

## Supporting Information

### **ZIF-8 Templated Fabrication of Rhombic Dodecahedron-shaped ZnO@SiO<sub>2</sub>, ZIF-8@SiO<sub>2</sub> Yolk-shell and SiO<sub>2</sub> Hollow Nanoparticles**

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## EXPERIMENTAL SECTION

**Materials.** Cetyltrimethylammonium bromide (CTAB,  $\geq 99\%$ ) and tetraethyl orthosilicate (TEOS,  $\geq 98\%$ ) were purchased from Sigma (USA). 2-methylimidazole (Hmim) was purchased from Chengdu Kelong Chemical Reagent Company.  $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  was purchased from Tianjin Fengchun Chemical Reagent Technologies Co., Ltd. Methanol and ethanol were purchased from Beijing Chemical Works. All other reagents and solvents for the synthesis were purchased from commercial sources and used as received. Deionized water (DI-water) was used in all experiments.

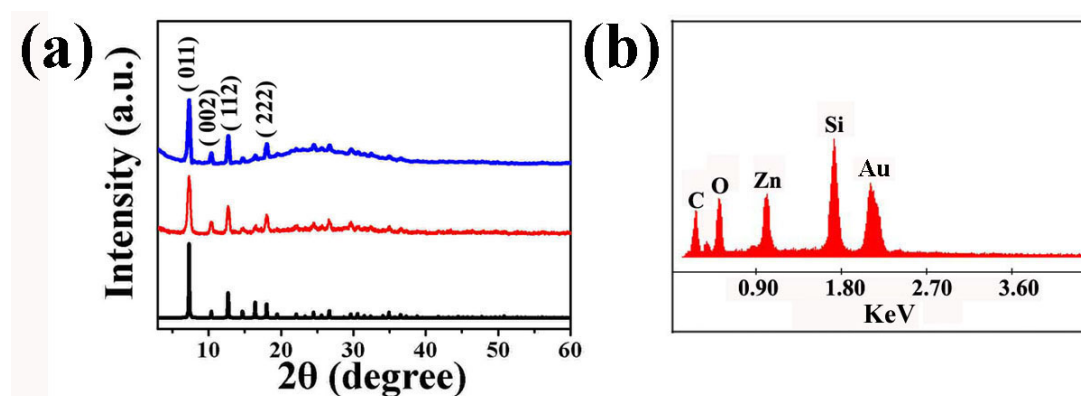
**Characterization.** Electron transmission microscopy (TEM) was performed on a JEOL-2100F transmission electron microscope under 200 kV accelerating voltage. Field-emission scanning electron microscope (FE-SEM) images and energy dispersive X-ray (EDX) spectrum were obtained by using an XL 30 ESEM-FEG field-emission scanning electron microscope (FEI Co.). Powder X-ray diffraction (PXRD) patterns were recorded on a Siemens D5005 diffractometer with Cu KR ( $\lambda=1.5418 \text{ \AA}$ ) radiation in the range of  $3\text{--}90^\circ$ . Fourier transform infrared (FTIR) spectrum was obtained on a Magna 560 FTIR spectrometer (Nicolet, USA). Thermogravimetric analysis (TGA) experiments were performed on a Perkin-Elmer TGA 7 analyzer heated from  $25$  to  $600^\circ\text{C}$  under air atmosphere with a heating rate of  $10^\circ\text{C min}^{-1}$ . The  $\text{N}_2$  sorption measurements were measured on an Autosorb-iQ analyzer (Quantachrome). Before gas adsorption measurements, the sample was activated by drying under a dynamic vacuum at  $150^\circ\text{C}$  overnight to remove methanol.

**Synthesis of ZIF-8 NPs.** All solutions used methanol as solvent. Firstly, a 0.1 mL CTAB (0.2 M) solution, 4 mL solution of  $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  (0.06 mM) were mixed together and then 4 mL solution of Hmim (0.25 mM ) was added. Subsequently, the mixture was allowed to react at room temperature for 24 h without stirring, during which the solution changed the appearance from clear to milky. Finally, the product ZIF-8 NPs were collected by centrifugation at 9000 rpm for 10 min, washed three times with methanol to remove the remaining reactant and then dried under vacuum for 10 h at 50 °C in an oven to get the powder.

