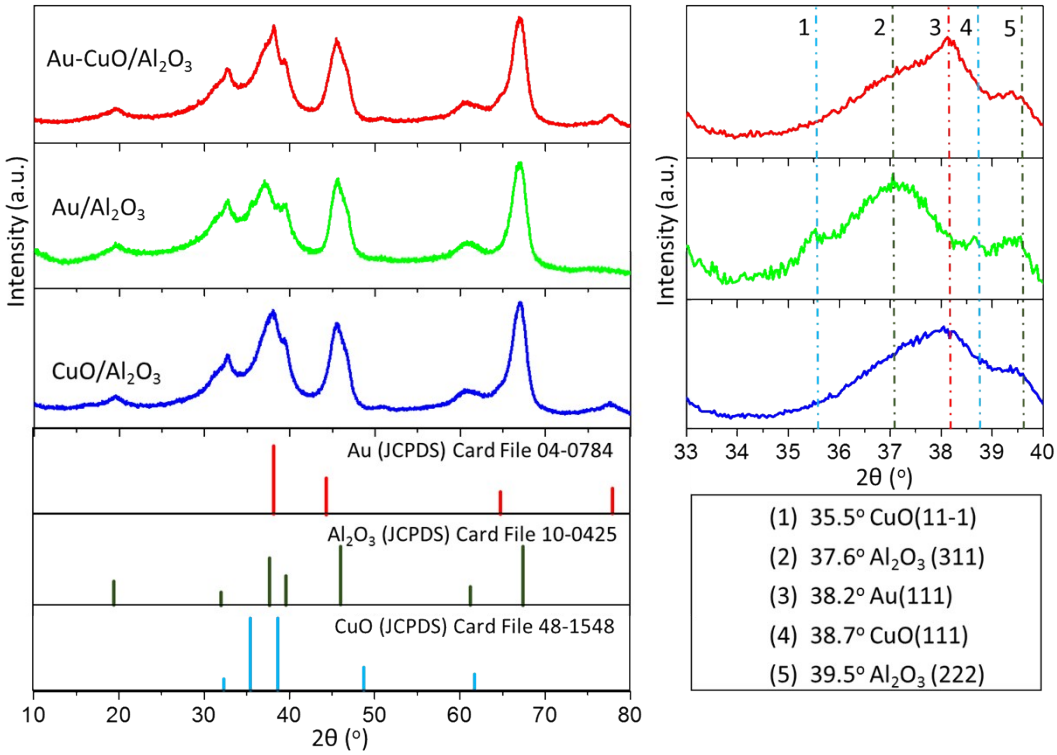


**Figure S3.** XRD patterns of typical samples (left) and zoomed spectra in the range of 33-40° (right).

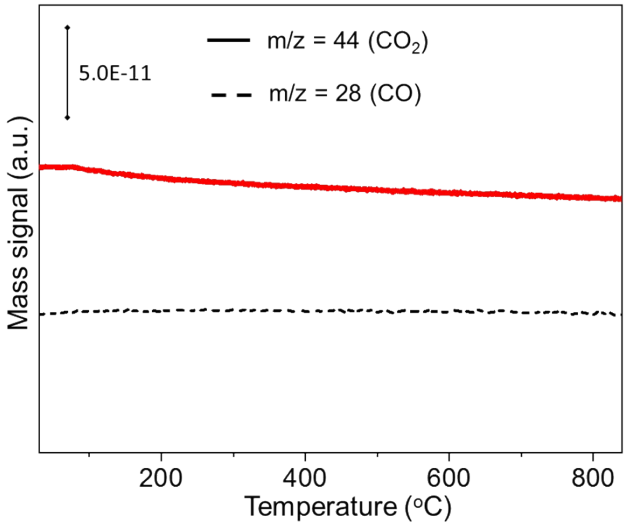


**Figure S4**. CO-TPD profiles of pure $Al_2O_3$ powder. The deposition compounds are monitored with m/z intensity of 28 and 44 for CO and $CO_2$, respectively, at a heating rate of 5 °C $min^{-1}$ in helium.

