Supporting Information

An ultra-low Pd loading nanocatalyst with efficient catalytic activity

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Experimental Section

Synthesis of ZnO nanorods. ZnO nanorods were prepared according to a typical synthesis. At room temperature, zinc acetate (0.01 mol) was dissolved in 100 ml deionized water. Then, sodium hydroxide (0.11 mol) was added under vigorous stirring until the solution turned clear. The reaction mixture was subsequently transferred into a Teflon-lined autoclave and kept at a constant temperature for several hours. The precipitates were collected and washed three times with deionized water to remove the excess ions, and then dried in an oven at 60 °C for 12 h.

Formation of Pd-ZnO hybrid nanostructures. The deposition of Pd on the ZnO nanorods was synthesized by the photoreduction method. Before self-assembly of Pd NPs on the surface of ZnO with the assistance of UV-light, 0.1g of the ZnO nanorods were first dispersed in 100 mL of aqueous solution and ultrasonicated for 10 min. Then, the required amount of $HPdCl_4$ aqueous solution (10 mM) was quickly added to the as-prepared ZnO nanorods suspension under stirring. Finally, the resulting dispersion was carried out photocatalytically in cylindrical quartz vessel using a 300 W high pressure Hg lamp in combination with a monochromator and a band-edge filter (365 nm) for 20 min, during which $PdCl_4^{2-}$ (Pd^{2+}) was photoreduced to Pd^0 on the ZnO surface. After standing for 12 h, the original light brown suspension precipitated, and the supernatant changed to colorless, indicating the formation of Pd-ZnO hybrid nanostructures. The mixture was centrifuged and washed with deionized water until there were no the excess ions, and then the as-prepared catalyst was dried at 60°C for 12 h in an oven.

Photocatalytic activity of Pd-ZnO hybrid nanostructures. The photocatalytic activity was explored against a model molecule-Rhodamine B(Rh B). In a typical process, the catalysts (30 mg) were added to the cylindrical quartz vessels containing 50 mL Rh B dye (5mg/L). After ultrasonication, the suspensions were stirred for 90 min in the dark at room temperature to achieve the adsorption and desorption equilibration. Then, the photocatalytic test was conducted by irradiation with a 300 W high pressure Hg lamp (the average light intensity was 30 mW cm^{-2}) with the main peak at wavelength of 365 nm. The samples with different reaction times were taken out and centrifuged for the absorbance measurements using a UV-2550 spectrophotometer (Shimadzu, Japan).

Catalyzed reduction of 4-NP.

The catalytic property of Pd-ZnO 0.05% composites was explored by studying the change of the absorbance intensity at the maximum absorbance wavelength of the 4-NP. In a typical procedure, 5.0 mg of Pd-ZnO 0.05% composites was homogeneously dispersed into the 3.0 mL 4-NP solution (0.1 mM), followed by a rapid injection of 0.1 mL of $NaBH_4$ solution (0.3 M) under stirring. The color of the mixture gradually changed from yellow-green to colorless, indicating that the Pd-ZnO 0.05% composites catalyzed the reduction of 4-NP.

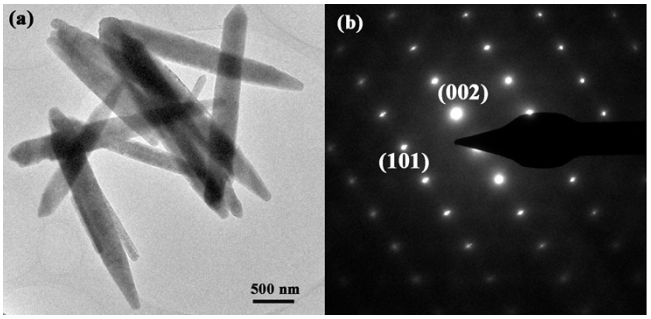

Fig. S1. TEM images of (a) ZnO nanorods and (b) the corresponding electron diffraction pattern.

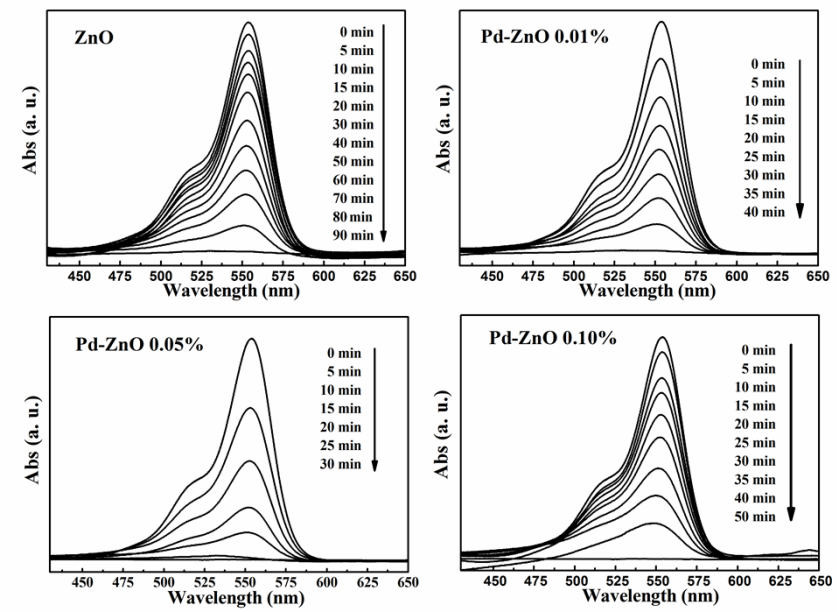

Fig. S2. UV-vis spectra at different times during the photocatalytic degradation of Rh B under UV irradiation. The arrows indicate the increase of reaction time.

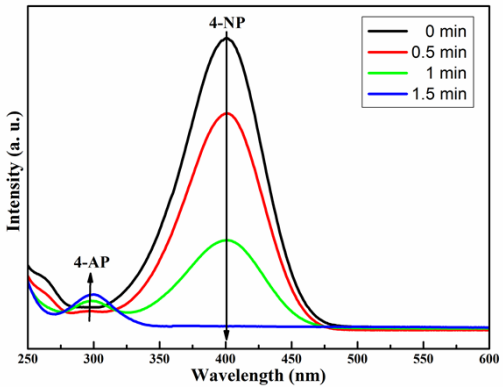

Fig. S3. Typical time-dependent evolution of UV-vis spectra of the catalytic reduction of 4-NP to

4-AP by Pd-ZnO (0.05 at. %).

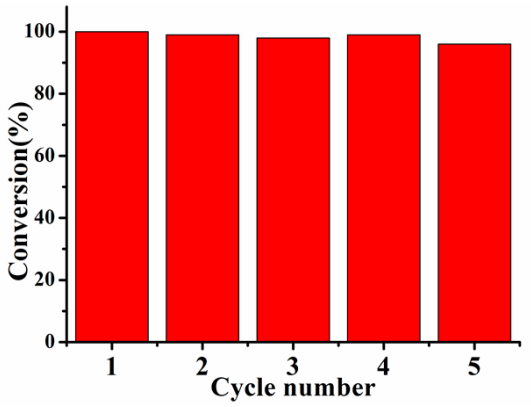

Fig. S4. Conversion efficiency of 4-NP to 4-AP in five successive cycles by Pd-ZnO (0.05 at. %) catalyst.