Supporting Information for

In situ encapsulation of Au nanoparticles in mesoporous core-shell

TiO$_2$ microspheres with enhanced activity and durability

Zhenfeng Biana, Jian Zhu$^b$, Fenglei Cao$^a$, Yunfeng Lu$^{b,*}$, Hexing Li$^{b,*}$

$^a$ Department of Chemistry, Shanghai Normal University, Shanghai 200234, P. R. China

$^b$ Chemical & Biomolecular Engineering Department, University of California, Los Angeles CA 90095, USA

Experimental

1. Catalyst Preparation

The Au/TiO$_2$ (Au/Ti molar ratio = 0.53%) was prepared by consecutive solvothermal and hydrothermal treatments. In a typical run of synthesis, a clear solution containing 20 ml ethanol, 1.0 ml TiOSO$_4$, 10 ml glycerol, 10 ml ethyl ether and desired amount of AuCl$_3$ was added into a 50 ml autoclave and allowed solvothermal treatment at 110°C for 1 h. After being filtered and washed thoroughly with absolute ethanol, the solid product was dispersed in 40 ml H$_2$O via ultrasonification, followed by hydrothermal treatment at 110°C for 4 h. The pure TiO$_2$ was prepared in the similar way in the absence of AuCl$_3$. Meanwhile, the Pd/TiO$_2$, Pt/TiO$_2$, and Ag/TiO$_2$ samples with M/Ti molar ratios of 6.6%, 0.62% and 1.1% were also prepared by using the corresponding metallic salts instead of Au/TiO$_2$.

2. Activity test

The catalytic performances of the as-prepared samples were evaluated by using liquid phase photocatalytic degradation of $p$-chlorophenol at 30°C in an 80 ml
self-designed quartz photochemical reactor containing 50 ml of $1.0 \times 10^{-4}$ M $p$-chlorophenol aqueous solution and 0.050 g catalyst. After reaching adsorption equilibrium, the photocatalytic reaction was initiated by irradiating the system with a 500 W xenon lamp located at 30 cm away from the reaction solution. All the UV lights with wavelength shorter than 360 nm were removed by a glass filter (JB-360). After reaction for 4 h, the unreacted $p$-chlorophenol was analyzed by a UV spectrophotometer (UV 7504/PC) at its characteristic wavelength ($\lambda = 224$ nm). The reproducibility of all results was checked by repeating the experiments at least three times and was found to be within acceptable limits ($\pm 5\%$).

In order to determine the catalyst durability, the photocatalyst was separated from aqueous solution after each run of reactions, followed by washing with H$_2$O for 3 times and drying at 100 °C for 12 h under vacuum. Then, the catalyst was used in the subsequent reaction under the identical conditions.
Figure S1. EDX patterns the Au/TiO$_2$ detected inside the core-shell chamber (a) and on the outer surface (b).
Figure S2. Mapping and TEM images of the Au/TiO₂ sample.
Figure S3. The Au content distribution in the Au/TiO₂ sample determined by XPS spectra with increasing Ar⁺ sputtering time.
Figure S4. N₂ adsorption-desorption isotherm (Left) and pore size distribution curve (Right) of the Au/TiO₂ sample.
Figure S5. TG/DTA curves of the Au/TiO$_2$ precursor obtained via solvothermal treatment at 110°C for 1 h.
Figure S6. FTIR spectrum of the Au/TiO$_2$ precursor obtained via solvothermal treatment at 110°C for 1 h.
Figure S7. SEM (Left) and HRTEM (Right) images of Pd/TiO₂, Pt/TiO₂, and Ag/TiO₂ samples.
**Figure S8.** TEM image of the Au/TiO$_2$ sample obtained via solvothermal treatment for 48 h. The attached is the SEM image.
**Figure S9.** SEM image of the Au/TiO$_2$ sample obtained via hydrothermal treatment at 110°C for 48 h in the presence of 5.0 ml water. The attached is the SEM image.