

Supporting information

Au Nanoparticles Doped Co₃O₄-CoFe₂O₄@SiO₂ as Catalyst for Visible-light-driven Water Oxidation

Wenlan Ma^a, Hui Li^a, Qian Xu^a, Yi Zhang^{a,b}, Wei Wang^{a,c} and Jide Wang^{*a}

^aKey Laboratory of Oil and Gas Fine Chemicals, Ministry of Education & Xinjiang Uygur, Autonomous Region, College of Chemistry and Chemical Engineering of Xinjiang University, Urumqi 830046, China

^bKey Laboratory of Resources Chemistry of Nonferrous Metals (Ministry of Education), College of Chemistry and Chemical Engineering, Central South University, Changsha, 410083, China.

^cDepartment of chemistry and Centre for pharmacy, University of Bergen, Bergen, N-5020, Norway, Email: wei.wang@uib.no

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Experimental and calculation

Quantum yield calculation

$$E = 52.8 \text{ mW} \cdot \text{cm}^{-2}$$

$$\begin{aligned} \text{Photo flux} &= \frac{P\lambda}{hc} = \frac{52.8 \times 10^{-3} \times 420 \times 10^{-9}}{6.626 \times 10^{-34} \times 3 \times 10^8} = 1.1156 \times 10^{17} \text{ mol} \cdot \text{s}^{-1} \cdot \text{cm}^{-2} \\ &= 4.016 \times 10^{20} \text{ mol} \cdot \text{h}^{-1} \cdot \text{cm}^{-2} \\ &= \frac{4.016 \times 10^{20}}{6.022 \times 10^{23}} \times 10^6 \text{ \mu einstein} \cdot \text{h}^{-1} \\ &= 6.6689 \times 10^2 \text{ \mu einstein} \cdot \text{h}^{-1} \\ &= 11.1148 \text{ \mu einstein} \cdot \text{min}^{-1} \end{aligned}$$

The total ζ_p

$$\begin{aligned} \text{rate} &= \frac{17.81}{6} \text{ \mu mol} \cdot \text{min}^{-1} = 2.968 \text{ \mu mol} \cdot \text{min}^{-1} \\ \zeta_p &= \frac{\text{rate}}{I_0} = \frac{2.968}{6.6689 \times 10^2} \times 100\% = 26.71\% \end{aligned}$$

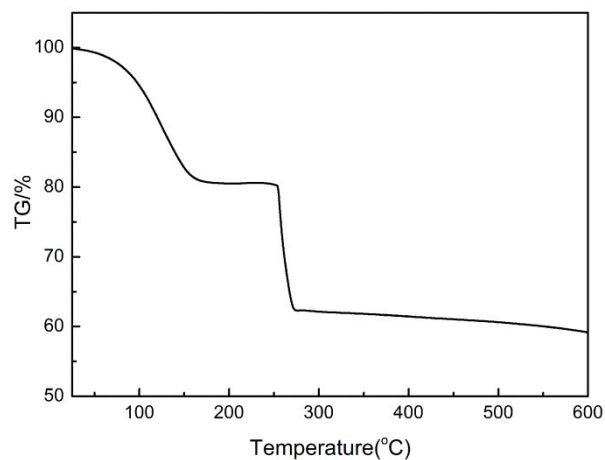


Fig. S1 TG analysis curve of as-synthesized $\text{Co}_3[\text{Fe}(\text{CN})_6]_2$ under air condition.

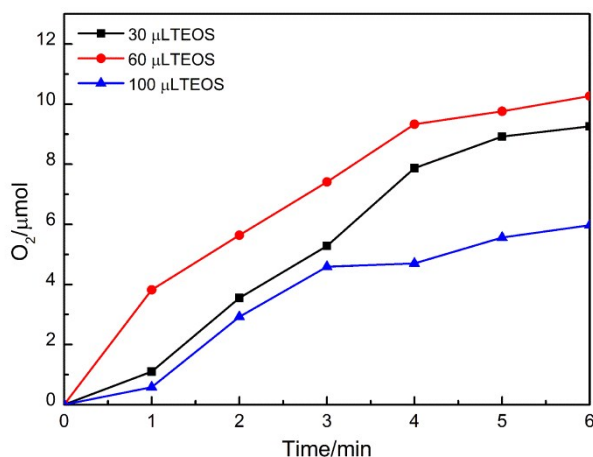


Fig. S2 Time courses of O_2 formation in the photocatalytic system using $Co_3O_4-CoFe_2O_4@SiO_2$ catalyst with different quantity of TEOS (30 μ L (black); 60 μ L (red); 100 μ L (teal blue)).