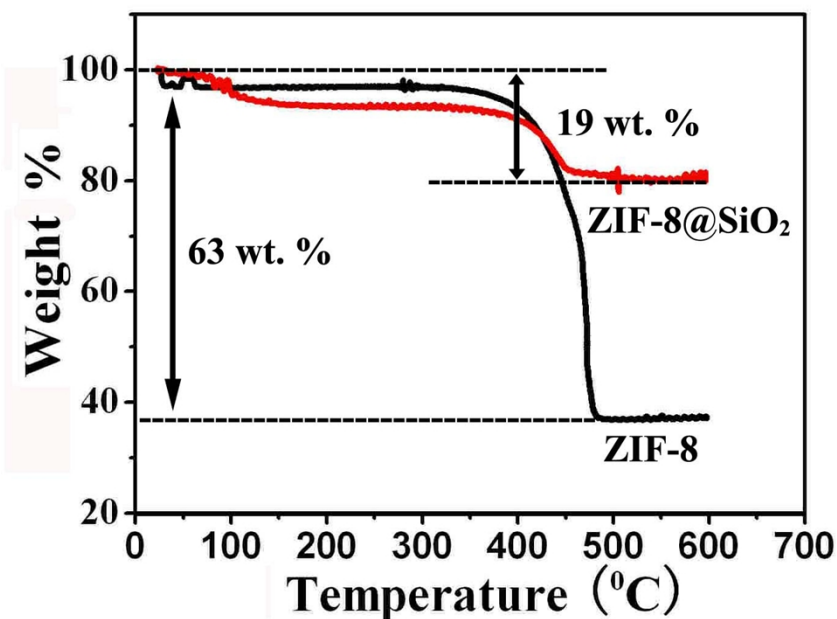
**Synthesis of ZIF-8@SiO<sub>2</sub> core-shell and ZnO@SiO<sub>2</sub> yolk-shell NPs.** The reported Stöber method was used to prepare the ZIF-8@SiO<sub>2</sub> core-shell NPs. Typically, 10 mL ethanol was poured into 0.2 mL of the prepared ZIF-8 ethanol solution (10 mg mL<sup>-1</sup>) under vigorous magnetic stirring. Then sodium hydroxide aqueous solution (0.1 M) was added into the above solution to adjust its pH to 8. Subsequently, 0.12 mL 20 % TEOS in ethanol was dropped into the weak alkaline solution and added 40 μL every 30 min interval. The reaction mixture was stirred for another 18 h after dropping all of the TEOS ethanol solution. Finally, the product was collected with centrifugation at 9000 rpm and washed with ethanol for several times before drying at 50 °C in an oven. ZnO@SiO<sub>2</sub> yolk-shell NPs were synthesized by directly calcined the ZIF-8@SiO<sub>2</sub> powders at 500 °C with a heating rate of 1 °C min<sup>-1</sup> in air for 2 h to complete the conversation of ZIF-8 cores into ZnO.

**Synthesis of ZIF-8@SiO<sub>2</sub> yolk-shell and SiO<sub>2</sub> hollow NPs.** Both of them were prepared through hydrothermal treatment process. Firstly, 2 mg of the as-prepared

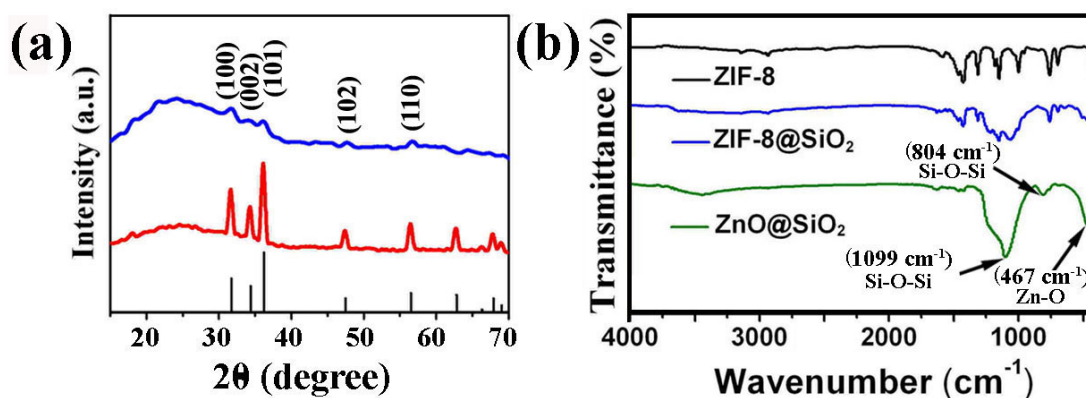
ZIF-8@SiO<sub>2</sub> core-shell NPs powders were re-dispersed in 2 mL DI-water with 10 uL hydrochloric acid (16 mM) by ultrasound. Then the solution was placed in a HP500 microwave vessel and sealed. Finally, the reaction was heated to 100 °C and held at this temperature for 2 h. After cooling to room temperature, the resulting ZIF-8@SiO<sub>2</sub> yolk-shell NPs were isolated by centrifugation at 9000 rpm for 10 min and washed with ethanol and DI-water alternately. The SiO<sub>2</sub> hollow NPs were obtained as the same process as the ZIF-8@SiO<sub>2</sub> yolk-shell NPs, only with the hydrothermal treatment time extending to 24 h.



**Fig. S1** (a) PXR D patterns of simulated ZIF-8 (black), as-synthesized ZIF-8 (red), ZIF-8@SiO<sub>2</sub> core-shell NPs (blue). (b) EDX spectrum for ZIF-8@SiO<sub>2</sub> core-shell NPs measured on copper substrate.



