Electronic Supporting Information

Selective deposition of redox co-catalyst(s) to improve the photocatalytic activity of single-domain ferroelectric $PbTiO_3$ nanoplates

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Sample preparation. Single-crystal, single-domain $PbTiO_3$ nanoplates were prepared according to the reported synthesis method [1]. In brief, anatase TiO_2 and $Pb(NO_3)_2$ powder (the molar ratio of Ti to Pb is 1:1.25) were added in a 6 M KOH aqueous solution. The mixed solution transferred to a Teflon-lined autoclave was heated at 200 ^oC for 24 h. The collected product was washed with 1% HNO_3 and deionized water, and then dried to obtain $PbTiO_3$ nanoplates.

Photodeposition of noble metal nanoparticles on $PbTiO_3$ nanoplates. The photodeposition of metal (Pt, Au, Ag) nanoparticles on the nanoplates was conducted by first suspending 200 mg powder of the nanoplates in 40 mL of solution of methanol and water (1:3 in volume) containing a certain amount of metal precursor (H_2PtCl_6, $HAuCl_4$ and $AgNO_3$). The suspension was then irradiated with a high-pressure mercury lamp for 6 h under stirring. The sample was collected by filtering and drying in air at room temperature.

Photodeposition of metal oxide nanoparticles on $PbTiO_3$ nanoplates. The photodeposition of MnO_x nanoparticles on the nanoplates was conducted by first suspending 200 mg powder of the nanoplates in 50 mL of 0.1 M $NaIO_3$ aqueous solution containing a certain amount of $MnSO_4$. The suspension was then irradiated with a high-pressure mercury lamp for 6 h under stirring. The sample was collected by filtering and drying in air at room temperature.

Simultaneous photodeposition of noble metal and metal oxide nanoparticles on $PbTiO_3$ nanoplates. 200 mg powder of the nanoplates was suspended in 40 mL of aqueous solution containing a certain amount of metal precursor (H_2PtCl_6, $HAuCl_4$ and $AgNO_3$) and $MnSO_4$. The

suspension was then irradiated with a high-pressure mercury lamp for 6 h under stirring. The sample was collected by filtering and drying in air at room temperature.

Characterization. X-ray diffraction pattern of the sample was recorded on a Rigaku diffractometer using Cu Kα irradiation. The morphology of samples before and after photodeposition of noble metal and metal oxide nanoparticles was determined by using scanning electron microscopy performed on a Nova NanoSEM 430.

Photocatalytic hydrogen generation measurements. Photocatalytic hydrogen generation reactions were carried out in a top-irradiation vessel connected to a glass closed gas circulation system. 100 mg of the photocatalyst powder was dispersed in 300 mL aqueous solution containing 10 vol% triethanolamine scavenger. The amount of H_2 evolved was determined using a gas chromatography (Agilent 6890). The light source was a 300 W Xe lamp (Beijing Trusttech Co. Ltd, PLS-SXE-300UV).

Reference

[1] C. Y. Chao, Z. H. Ren, Y. H. Zhu, Z. Xiao, Z. Y. Liu, G. Xu, J. Q. Mai, X. Li, G. Shen and G. R. Han, *Angewandte Chemie-International Edition*, 2012, **51**, 9283-9287.

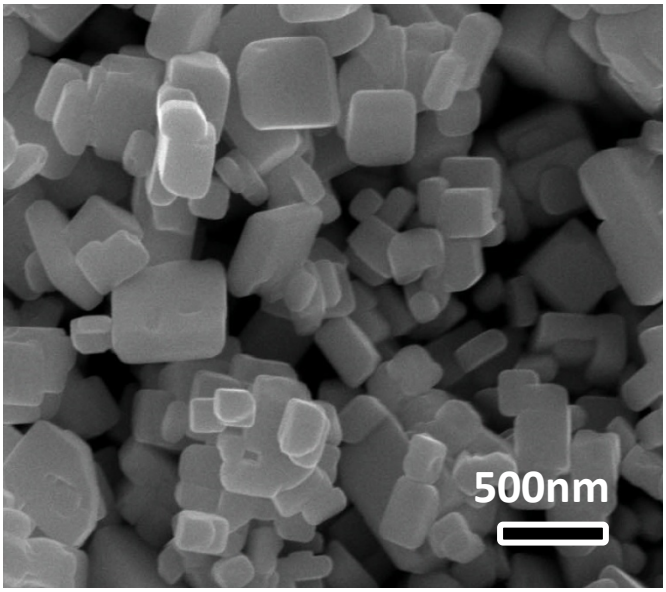

Fig. S1 Low-magnitude SEM image of $PbTiO_3$ nanoplates.