Conditions: 300 W Xe lamp ($\lambda \geq 420$ nm), 1.0 mg catalyst, 1.0 mM $[Ru(bpy)_3](ClO_4)_2$, 5.0 mM $Na_2S_2O_8$, and 80 mM sodium borate buffer (initial pH 8.0); total reaction volume 10 mL; overall volume ~ 23 mL; vigorous agitation by a magnetic stirrer.

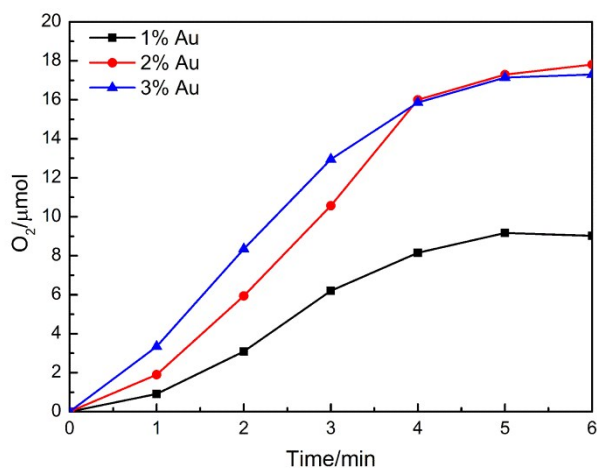


Fig. S3 Time courses of O_2 formation in the photocatalytic system using $Co_3O_4-CoFe_2O_4@SiO_2@Au$ catalyst with different percentage composition of Au nano particle (1% (black); 2% (red); 3% (blue)).

Conditions: 300 W Xe lamp ($\lambda \geq 420$ nm), 1.0 mg catalyst, 1.0 mM $[Ru(bpy)_3](ClO_4)_2$, 5.0 mM $Na_2S_2O_8$, and 80 mM sodium borate buffer (initial pH 8.0); total reaction volume 10 mL; overall volume ~ 23 mL; vigorous agitation by a magnetic stirrer.

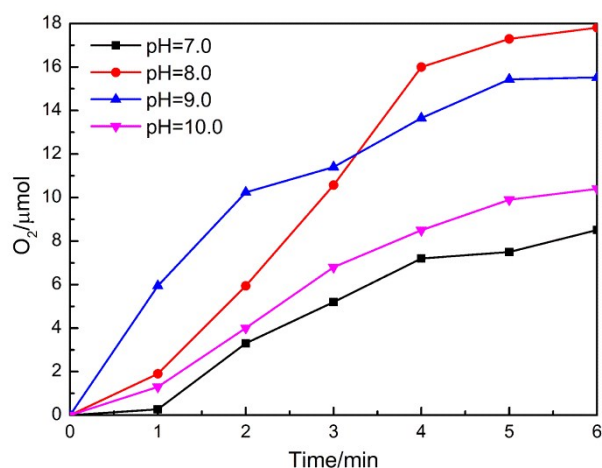


Fig. S4 Time courses of O₂ formation in the photocatalytic system using Co₃O₄-CoFe₂O₄@SiO₂@Au at various pH values.

Conditions: 300 W Xe lamp ($\lambda > 420$ nm), 1.0 mM [Ru(bpy)₃](ClO₄)₂, 5.0 mM Na₂S₂O₈, 80 mM sodium borate buffer at different pH of borate buffer ((pH 7 (black); pH 8 (red); pH 9 (teal blue); pH 10 (pink)); total reaction volume 10 mL; overall volume ~23 mL; vigorous agitation by a magnetic stirrer.

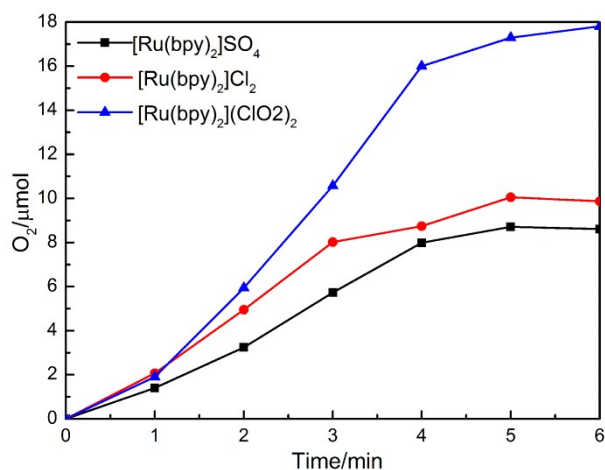


Fig. S5 Time courses of O₂ formation in the photocatalytic system using different photosensitizers (1.0 mM [Ru(bpy)₃](ClO₄)₂ (black); 1.0 mM [Ru(bpy)₃]SO₄ (red); 1.0 mM [Ru(bpy)₃]Cl₂ (blue)).

