Gold Nanoparticles Located at the Interface of Anatase/Rutile TiO_2 Particles as Active Plasmonic Photocatalysts for Aerobic Oxidation

Daijiro Tsukamoto,[†] Yasuhiro Shiraishi,*[,†] Yoshitsune Sugano,[†] Satoshi Ichikawa,[‡] Shunsuke Tanaka,[§] and Takayuki Hirai[†]

[†]Research Center for Solar Energy Chemistry, and Division of Chemical Engineering, Graduate School of Engineering Science, Osaka University, Toyonaka 560-8531, Japan.

[‡]Institute for NanoScience Design, Osaka University, Toyonaka 560-8531, Japan.

[§]Department of Chemical, Energy and Environmental Engineering, Kansai University, Suita 564-8680, Japan.

E-mail: shiraish@cheng.es.osaka-u.ac.jp

Supporting Information

Contents

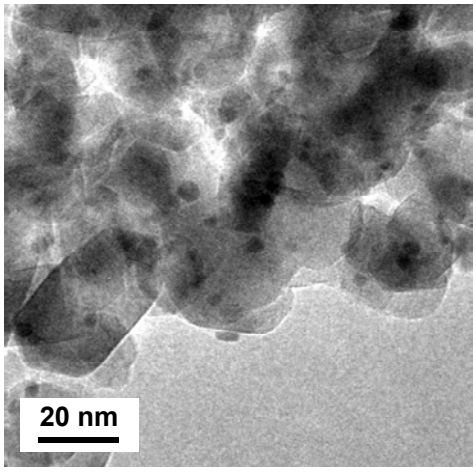
page

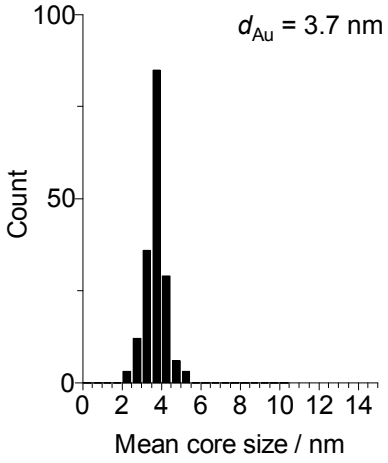
Table S1. Properties of the catalysts used

catalyst	S_{BET} / m^2 g^{-1} [a]	d_p / nm [b]	d_{Au} / nm [c]	pzc / pH [d]
P25 (JRC-TIO-4)	57	24		5.7
anatase (JRC-TIO-1)	80	15		
rutile (JRC-TIO-6)	104	15		
CeO_2 (JRC-CEO-3)	82	20		
$Au_2(DP_{673})$/P25	56	30	3.7	5.9
$Au_2(DP_{673})$/anatase	80		4.6	
$Au_2(DP_{673})$/rutile	68		4.2	
$Au_2(DP_{673})/CeO_2$	81		3.9	
Au_2(photo)/P25	57	71	20.2	
Au_2(photo)/anatase	82		45.3	
Au_2(photo)/rutile	101		26.5	
$Au_2(photo)/CeO_2$	74		44.4	
$Au_{0.5}(DP_{673})$/P25			2.4	
$Au_1(DP_{673})$/P25				
$Au_{1.5}(DP_{673})$/P25				
$Au_3(DP_{673})$/P25			4.9	
$Au_4(DP_{673})$/P25				
$Au_5(DP_{673})$/P25			7.8	
$Au_2(DP_{473})$/P25			3.3	
$Au_2(DP_{573})$/P25			3.4	
$Au_2(DP_{773})$/P25	56	33	7.6	5.9
$Au_2(DP_{873})$/P25	46	34	8.3	6.0

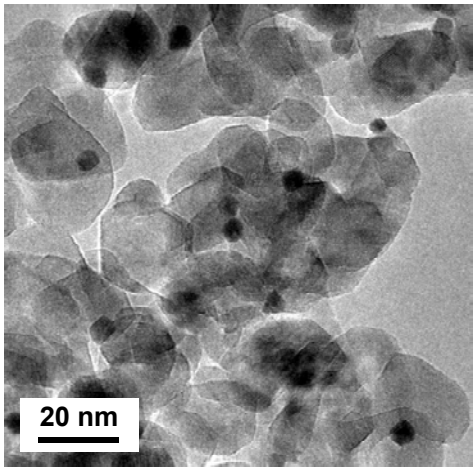
[a] BET surface area, determined by N_2 adsorption/desorption measurements at 77 K using an AUTOSORB-1-C/TCD analyzer (Yuasa Ionics Co., Ltd.). All of the samples showed IUPAC type-II isotherms. [b] Mean particle diameter of catalysts, determined using a Horiba LB-500 dynamic light-scattering particle size analyzer. [c] Diameter of Au particles determined by TEM observations. [d] Point of zero charge of catalyst, determined by acid/base titration with 10 μM HCl or NaOH.