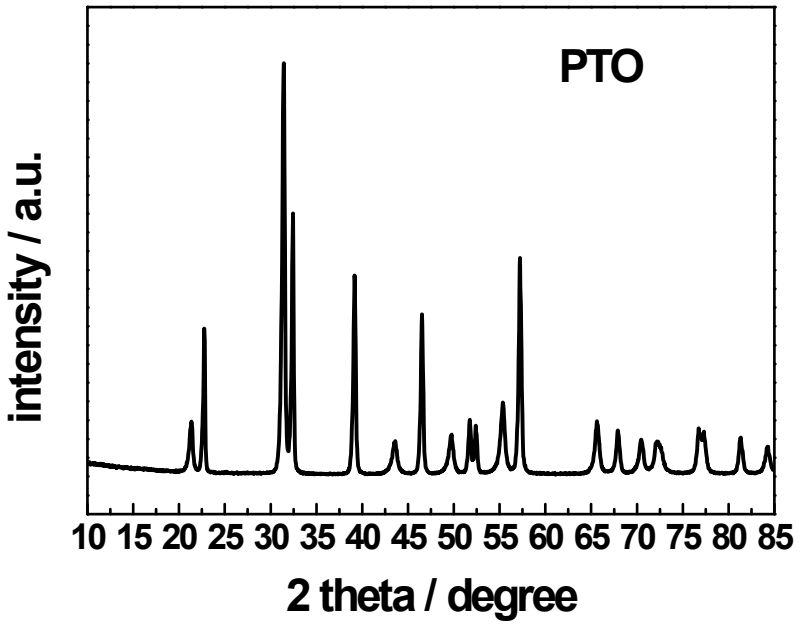

Fig. S2 XRD pattern of $PbTiO_3$ nanoplates.

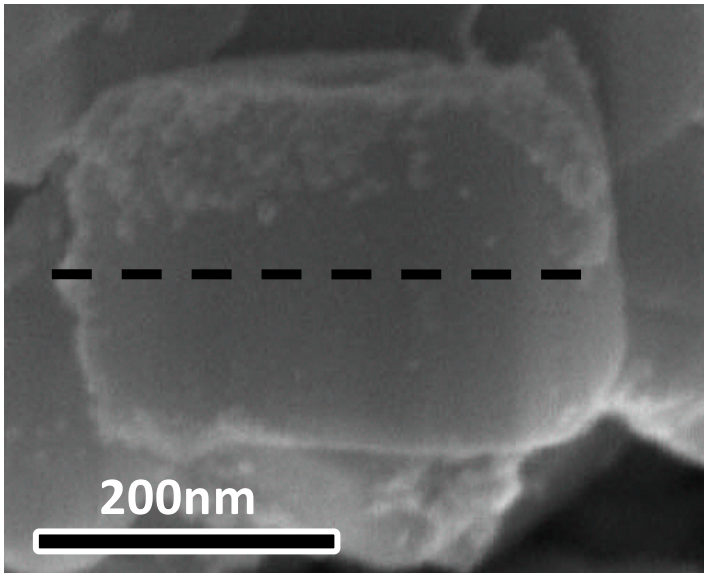

Fig. S3 SEM image of a $PbTiO_3$ nanoplate with the photodeposition of Pt.