Conditions: 300 W Xe lamp ($\lambda > 420$ nm), 1.0 mg catalyst, 5.0 mM Na₂S₂O₈, and 80 mM sodium borate buffer (initial pH 8.0); total reaction volume 10 mL; overall volume ~23 mL; vigorous agitation by a magnetic stirrer.

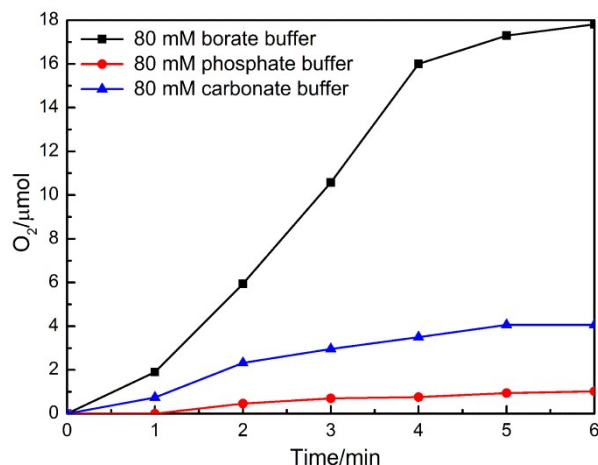


Fig. S6 Time courses of O₂ formation in the photocatalytic system using different kinds of buffers (pH=8.0, 80 mM borate buffer (black); pH=8.0, 80 mM phosphate buffer (blue); pH=8.0, 80 mM carbonate buffer (red)).

Conditions: 300 W Xe lamp ($\lambda > 420$ nm), catalysts: 1.0 mg Co₃O₄-CoFe₂O₄@SiO₂@Au, 1.0 mM [Ru(bpy)₃](ClO₄)₂, and 5.0 mM Na₂S₂O₈; total reaction volume 10 mL; overall volume ~23 mL; vigorous agitation by a magnetic stirrer.

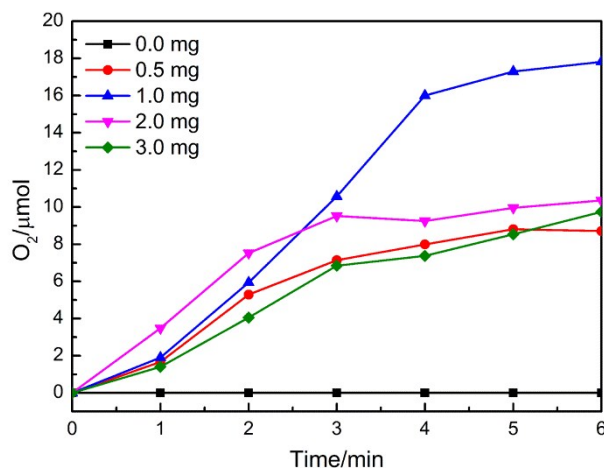


Fig. S7 Time courses of O₂ formation in the photocatalytic system using different amounts of Co₃O₄-CoFe₂O₄@SiO₂@Au (0 mg (black); 0.5 mg (red); 1.0 mg (blue); 2.0 mg (pink); 3.0 mg (green)).

Conditions: 300 W Xe lamp ($\lambda > 420$ nm), 1.0 mM [Ru(bpy)₃](ClO₄)₂, 5.0 mM Na₂S₂O₈, 80 mM sodium borate buffer (initial pH 8.0); total reaction volume 10 mL; overall volume ~23 mL; vigorous agitation by a magnetic stirrer.

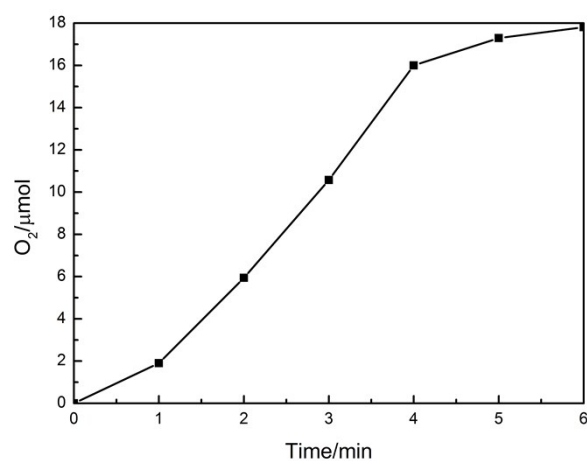


Fig. S8 Time courses of O₂ formation in the photocatalytic system using Co₃O₄-CoFe₂O₄@SiO₂@Au.

Conditions: 300 W Xe lamp ($\lambda > 420$ nm), 1.0 mg catalyst, 1.0 mM [Ru(bpy)₃](ClO₄)₂, 5.0 mM Na₂S₂O₈, and 80 mM sodium borate buffer (initial pH 8.0); total reaction volume 10 mL; overall volume 23 mL; vigorous agitation using a magnetic stirrer.