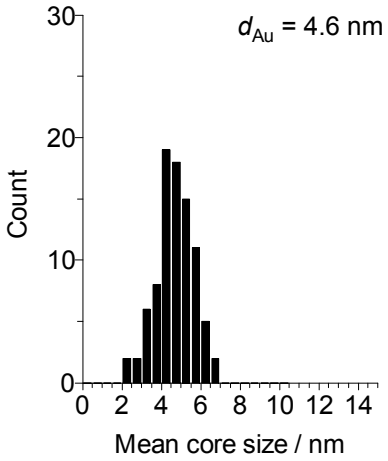
$Au_2(DP_{673})$/P25



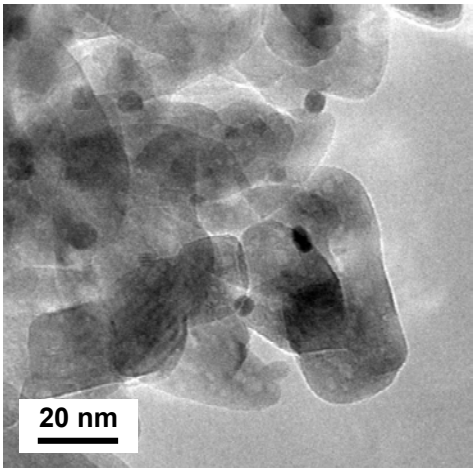


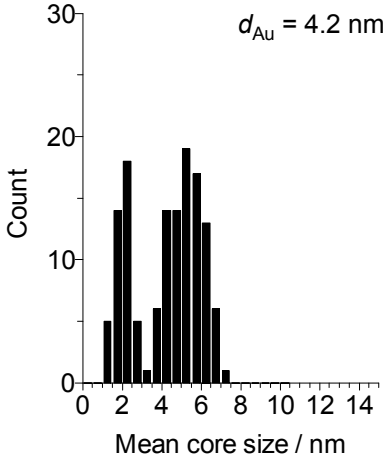
$Au_2(DP_{673})$/anatase



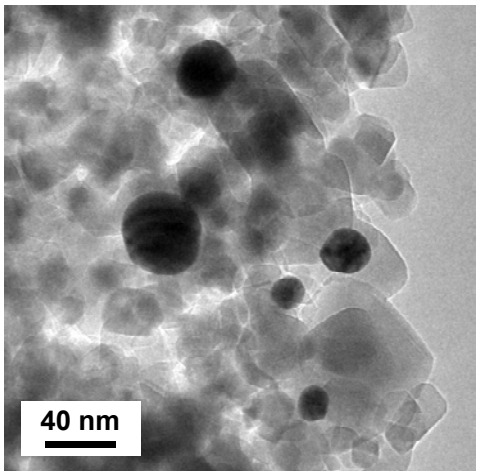


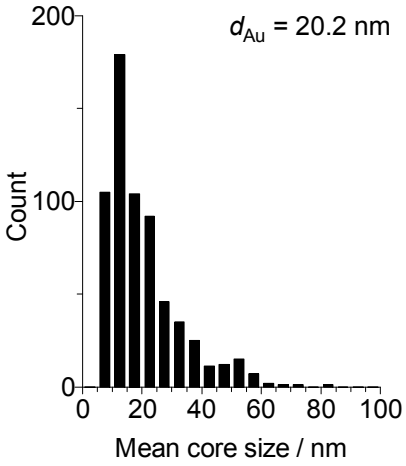
$Au_2(DP_{673})$/rutile



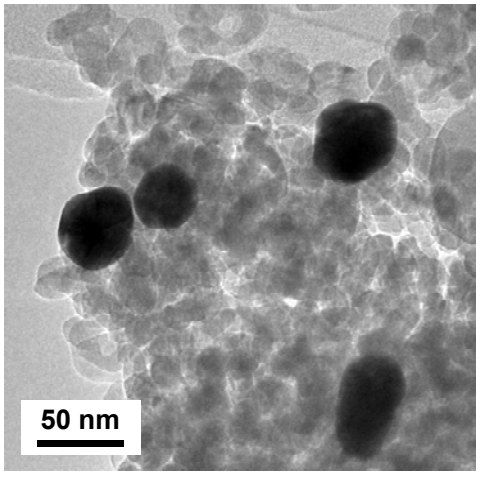


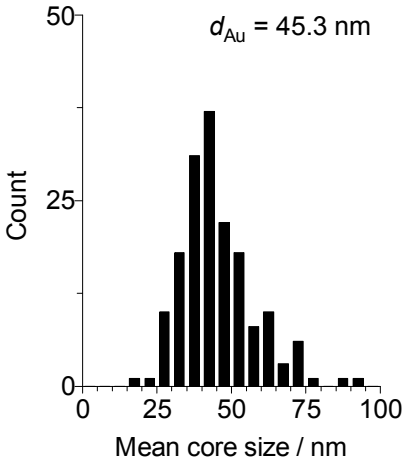
Au_2(photo)/P25