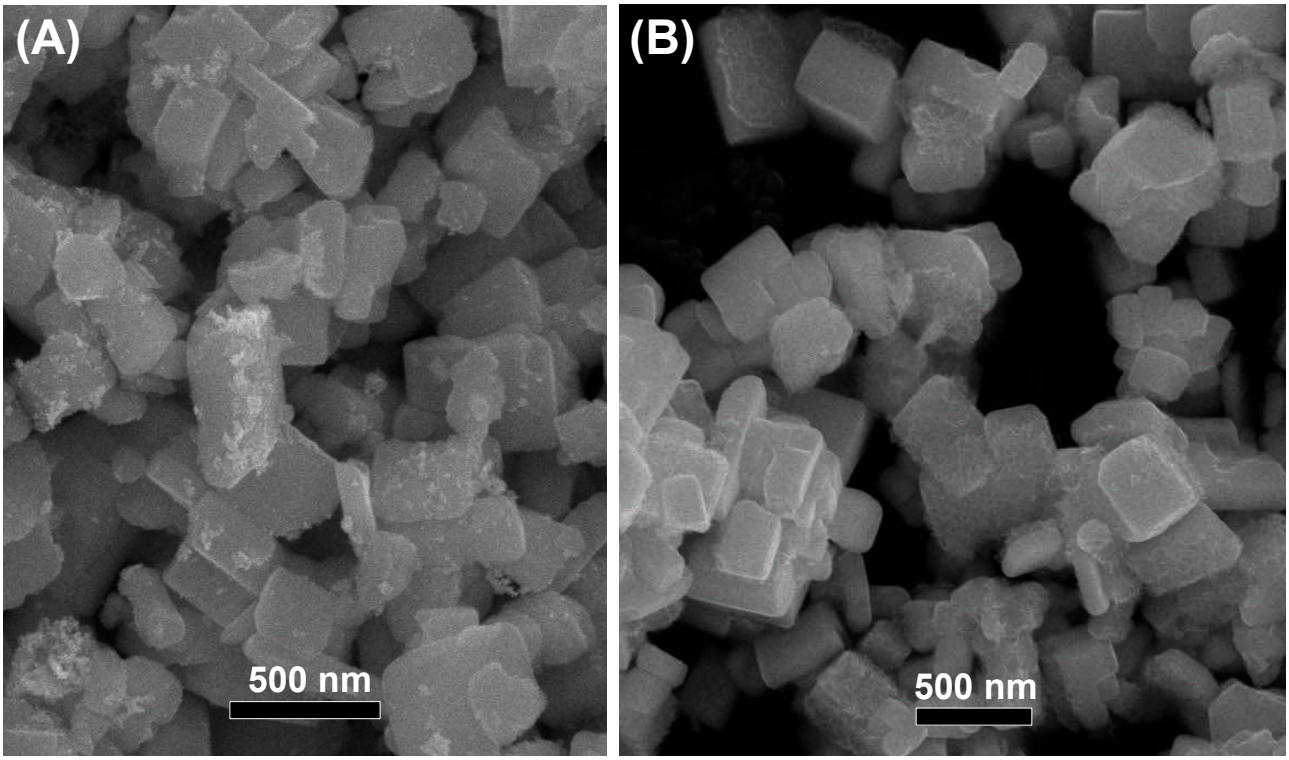

Fig. S4 Low-magnification SEM images of $PbTiO_3$ nanoplates with photo-deposited (A) Pt and (B) MnO_x nanoparticles.

