Supplemental Materials

Strong metal-support interactions between gold nanoparticles and ZnO nanorods in CO oxidation

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Chemicals:

Zinc nitrate hexahydrate ($Zn(NO_3)_2 \cdot 6H_2O$, 98%), hexadecyltrimethylammonium bromide (CTABr, 99+%), hydrogen tetrachloroaurate(III) trihydrate ($HAuCl_4 \cdot 3H_2O$, for analysis ACS) and ethylenediamine ($C_2H_4(NH_2)_2$, EDA, 99%) were purchased from Acrös. Sodium hydroxide pellets (NaOH) and ethanol (EtOH, 99.9%) were purchased from J. T. Baker. Sodium borohydride ($NaBH_4$, 98%) and sodium carbonate (Na_2CO_3, anhydrous) were bought from Alfa and OSAKA, respectively. All chemicals were used without further purifications.

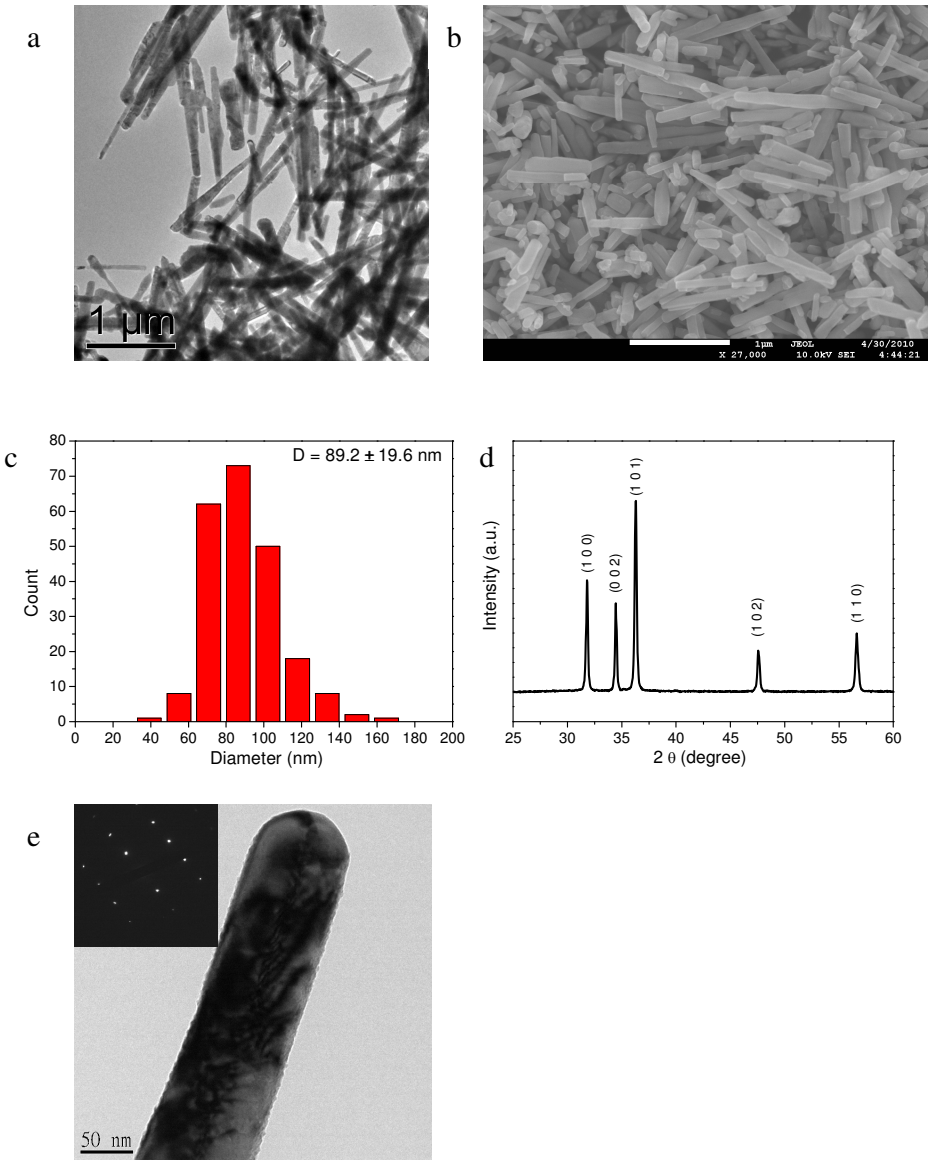

Figure S1 Basic nature of the ZnO nanorods: TEM image (a); SEM image (b); diameter distribution determined by the SEM images (c); XRD pattern (d); selected area electron diffraction patterns from an arbitrarily selected single ZnO nanorod (e).