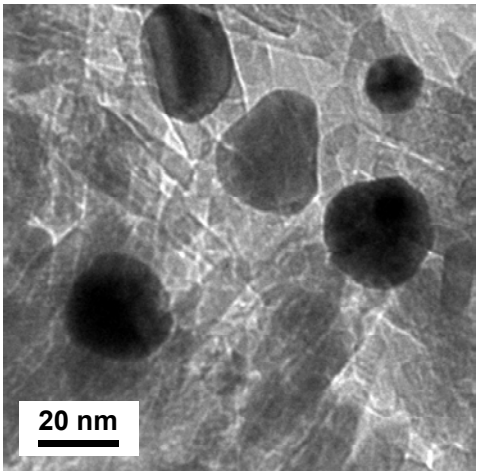


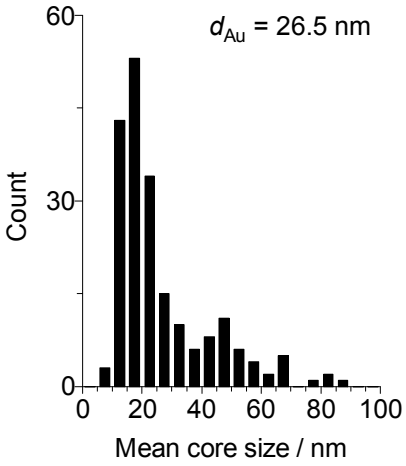
Au_2(photo)/anatase



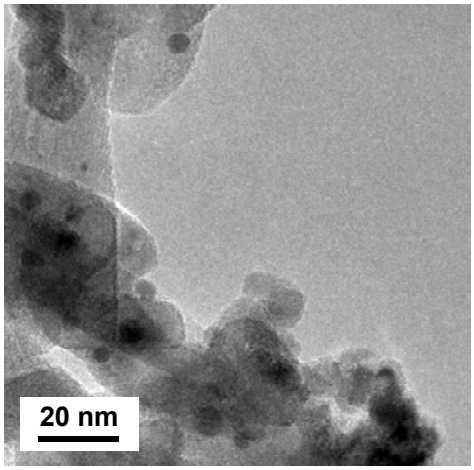


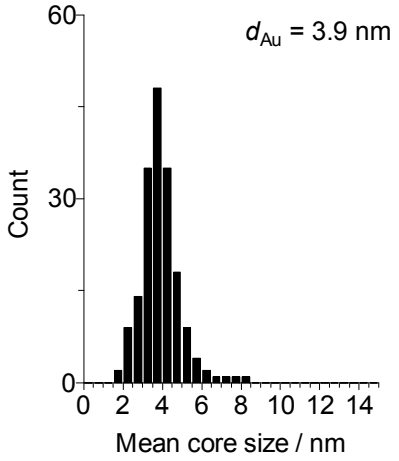
Au_2(photo)/rutile



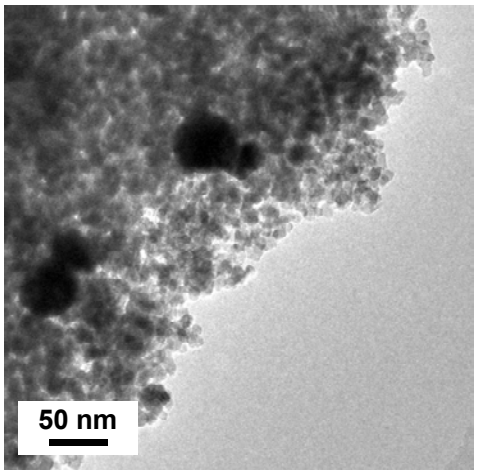


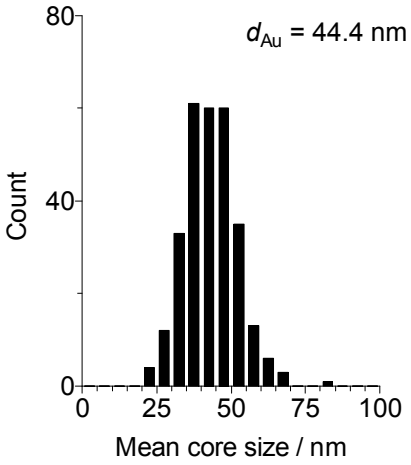
$Au_2(DP_{673})/CeO_2$



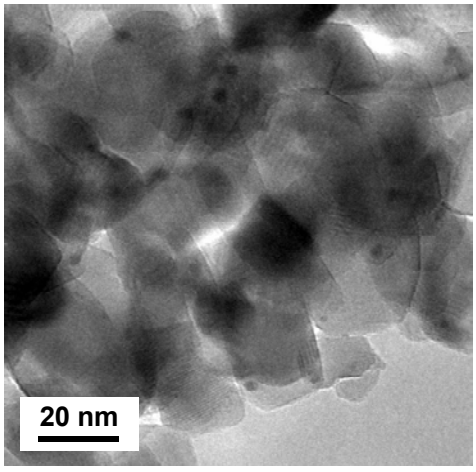


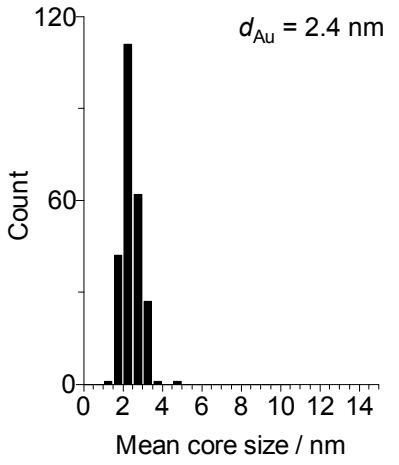