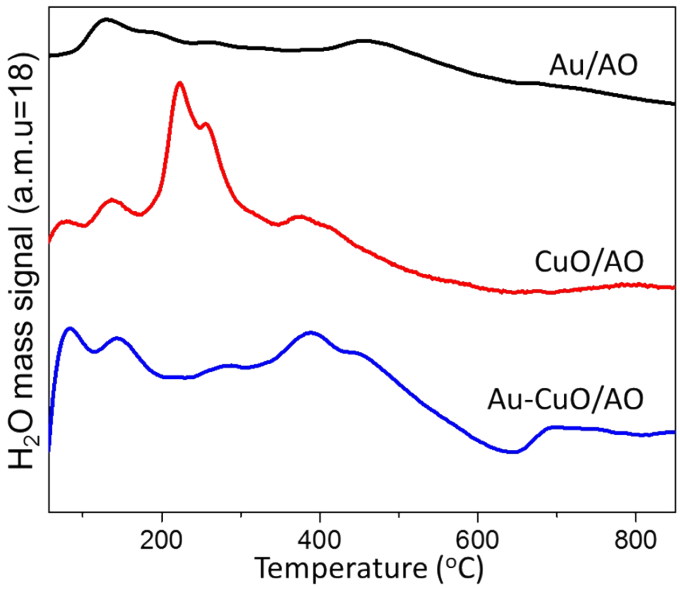


**Figure S5**. $H_2$-TPR profiles of the Au/AO, CuO/AO and Au-CuO/AO catalysts. The reduction compounds are monitored by mass spectroscopy with m/z intensity of 18 for $H_2O$, at a heating rate of 10 $^oC \cdot min^{-1}$ in 5% $H_2$ balanced with helium.