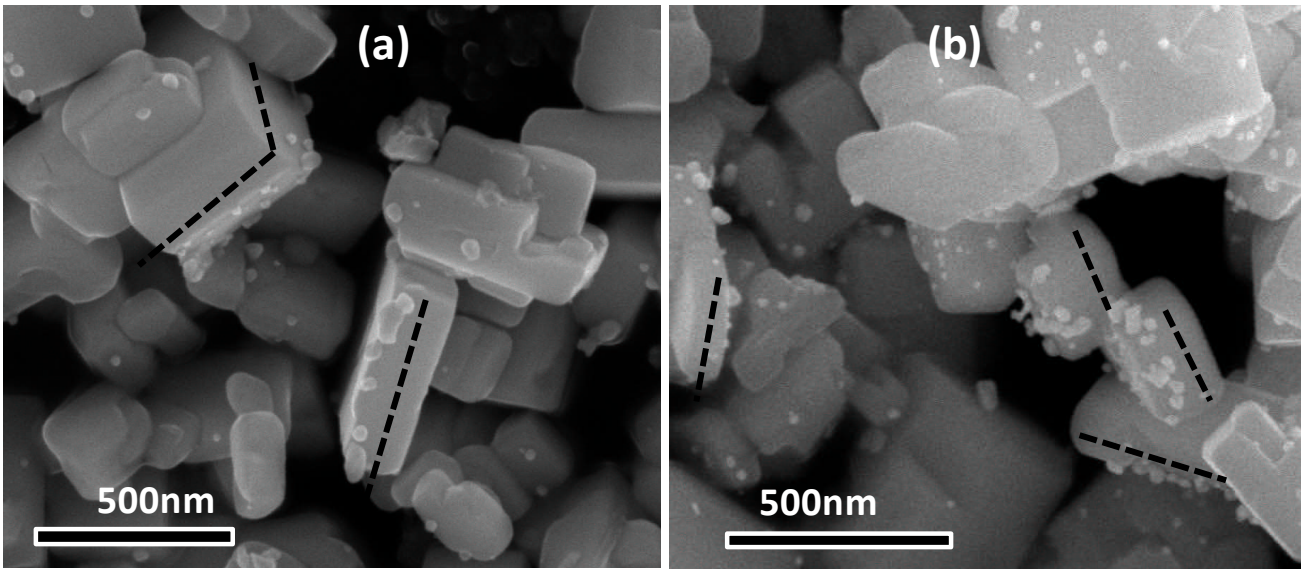

Fig. S5 SEM images of $PbTiO_3$ nanoplates with (a) Au and (b) Ag depositions.

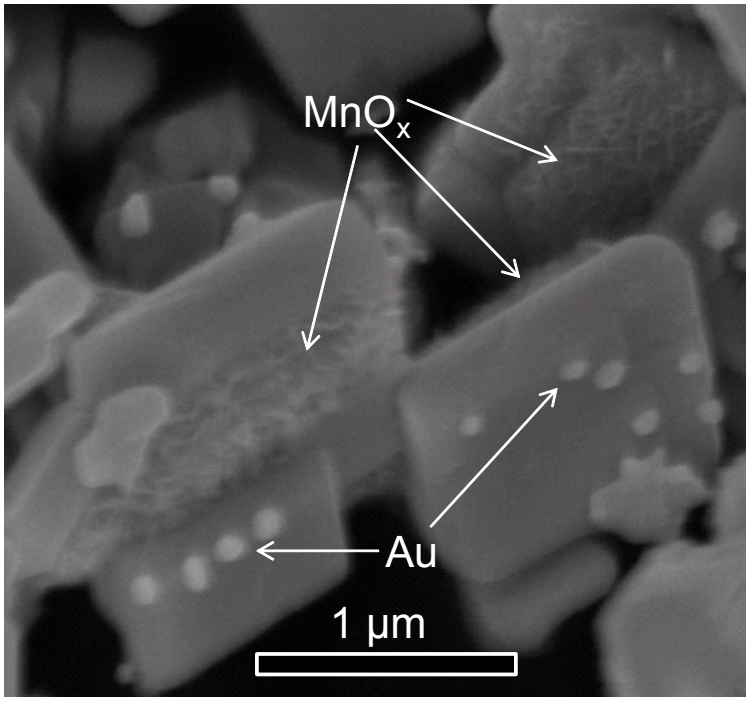

Fig. S6 SEM images of $PbTiO_3$ nanoplates with simultaneously photo-deposited MnO_x and Au nanoparticles on two pposite sides of the nanoplates. The contents of deposited MnO_x and Au are 4 wt% and 3 wt%, respectively.

