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## **Controllable fabrication of immobilized ternary CdS/Pt-TiO<sub>2</sub> heteronanostructures toward high-performance visible-light driven photocatalysis**

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## **Synthetic procedure and Photocatalytic activity test of CdS/Pt/TiO<sub>2</sub> NTAs**

### **Preparation of TiO<sub>2</sub> nanotube arrays**

The anodization process was performed in a two-electrode electrochemical cell with Ti foils as the anode and a piece of highly pure graphite as the cathode. The Ti foils were anodized at 60 V for 10 h in the electrolyte containing NH<sub>4</sub>F (0.1 M), ethylene glycol and water (10vol%). After anodization, the obtained samples were ultrasonically cleaned in ethylene glycol for 90 s to remove the debris and other impurities, then dried in air. Finally, the samples were annealed in air at 500°C for 2 h.

### **Deposition of Pt, CdS NPs**

Pt/TiO<sub>2</sub> NTAs were prepared by photoreduction deposition method. First, TiO<sub>2</sub> NTAs were immersed in a 14 ml aqueous solution for 2 h which contained 7 ml methanol and H<sub>2</sub>PtCl<sub>6</sub>·6H<sub>2</sub>O with different concentrations. Then the samples were bubbled in nitrogen for 30 min to remove the dissolved oxygen. After that, the samples were illuminated by a 500 W Mercury lamp for 30 min at room temperature. Finally, the samples were rinsed with deionized water and dried in oven at 40°C for 2 h.

CdS/TiO<sub>2</sub> NTAs and CdS/Pt/TiO<sub>2</sub> NTAs were prepared by chemical bath deposition method (CBD). First, TiO<sub>2</sub> NTAs were immersed in a 0.02 M cadmium chloride aqueous solution for 30 s, rinsed with deionized water for 60 s and then in a 0.02 M sodium sulfide aqueous solution for 30 s, followed with additional rinse in deionized water for 60 s. The two-step immersing procedure was termed as one CBD cycle. This deposition cycle was repeated for 13 times. Finally, the modified samples were dried in an oven at 40°C for 2 h and then were annealed at 350°C for 2 h in Argon atmosphere with the heating rate of 1°C·min<sup>-1</sup>.

### **Photocatalytic activity test**

The photocatalytic activities of as-prepared samples under visible light were tested by an XPA-7 photochemical reactor (Nanjing Xujiang Machine-electronic Plant, China). Methyl Orange (MO) aqueous solution was used as a model pollutant to be degraded. A 250 W metal halide lamp with a UV cut-off filter was used as the resource of visible light ( $\lambda > 420$  nm), the photoreactor was cooled by circulating water during the photodegradation process. The volume of MO aqueous solution was 12 ml with the concentration of 10 mg/L, and the size of sample was 1.5×3 cm.