$Au_2(photo)/CeO_2$



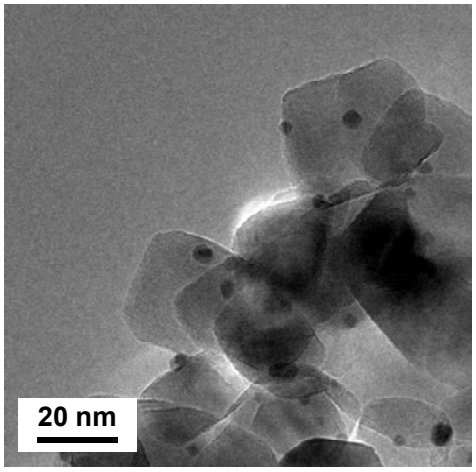


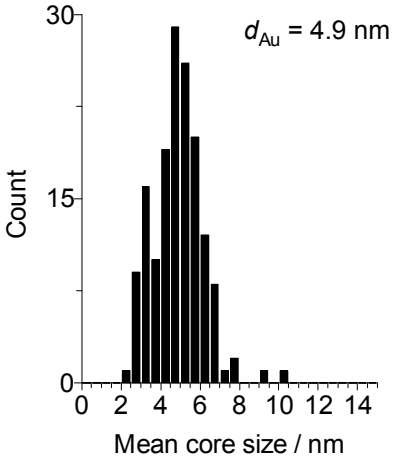
$Au_{0.5}(DP_{673})/P25$



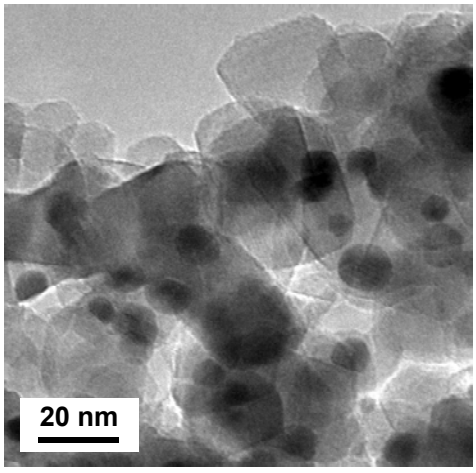


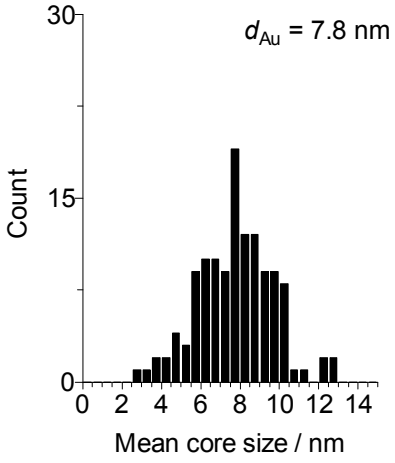
$Au_3(DP_{673})$/P25



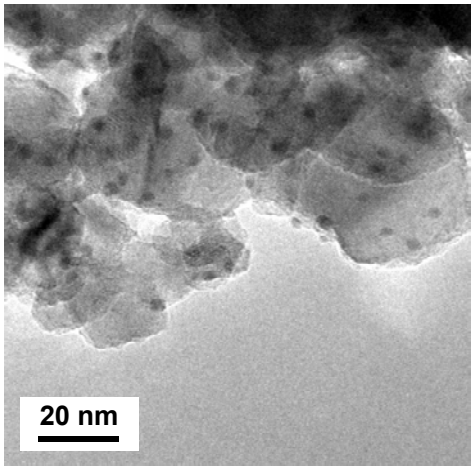


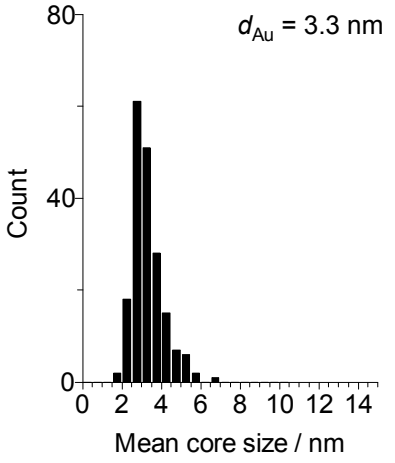
$Au_5(DP_{673})$/P25



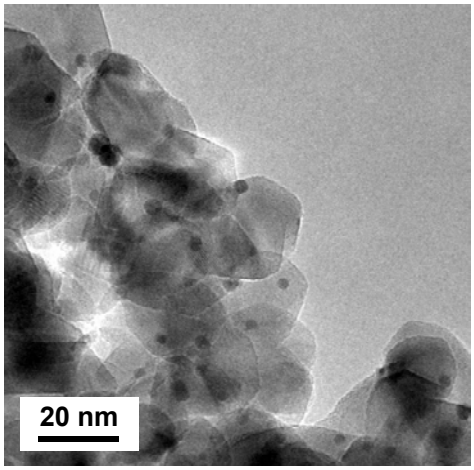