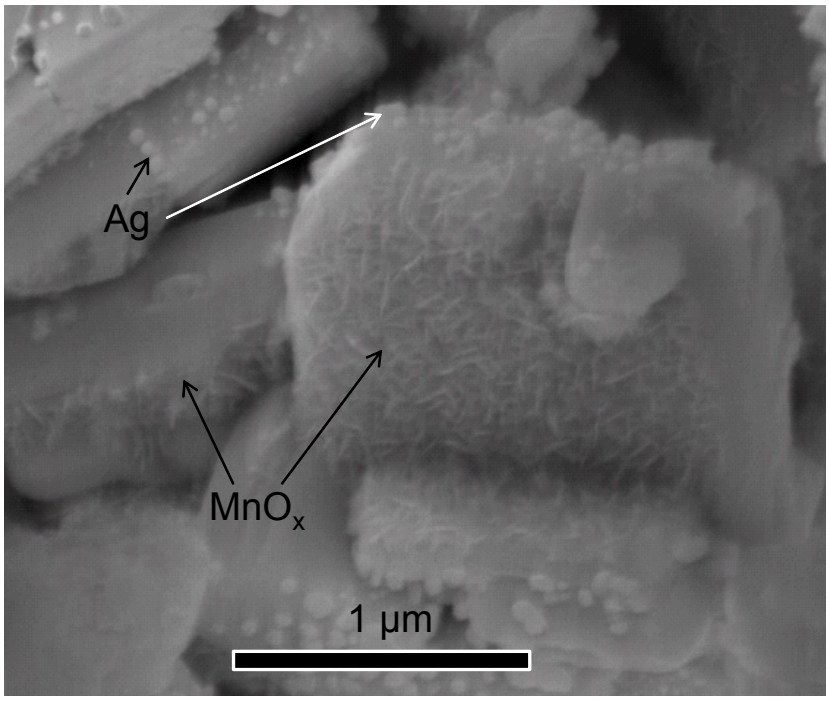

Fig. S7 SEM images of $PbTiO_3$ nanoplates with simultaneously photo-deposited MnO_x and Ag nanoparticles on two opposite sides of the nanoplates. The contents of deposited MnO_x and Ag are 4 wt% and 3 wt%, respectively.

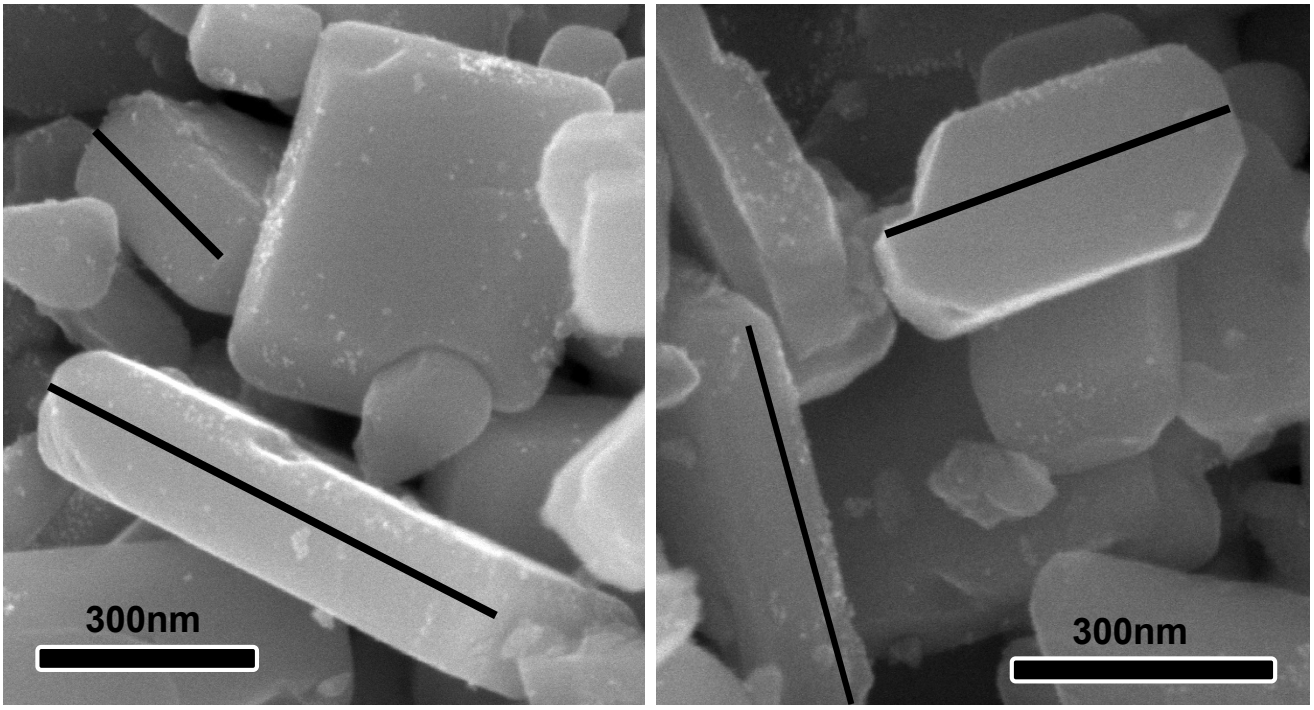

Fig. S8 SEM images of $PbTiO_3$ nanoplates with 1 wt% Pt deposition.