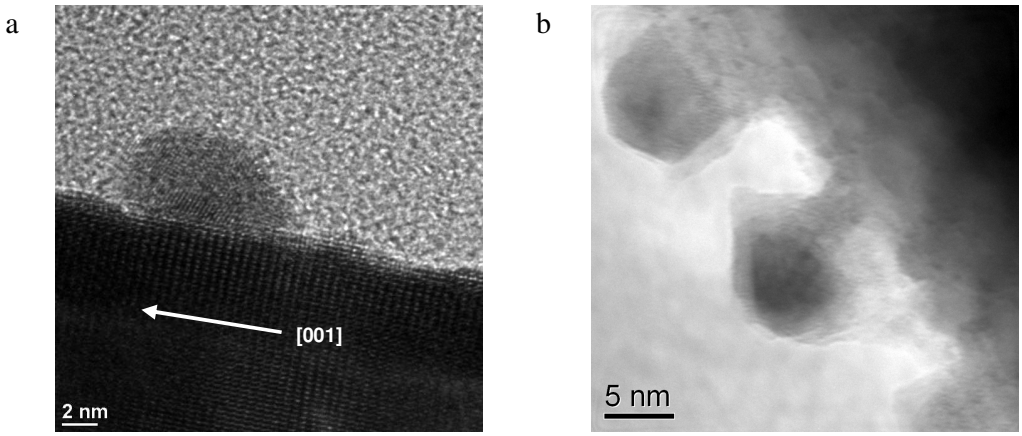

Figure S2 HRTEM images of Au/ZnO-nanorod pretreated at 200 ^{o}C (a) and 300 ^{o}C (b) under oxygen atmosphere, respectively.

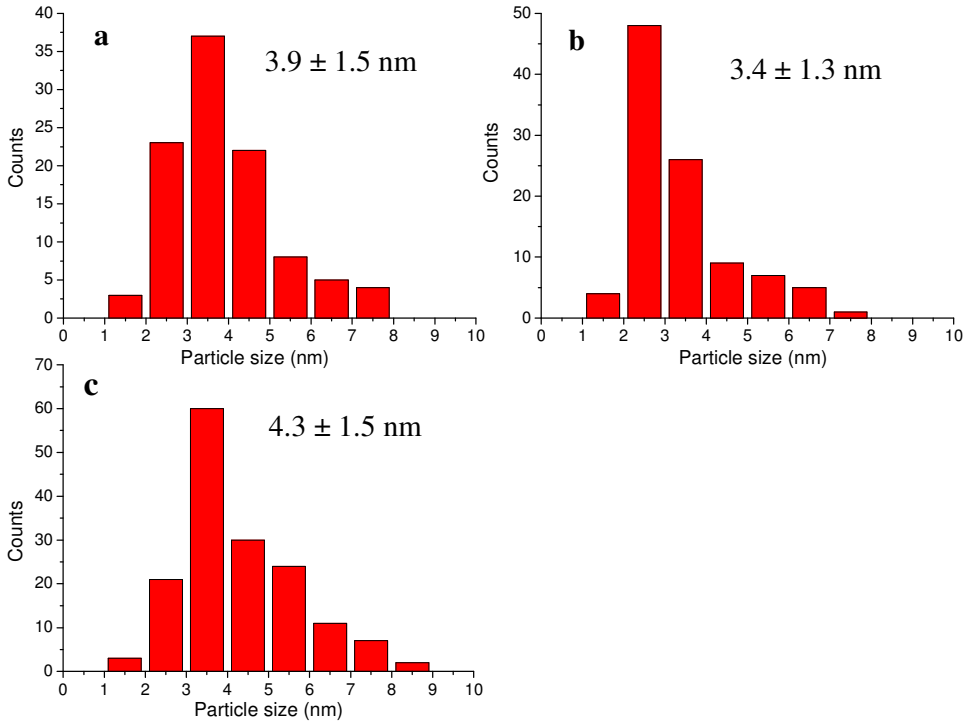

Figure S3 Size distribution of gold nanoparticles supported on ZnO nanorods pretreated under oxygen atmosphere at 200 ^{o}C (a), 300 ^{o}C (b) and followed by further pretreatment under hydrogen gas flow at 300 ^{o}C (c).