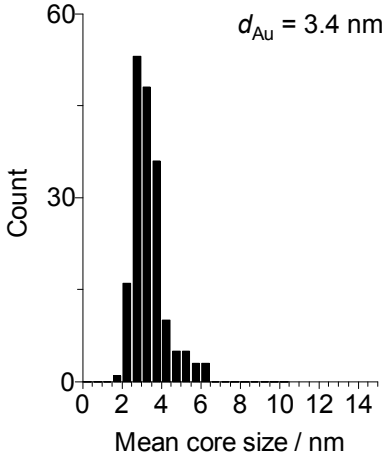
$Au_2(DP_{473})$/P25



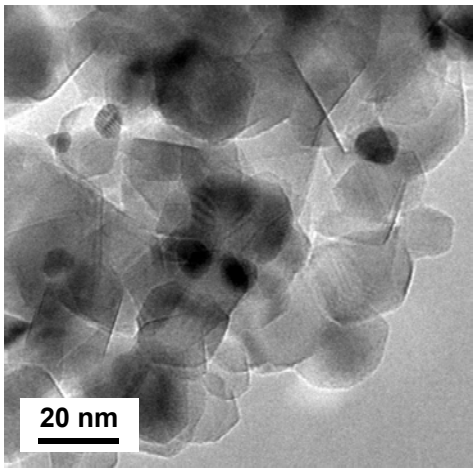


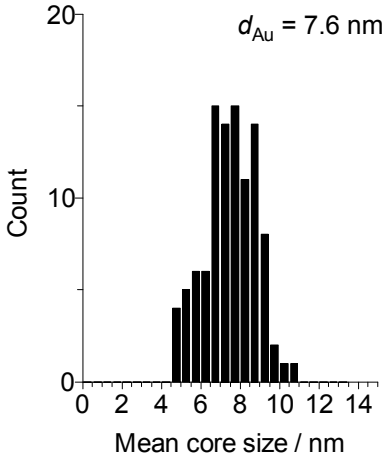
$Au_2(DP_{573})$/P25



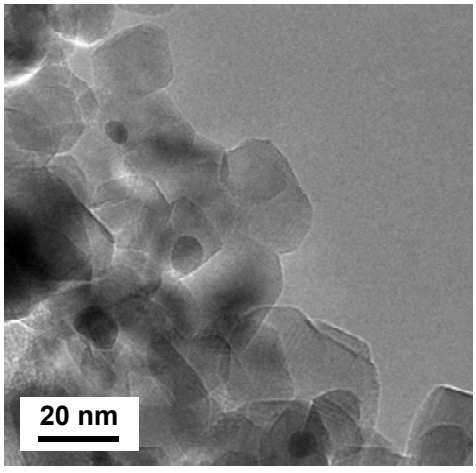


$Au_2(DP_{773})$/P25





$Au_2(DP_{873})$/P25



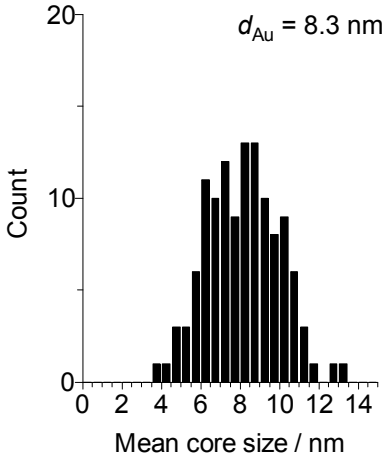


Figure S1. Typical TEM images and size distributions of Au particles on respective catalysts.