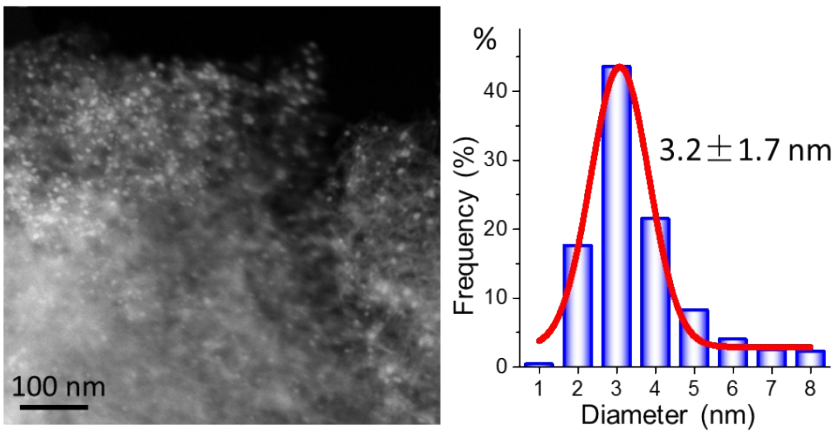


**Figure S6**. STEM image and size distribution of Au/AO-$_{3.2}$ with smaller AuNPs.

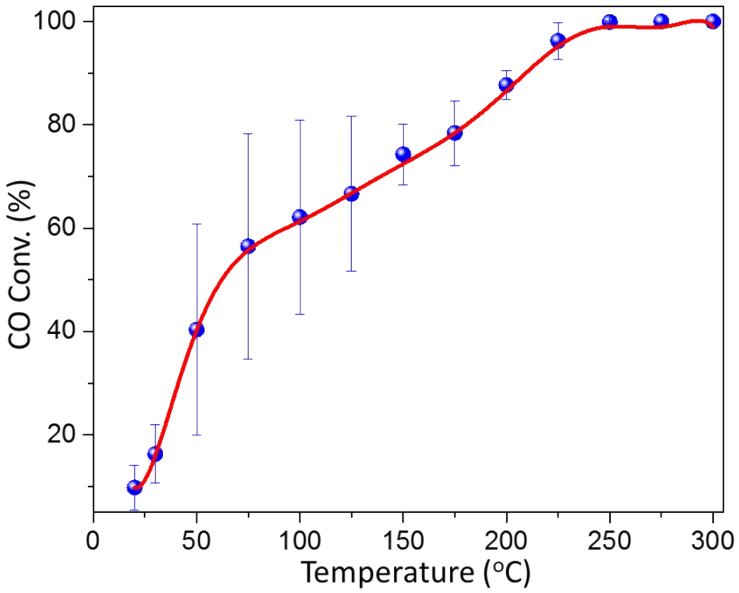


**Figure S7**. CO conversion over three catalysts in CO oxidation as a function of reaction temperature. Conditions: Gas flow rate of 20 ml·min$^{-1}$, 50 mg catalyst, 1 vol % CO in air. The error bars were marked based on three continuous reaction cycles from room temperature to 300 °C.

