Supporting Information

An Unusual Charge Distribution on the Facet of SrTiO$_3$ Nanocube under Light Irradiation

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Figure S1. (a) SEM image of SrTiO$_3$ nanocube; (b) XRD pattern of SrTiO$_3$ nanocube.
Figure S2. (a) UV-vis diffuse reflectance spectrum of SrTiO$_3$ nanocube; (b) Band structure of SrTiO$_3$ nanocube.
Figure S3. (a) XPS of Co$_3$O$_4$ cocatalysts photo-deposited at different light intensities on SrTiO$_3$ nanocube. (b) HRTEM of Co$_3$O$_4$ cocatalysts photo-deposited on SrTiO$_3$ nanocube.
Figure S4. EDX analysis of Pt at different light intensities. Density of photon: (a) $5 \times 10^{16} \text{s}^{-1} \cdot \text{cm}^{-2}$; (b) $10^{18} \text{s}^{-1} \cdot \text{cm}^{-2}$.
Figure S5. Photodeposited Co$_3$O$_4$ at different time under strong illumination.
Figure S6. More SEM images of Pt and Co$_3$O$_4$ on SrTiO$_3$ nanocube under weak illumination.
Figure S7. The random distribution of Pt and Co$_3$O$_4$ under strong light intensity on SrTiO$_3$ nanocube.
Figure S8. The size distribution of (a) Pt and (b) Co$_3$O$_4$ on SrTiO$_3$ nanocube.
Figure S9. The photocatalytic activities on different kinds of SrTiO$_3$ samples and the photocatalytic properties of only one cocatalyst (Pt) photodeposited on SrTiO$_3$ nanocube under weak illumination. There are no photocatalytic activities when only one cocatalyst (Co$_3$O$_4$) photodeposited on SrTiO$_3$ nanocube.
1. Synthesis of SrTiO$_3$–based photocatalysts

The SrTiO$_3$ nanocrystals were prepared by a hydrothermal synthesis method. Titanium tetrachloride (TiCl$_4$) aqueous solution was used as titanium precursor and strontium chloride (SrCl$_2$) aqueous solution was used as strontium source. All chemicals used in our experiment were of analytical grade and used without further purification. Aqueous solutions were prepared using ultrapure water. In a typical synthesis, 0.26 mL of TiCl$_4$ was dropwised into 25 mL of deionized water containing 2.0 g methanol cooled in an ice bath. After stirring for 5 min, 30 mL of LiOH solution containing 4.0 g LiOH·H$_2$O was added. After stirring for 30 min, 10 mL solution containing 0.7 g SrCl$_2$·6H$_2$O was added. After stirring for another 30 min, the resulting solution was transferred to a homemade 100 mL Teflon-lined stainless steel autoclave. Subsequently, the autoclave was heated for 48 hours at 180 °C, then was allowed to cool to room temperature naturally. Afterwards, the sample was centrifuged at 5000 rmp for 8 min. Finally, the SrTiO$_3$ nanocubes were centrifuged five times in deionized water and anhydrous ethanol, respectively, and dried at 80 °C for 12 hours.
The impregnation method was taken place at 200 °C for 2 hour. The impregnated Pt was achieved with H$_2$PtCl$_6$ as the precursor. The impregnated Co$_3$O$_4$ was achieved with Co(NO$_3$)$_2$ as the precursor.

2. Photo-deposition of noble metals and/or metal oxides

The photon intensity was detected by photon counter and illumination was controlled by electric current, from 6A to 22A. The photo-deposition of the Pt was achieved with H$_2$PtCl$_6$ as the precursor. H$_2$PtCl$_6$ solution (1.37 mL, 0.73 mg/mL) was added and the suspension was then irradiated by a 300 W Xe lamp (Ushio-CERMAXLX300) under a constant stirring. The suspension was centrifuged five times in deionized water and anhydrous ethanol, respectively, and dried at 70 °C for 12 hours in a vacuum oven. The photo-deposition of the Co$_3$O$_4$ was achieved with Co(NO$_3$)$_2$ as the precursor, and NaIO$_3$ was employed as the electron acceptor. 0.5 mL Co(NO$_3$)$_2$ solution (2.00 mg/mL) was and the suspension was then irradiated by a 300 W Xe lamp (Ushio-CERMAXLX300) under a constant stirring. The suspension was centrifuged five times in deionized water and anhydrous ethanol, respectively, and dried at 70 °C for 12 hours in a vacuum oven. The
photo-deposition experiments were taken place in ice bath for five minutes.

3. Test of photocatalytic water splitting performances

The photocatalytic water splitting reactions were carried out in a closed gas circulation and evacuation system using a 300 W Xe lamp (Ushio-CERMAXLX300), 150 mL H$_2$O, 50 mg catalysts. The apparent quantum efficiency was measured at 365 nm by filter. Before irradiation, the reaction system was thoroughly degassed by evacuation in order to drive off the air inside. The amount of evolved H$_2$ and O$_2$ was determined by an on-line gas chromatograph (Agilent, GC-7890, TCD, Ar carrier). The rate of H$_2$ and O$_2$ evolution in the initial one hour was recorded for comparison. CH$_3$OH and NaIO$_3$ as sacrificial agent for HER and OER, respectively

4. Characterizations

The as-prepared samples were characterized by X-ray power diffraction (XRD) on a Rigaku D/Max-2500/PC powder diffractometer. The sample power was scanned using Cu-K$_\alpha$ radiation with an operating voltage of 40 kV and current of 200 mA. The scan rate of 5°/min was applied to
record the patterns in the range of 20-80° at a step size of 0.02°. UV-visible (UV-vis) diffuse reflectance spectra were recorded on a UV-vis spectrophotometer (JASCO V-650) equipped with an integrating sphere. The morphologies and particle sizes were examined by scanning electron microscopy (SEM) taken with a Quanta 200 FEG scanning electron microscope. HRSEM was carried out on a Hitachi high-technology S-5500 with an operating voltage of 30 kV. The HRTEM images were obtained on a Tecnai G2 F30 S-Twin (FEI Company). X-ray photoelectron spectroscopy (XPS) measurements were carried out on a VG ESCALAB MK2 spectrometer with monochromatized Al-Kα excitation, and the C 1s peak (284.6 eV) was used as the reference, arising from adventitious carbon.

5. Chemical reagents

All chemicals used in our experiments were of analytical grade and used without further purification. Aqueous solutions were prepared using deionized water with 18.2 MΩ·cm from a Millipore deionized water system. SrCl₂·6H₂O, TiCl₄, LiOH·H₂O, CH₃OH were obtained from Alfa Aesar. H₂PtCl₆, Co(NO₃)₂, NaIO₃ were obtained from Tianjin Kemiou.