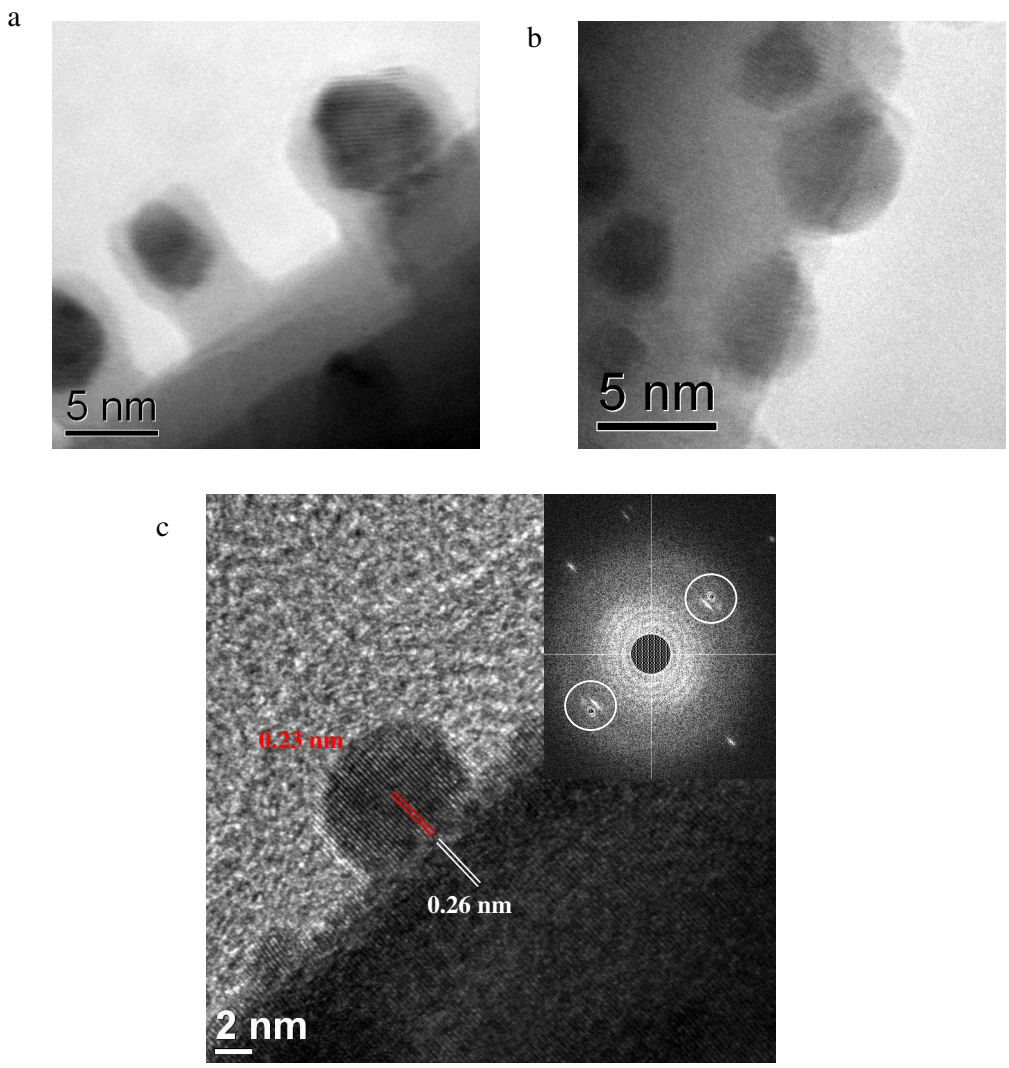

Figure S4 HRTEM images of Au/ZnO-nanorod pretreated at 300 ^{o}C in H_2 (99.999% H_2, flow rate: 30 mL•min^{-1}).