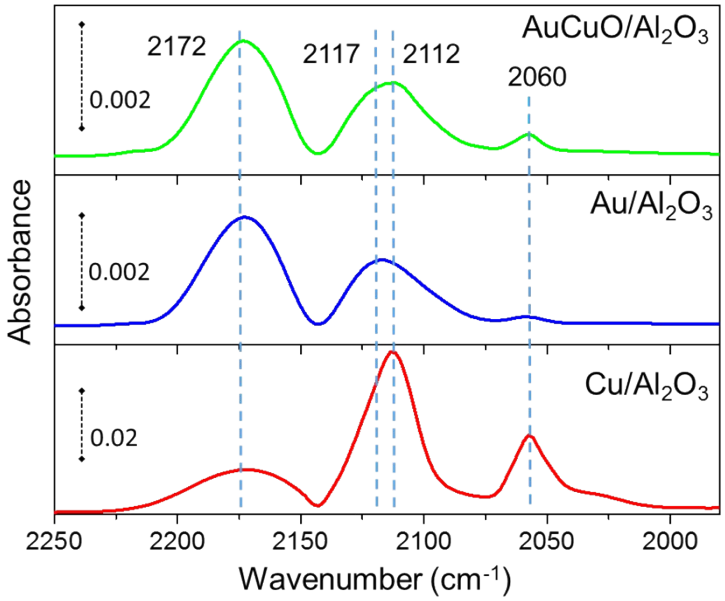


**Figure S8.** FT-IR spectra of different samples as CO adsorption for 30 min in the range of 2250-1980 cm$^{-1}$.

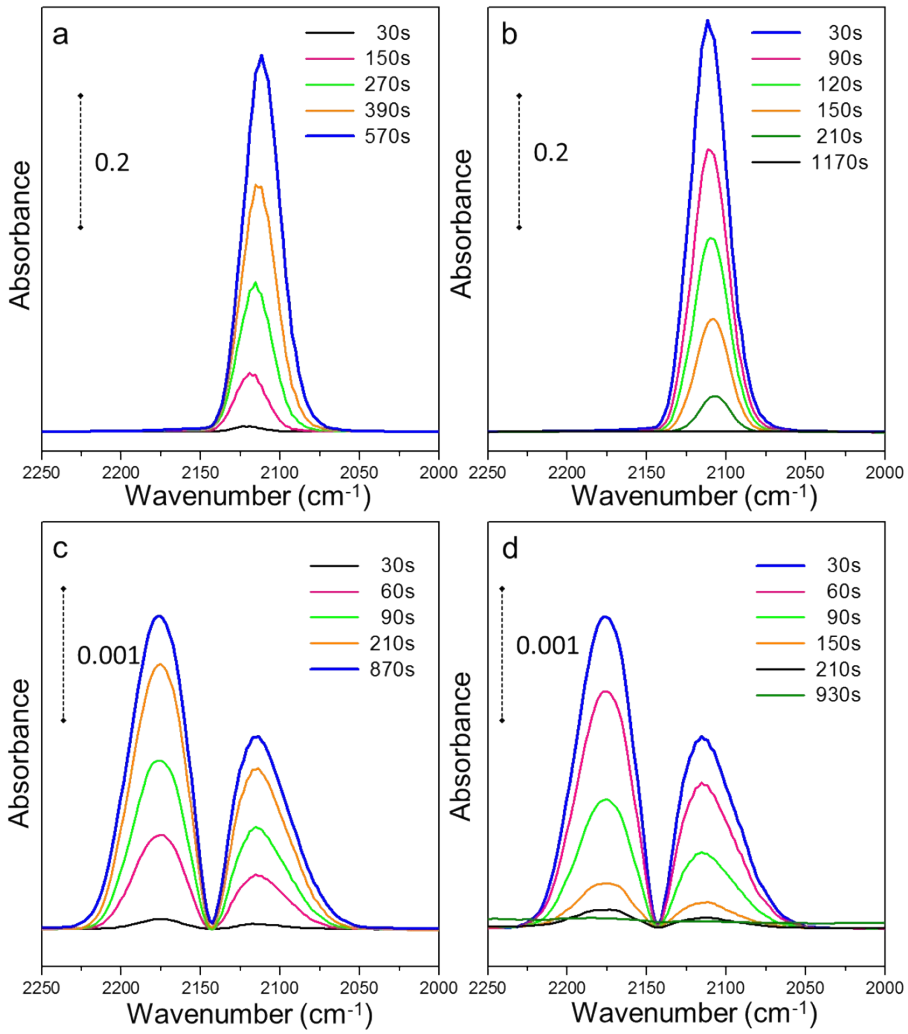


**Figure S9.** Operando DRIFT spectra of CuO/AO (a-b) and Au/AO (c-d) samples as CO adsorption for 30 min in the range of 2250-1980 $cm^{-1}$.

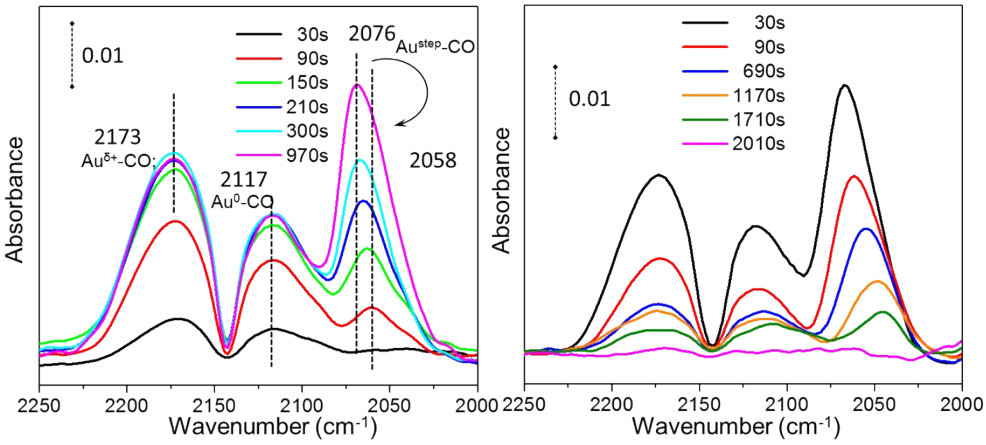


**Figure S10**. Operando DRIFT spectra of Au/AO-$_{3.2}$ at 25 °C under: CO adsorption (left) and He purging (right) until the adsorption peaks become stable. Conditions: Gas flow rate of 20 ml·min$^{-1}$, 2 vol % CO in helium, 30 mg catalyst.