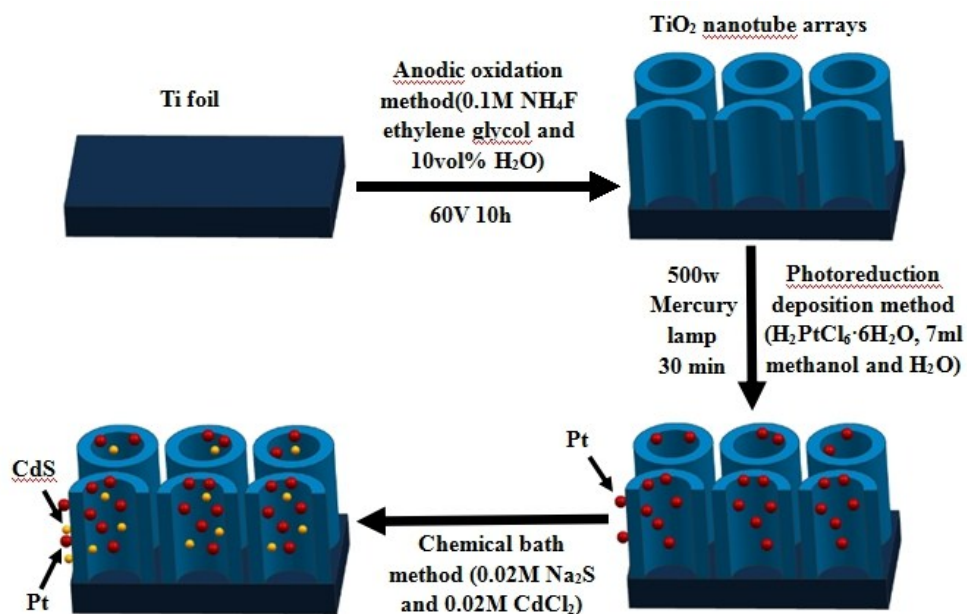


Fig.S1. Schematics of the fabrication process of CdS/Pt/TiO<sub>2</sub> NTAs

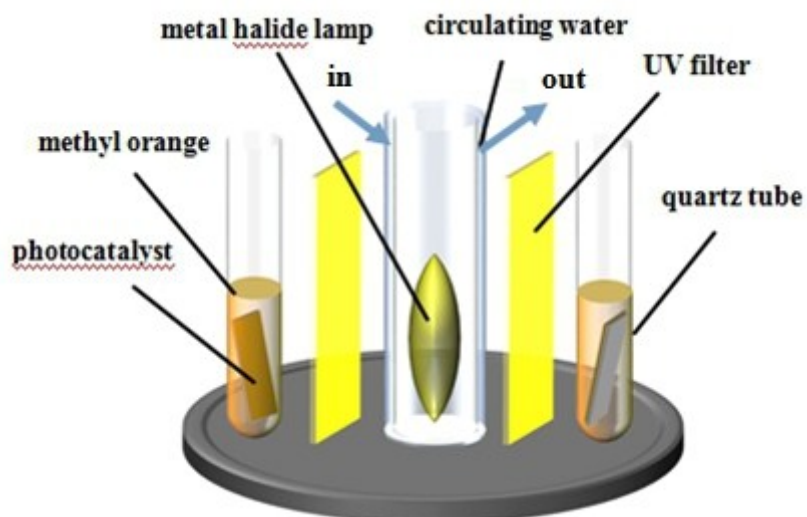
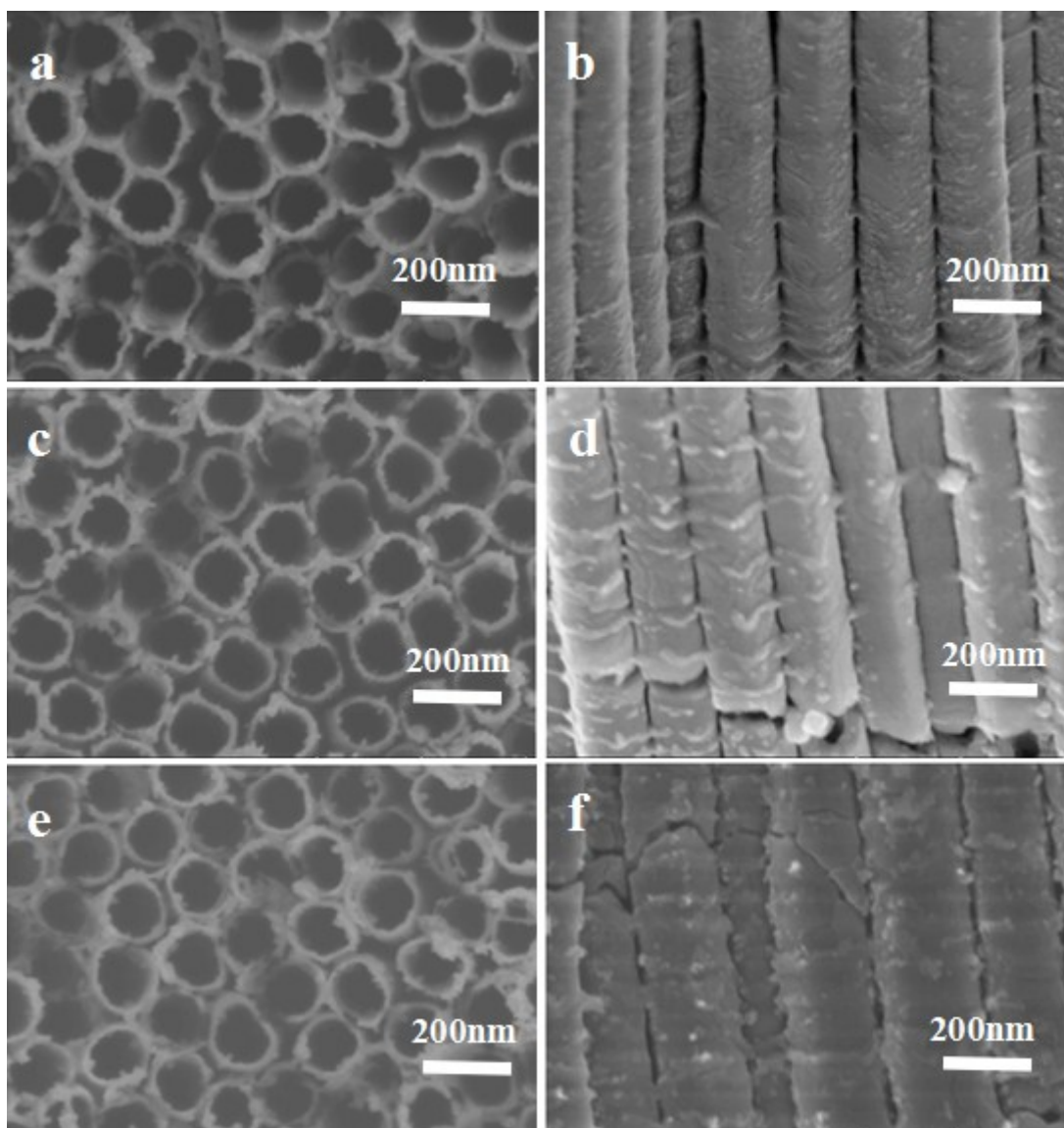
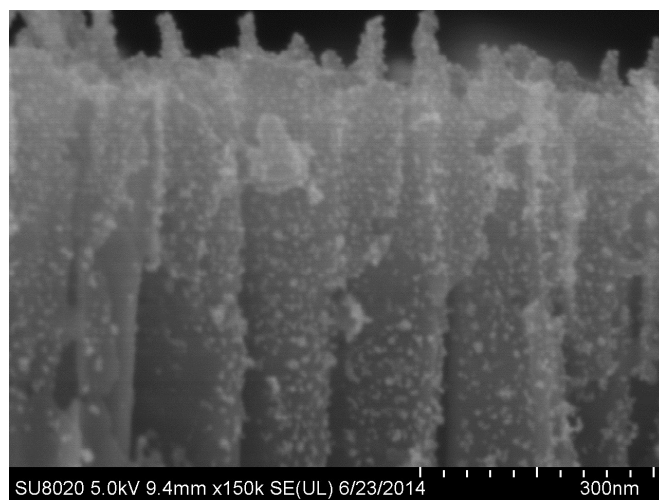