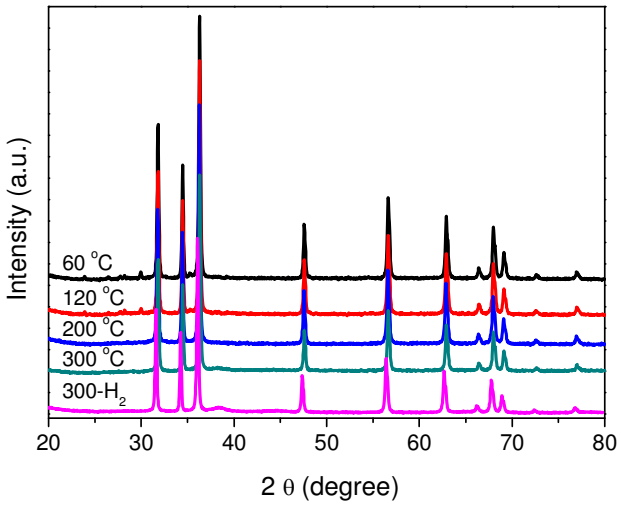

Figure S5 XRD patterns of Au/ZnO-nanorods pretreated under oxygen atmosphere at 60 ^{o}C, 120 ^{o}C, 200 ^{o}C, 300 ^{o}C and followed by further pretreatment under hydrogen gas flow at 300 ^{o}C.

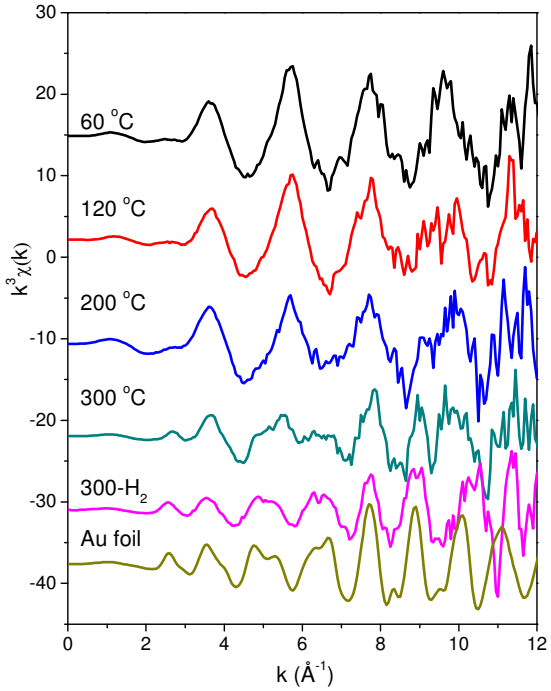

Figure S6 The k^3-weighted EXAFS spectra at Au L_{III}-edge for 20Au/ZnO-nanorods pretreated under oxygen atmosphere at 60 °C, 120 °C, 200 °C, 300 °C and followed by further pretreatment under hydrogen gas flow at 300 °C. The noise level ratio increased when k > ~11.0 $Å^{-1}$. Therefore, Δk = 3.1 - 11.1 $Å^{-1}$ was used for Au foil and 20Au/ZnO-nanorod pretreated under O_2 atmosphere at various temperatures, while Δk = 2.9 - 10.8 $Å^{-1}$ was used for 20Au/ZnO-nanorod pretreated under H_2 atmosphere at 300 °C.

Table S1 XPS analysis results of the Au/ZnO-nanorod catalysts.

Au/ZnO-nanorod (pretreatment temperature)	XPS Au_{4f} and Zn_{3p} peak			
	Au^0 (atom%)	Au^+ (atom%)	Au^{3+} (atom%)	Au/Zn (surface atomic ratio)
60	62.3	14.5	23.2	0.65
120	74.8	13.3	11.9	0.56
200	74.5	13.3	12.2	0.52
300	80.6	14.3	5.1	0.30
300-H_2	97.3	2.7	0	0.32

The Au/ZnO-nanorod was pretreated under oxygen atmosphere at 60, 120, 200, 300 ^oC and followed by further pretreatment under hydrogen gas flow at 300 ^oC.

Table S2 Contrasts between classical SMSI with that of Au/ZnO.

SMSI	Classical SMSI	O-SMSI	R-SMSI
Treatment	H_2-reduction	O_2-oxidation	H_2-reduction
Adsorption	reduced H_2, CO adsorption	reduced CO adsorption	reduced CO adsorption
Encapsulation	Yes, T > Ti	Yes, T > Ti	No, alloy, epitaxial interaction and sinking into the support
Activity	T > Ti, reduced activity	T > Ti, reduced activity	T > Ti, reduced activity
Electron transfer	substrate-to-metal	metal-to-substrate	substrate-to-metal
Reversibility	Yes	Yes	Yes