Supplementary Information

Investigation of Charge Transfer in Au Nanoparticle-ZnO Nanosheet Composite Photocatalysts

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Experimental details

The ZnO seed layer was prepared by the spin coating of a 30 mM ethanol solution of zinc acetate and ethanolamine on the ITO substrate followed by a heat treatment at 350°C for 1 h. To synthesize ZnO nanosheets, ZnO nanoneedles were first grown on the seeded ITO substrates by chemical bath deposition at 95°C for 20 min. The aqueous precursor solution for the ZnO nanoneedle growth consists of 0.02 M zinc acetate and 0.02 M hexamethylenetetramine (HMTA), 190 mM 1,3-Diaminopropane and 6 at. % aluminum nitrate. The ZnO nanoneedles/ITO substrate was then immersed in a stirred aqueous solution of zinc acetate and NaOH at room temperature for 20 min. The transparent solution was obtained by preparing a 4 mL of aqueous solution of 0.57 M zinc acetate and 5M NaOH and subsequently diluting to 65 mL. Au nanoparticles were deposited on ZnO nanosheets by sputter coator (EMITECH, K550X). The sputtering current and time were 10 mA and 120 s, respectively. The morphologies of the ZnO nanostructures were examined using scanning electron microscopy (SEM, JEOL JSM-7000F). The crystal structures were investigated using transmission electron microscopy (TEM, FEI E.O Tecnai F20 G2 MAT S-TWIN).

Photodegradation of methyl orange (MO) was performed at 27 °C under 365-nm irradiation with an intensity of 150 mW/cm^2. The initial concentration of MO solutions is 15 ppm. Due to its strong absorption at 465 nm, a calibration curve of the absorbance at 465 nm versus the concentration of the MO solution in the range of 0-20 ppm was employed to determine the evolution of the MO concentration during photodegradation. The absorbance of the MO solution was measured using a UV-vis spectrophotometer (VARIAN Cary-100) with a deuterium discharge tube and a tungsten iodine lamp.

In addition, scanning probe microscopy (SPM) techniques were employed to examine the surface properties of the ZnO nanostructures. The samples of both the pure ZnO and Au-coated ZnO nanosheets were characterized by atomic force microscopy (AFM) and scanning Kelvin microscopy (SKM) methods using Pt-coated silicon probes with an apex radius of ~ 10 nm. SPM measurements of the ZnO nanosheets were carried out using an air-operated SPM Solver P47 (NT-MDT), with a two-scan procedure being applied. During the 1st scan, the AFM was employed to measure the surface morphology over a scan area of 2.5×2.5 μm^2 in tapping mode. During the 2nd scan, the same surface area was examined in noncontact mode using the SKM method, when the probe was held at $\Delta Z = 50$ nm from the surface and the contact potential difference (CPD), $\Delta\varphi$, between the probe and sample surface was measured. The obtained $\Delta\varphi$ data were normalized to the total number of the recorded points (256x256 points of each scan area) to get the resulting $\Delta\varphi$ distribution over the surface. The AFM image of a 0.5x0.5 μm^2 surface area was also obtained using a super sharp silicon probe (NANOSENSORS™ SSS-NCHR) with a tip radius of 2 nm.

The photoluminescence (PL) spectra of Au NP/ZnO nanosheets were obtained at room temperature using fluorescence spectrophotometer (Hitachi F-4500). The excitation wavelength was 325 nm.

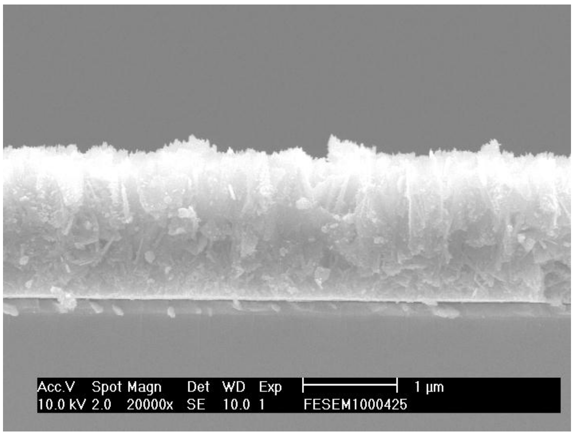

Fig. S1 Cross-sectional-view SEM image of ZnO nanosheet framework.