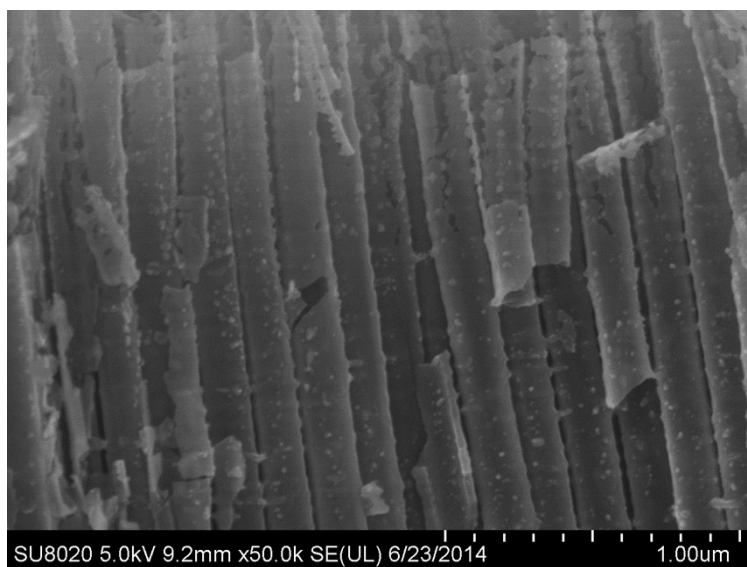
Fig.S2. Schematic diagram of XPA-7 photochemical reactor