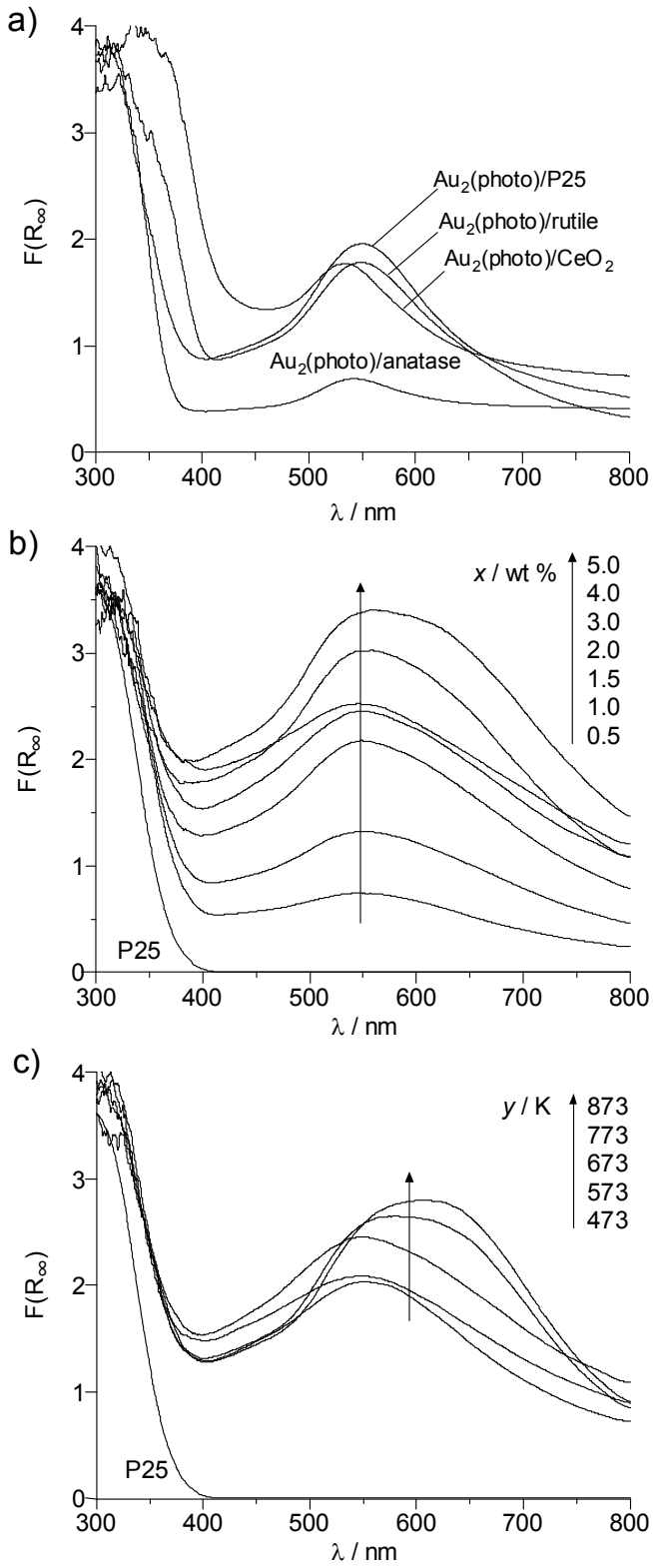
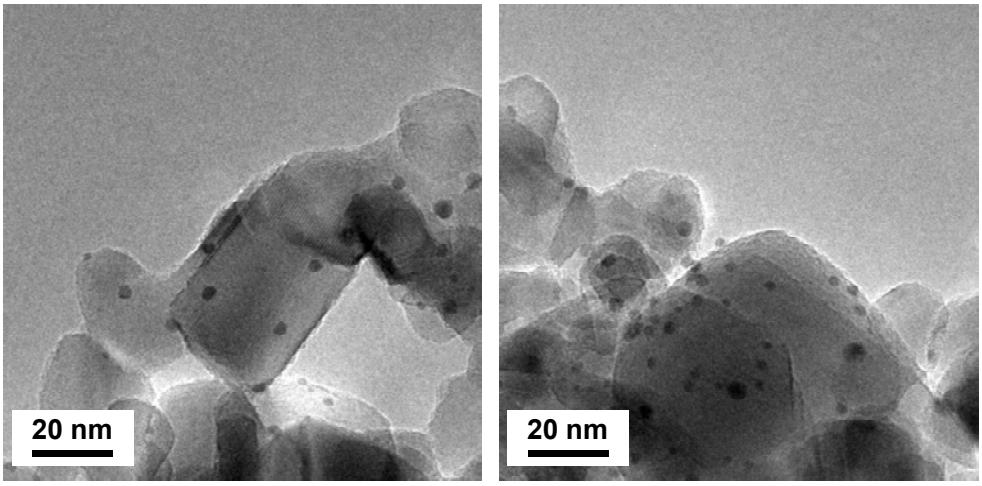
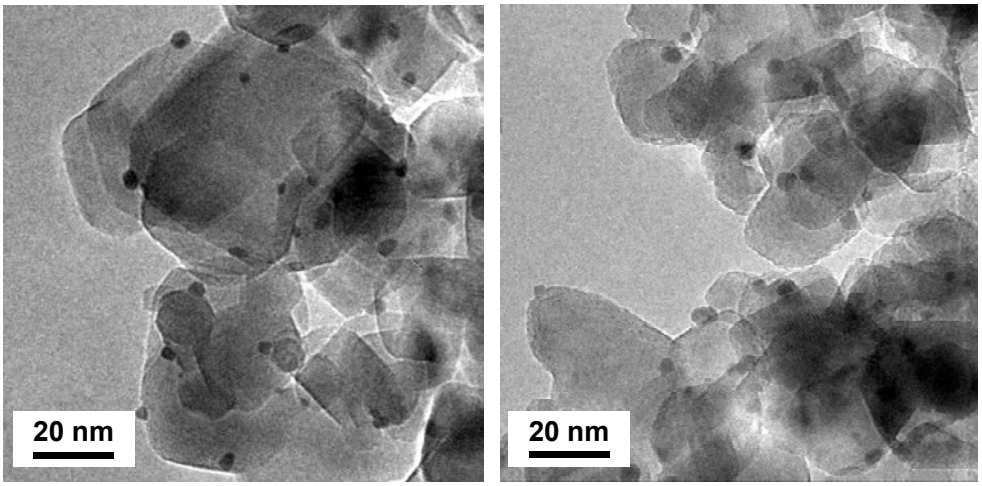


Figure S2. Diffuse reflectance UV-vis spectra of (a) Au_2(photo)/TiO_2 and Au_2(photo)/CeO_2, (b) $Au_x(DP_{673})$/P25, and (c) $Au_2(DP_y)$/P25 catalysts.