**Fig. S2** TGA analysis of the ZIF-8 NPs (black) and ZIF-8@SiO<sub>2</sub> core-shell NPs (red) in air.



**Fig. S3** (a) PXRD patterns of simulated ZnO (black), ZnO NPs (red) and ZnO@SiO<sub>2</sub> yolk-shell NPs (blue) obtained by direct calcination of ZIF-8 and ZIF-8@SiO<sub>2</sub> core-shell NPs at 500 °C, respectively. (b) FTIR spectra of ZIF-8 (black), ZIF-8@SiO<sub>2</sub> core-shell (blue) and ZnO@SiO<sub>2</sub> yolk-shell NPs (green).

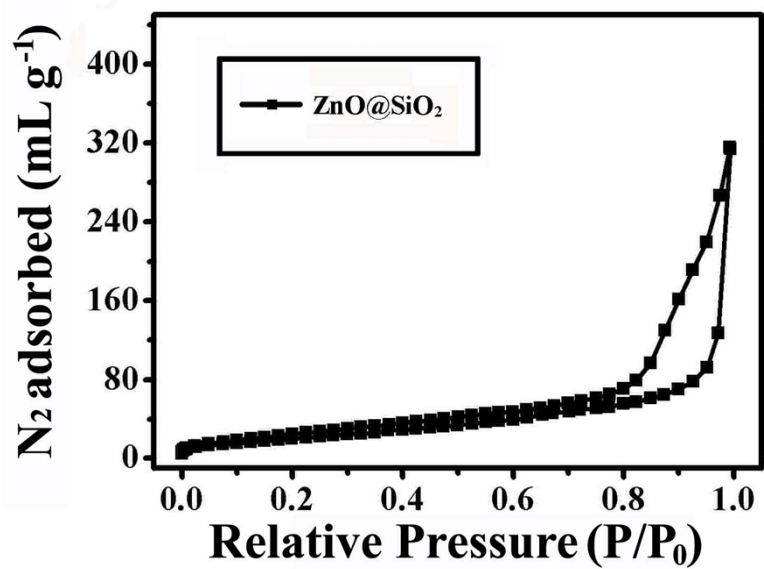


Fig. S4 N<sub>2</sub> sorption isotherm of ZnO@SiO<sub>2</sub> yolk-shell NPs collected at 77.35 K.

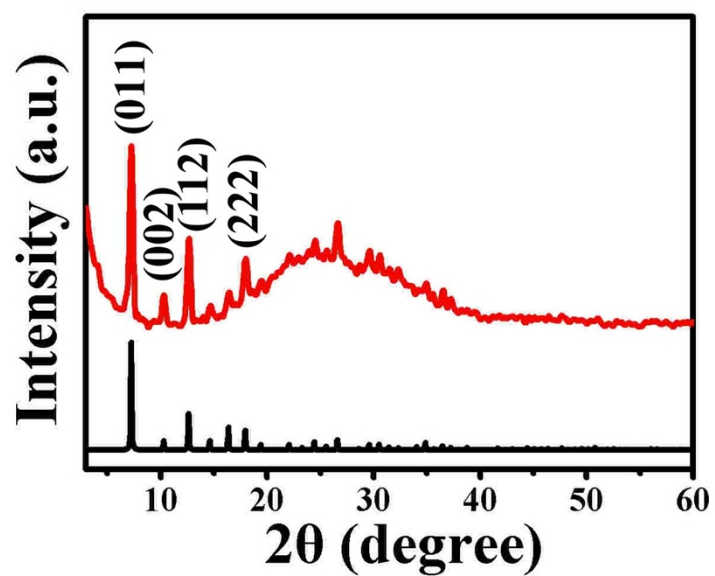
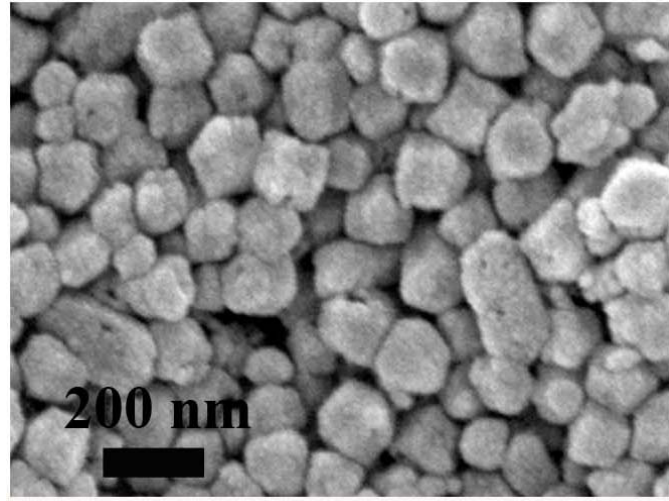


Fig. S5 PXRD patterns of simulated ZIF-8 (black) and as-synthesized ZIF-8@SiO<sub>2</sub> yolk-shell NPs (red).



**Fig. S6** FE-SEM image of the SiO<sub>2</sub> hollow NPs.