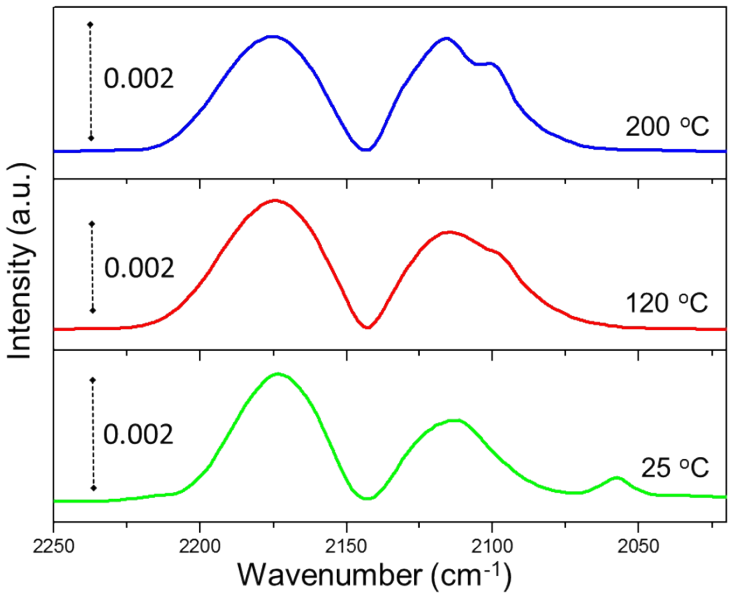


**Figure S11.** FT-IR spectra of Au-CuO/AO under different temperature at steady state in CO adsorption in the range of 2250-1980 cm$^{-1}$.

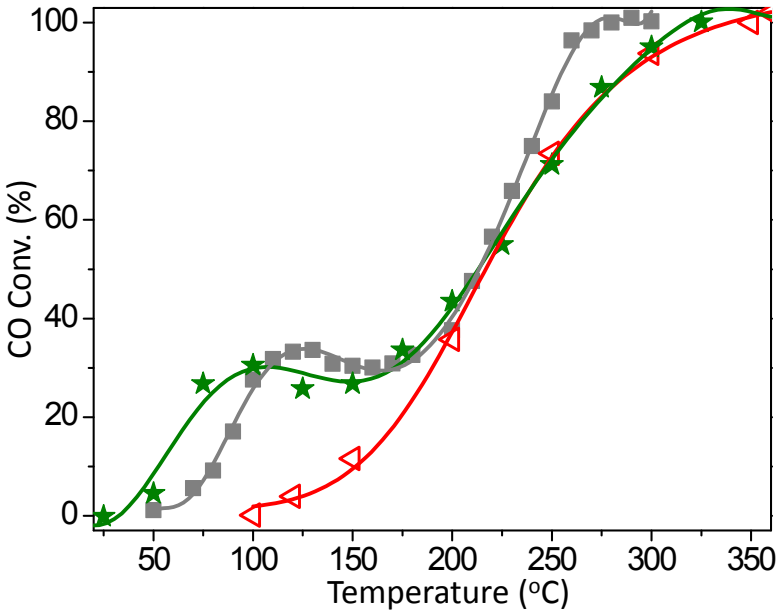


**Figure S12.** CO conversion over Au-CuO/AO as a function of reaction temperature, 2nd reaction cycle of calcined Au-CuO/AO (■), 1st (◁) and 2nd (★) reaction cycles after reduction at 300 °C in $H_2$ for 1 h.

**Table S1** Information of surface metal compositions revealed by XPS analysis.

| Catalyst | Au/Cu | | Au 4f | | | Cu 2p | |
|---|---|---|---|---|---|---|---|
| | XPS | ICP | $Au^0$ | $Au^{\delta+}$ | BE of $Au^0$ (eV) | $Cu^0$ or $Cu^+$ | $Cu^{2+}$ |
| Au/AO | - | - | 80.3% | 19.7% | 83.7 | - | - |
| Cu/AO | - | - | - | - | - | 88.1% | 11.9% |
| Au-Cu/AO | 1:5.2 | 1:1.6 | 90.5% | 9.5% | 83.4 | 89.0% | 11.0% |