$Au_2(DP_{473})$/P25



$Au_2(DP_{673})$/P25



$Au_2(DP_{873})$/P25

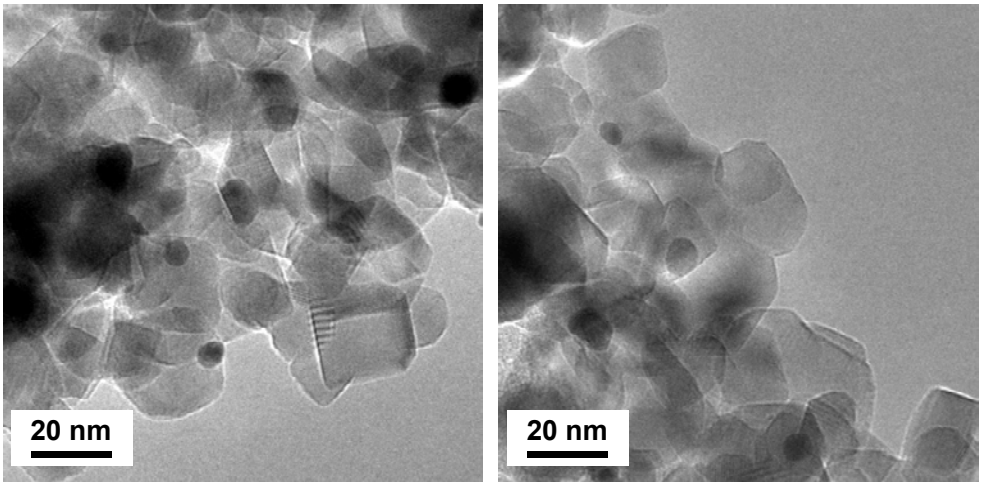


Figure S3. Typical TEM images of $Au_2(DP_y)$/P25 catalysts.

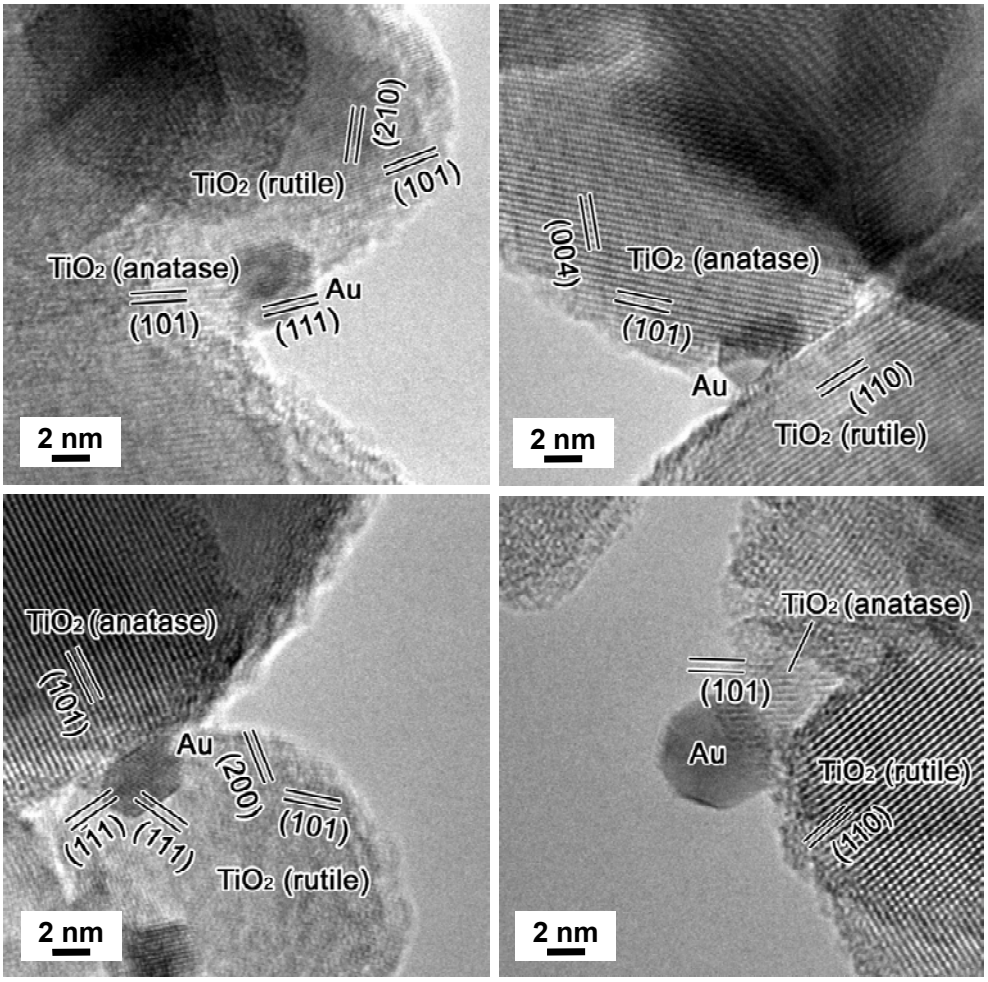


Figure S4. HRTEM images of Au particle located at the anatase/rutile interface of $Au_2(DP_{673})$/P25.