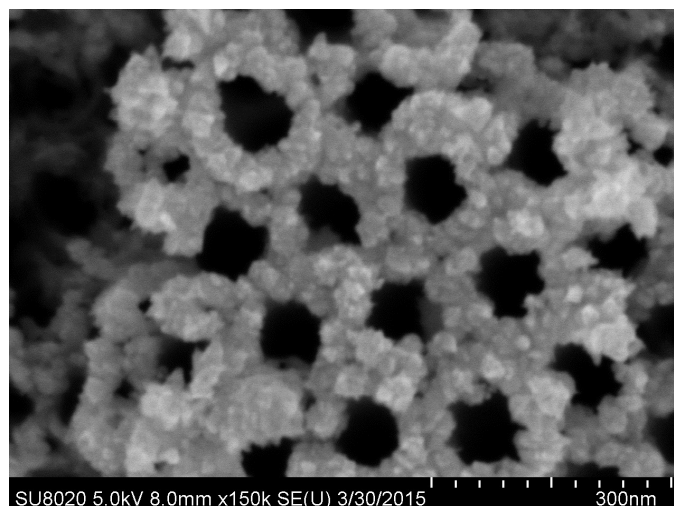
**Fig.S3. FESEM morphologies of CdS/Pt/TiO<sub>2</sub> NTAs prepared with different  $\text{H}_2\text{PtCl}_6$  concentrations (a,b 1 mmol·L<sup>-1</sup>; c,d 2 mmol·L<sup>-1</sup>; e,f 3 mmol·L<sup>-1</sup>), 13 deposition cycles of CdS**



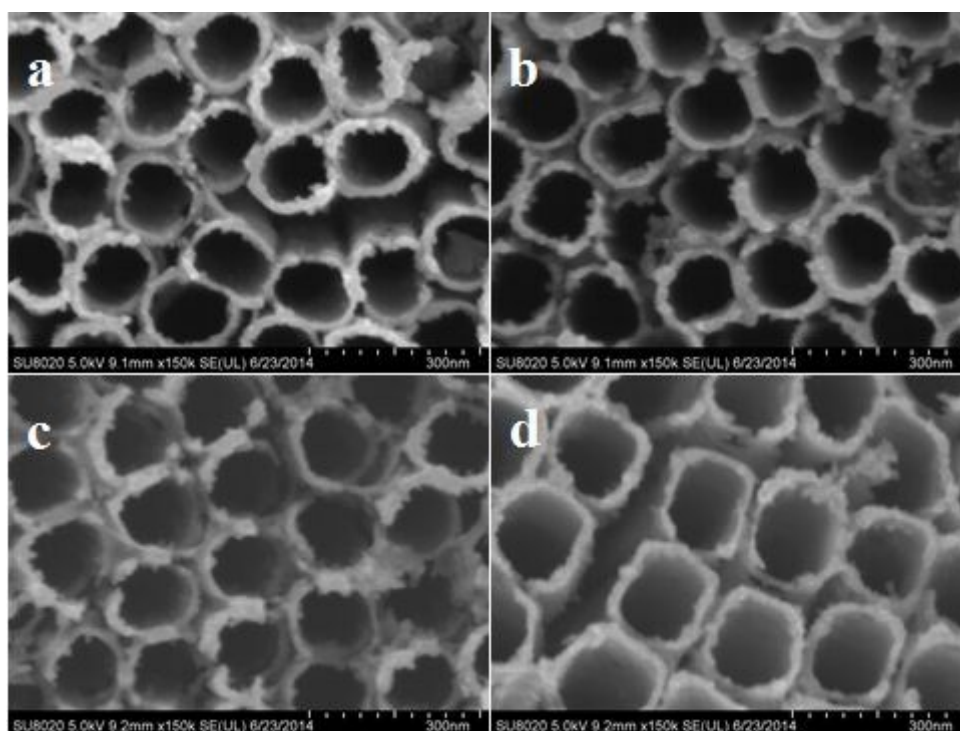
**Fig.S4. FESEM morphology of Pt/TiO<sub>2</sub> NTAs prepared with 1 mmol·L<sup>-1</sup>H<sub>2</sub>PtCl<sub>6</sub>**



**Fig.S5. FESEM morphologies of CdS/Pt/TiO<sub>2</sub> NTAs (CdS deposition cycle: 13 cycles; the concentration of H<sub>2</sub>PtCl<sub>6</sub>: 1 mmol·L<sup>-1</sup>)**



**Fig.S6. FESEM morphologies of CdS/Pt/TiO<sub>2</sub> NTAs (CdS deposition cycle: 13 cycles; the concentration of H<sub>2</sub>PtCl<sub>6</sub>: 4 mmol·L<sup>-1</sup>)**



**Fig.S7. FESEM morphologies of CdS/Pt/TiO<sub>2</sub> NTAs (CdS deposition cycle: 13 cycles; the concentration of H<sub>2</sub>PtCl<sub>6</sub>: 1 mmol·L<sup>-1</sup>) after being reused for different times (a: 5 times; b: 10 times; c: 15 times; d: 20 times).**