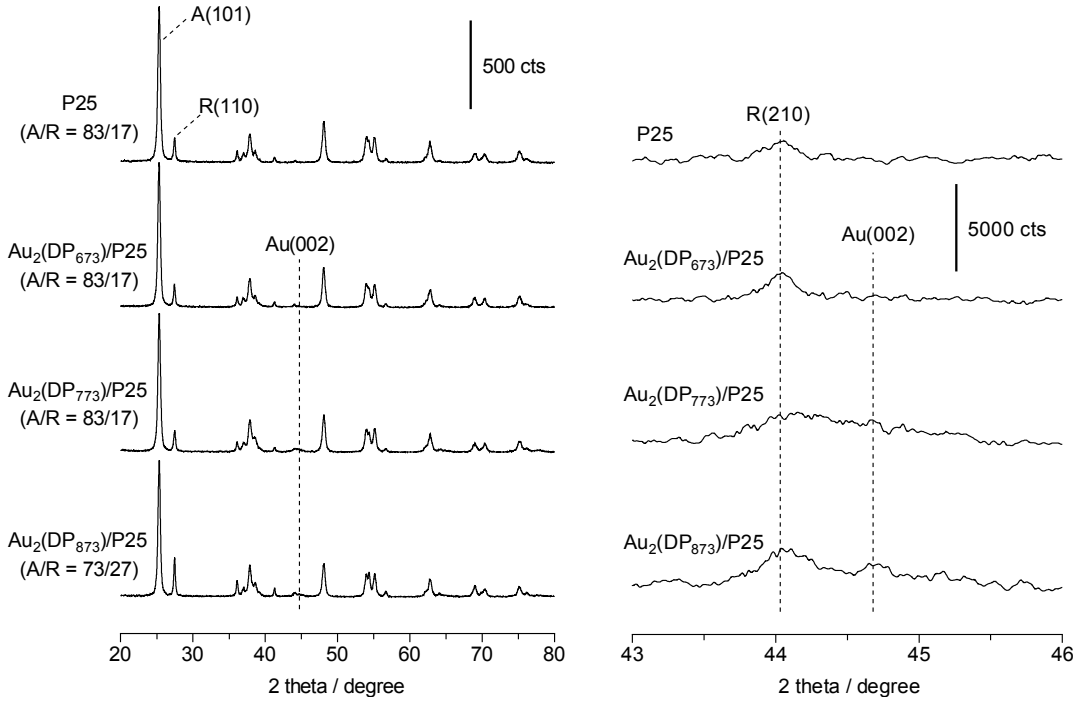


Figure S5. XRD patterns of $Au_2(DP_y)$/P25 catalysts. The anatase (A) and rutile (R) contents were determined with the equation; A (%) = $I_{A(101)}$ / ($I_{A(101)}$ + 1.4$I_{R(110)}$) × 100 (Ramis, G.; Busca, G.; Cristiani, C.; Lietti, L.; Forzatti, P.; Bregani, F. *Langmuir* **1992**, *8*, 1744–1749).

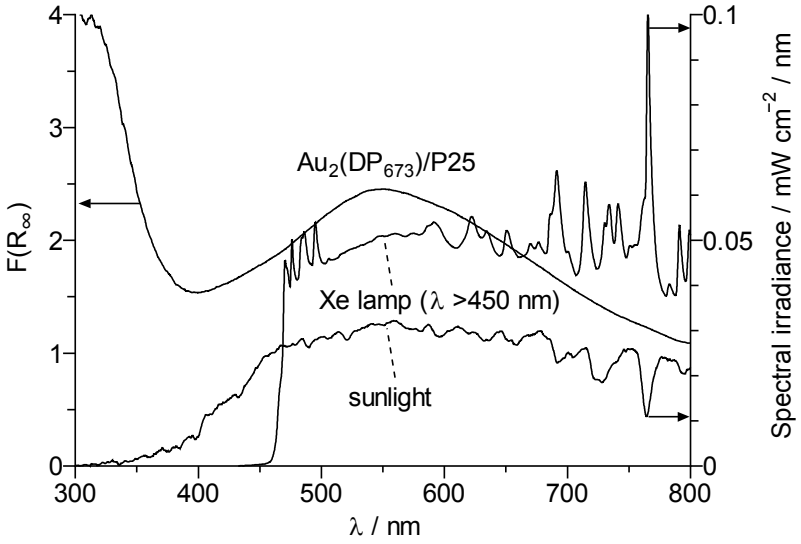


Figure S6. Spectral irradiance of light sources.

Figure S7. A picture for sunlight reaction.