

Electronic Supplementary Information (ESI) for

Visible-light-induced water splitting on hierarchically constructed Z-scheme photocatalyst composed of zinc rhodium oxide and bismuth vanadate

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Contents

ESI-1) XRD patterns of BiVO₄ and Au/BiVO₄ (Fig. S1).

ESI-2) SEM images of BiVO₄ calcined at various temperature (Fig. S2).

ESI-3) Complementary water-splitting tests (Fig. S3).

ESI-4) XRD patterns of ZnRh₂O₄/Au/BiVO₄, ZnRh₂O₄/Au/*sp*-BiVO₄, and ZnRh₂O₄/*ran*-Au/BiVO₄ (Fig. S4).

ESI-5) SEM images of ZnRh₂O₄/Au/*sp*-BiVO₄ and ZnRh₂O₄/*ran*-Au/BiVO₄ (Fig. S5).

ESI-6) UV-vis absorption spectra of ZnRh₂O₄/Au/BiVO₄, ZnRh₂O₄/Au/*sp*-BiVO₄, and ZnRh₂O₄/*ran*-Au/BiVO₄ (Fig. S6).

ESI-7) XPS spectra of ZnRh₂O₄/Au/BiVO₄ before and after the water-splitting experiment (Fig. S7)

ESI-8) Complementary Table for water-splitting tests under monochromic LED lights (Table S1).

ESI-1) XRD patterns of BiVO_4 and Au/BiVO_4 (Fig. S1).

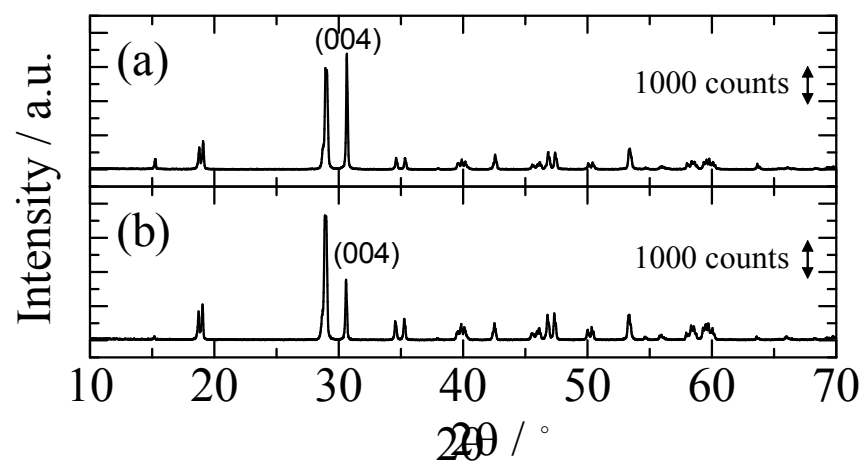


Fig. S1 XRD patterns of (a) BiVO_4 and (b) Au/BiVO_4 .

ESI-2) SEM images of BiVO_4 calcined at various temperatures (Fig. S2).

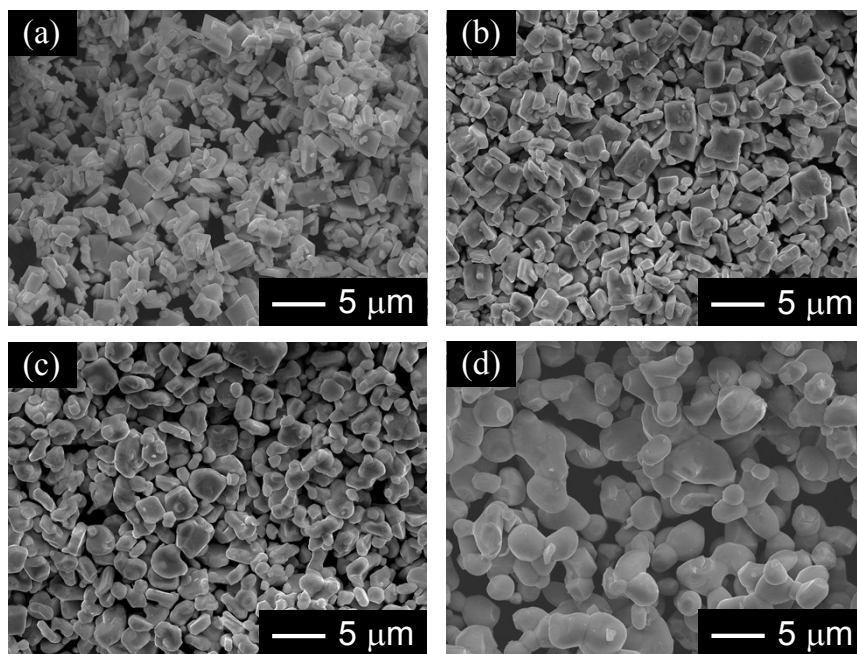


Fig. S2 SEM images of BiVO_4 calcined at (a) 550 $^{\circ}\text{C}$, (b) 650 $^{\circ}\text{C}$, (c) 750 $^{\circ}\text{C}$, and (d) 850 $^{\circ}\text{C}$,.

ESI-3) Complementary water-splitting tests (Fig. S3).

Figure S3 shows the time courses of H_2 and O_2 evolution from pure water using directly connected ZnRh_2O_4 and BiVO_4 without Au under irradiation with a xenon (Xe) lamp equipped with a Y-44 optical filter ($> 420 \text{ nm}$). Neither H_2 nor O_2 was detected, demonstrating that Au nanoparticles inserted between ZnRh_2O_4 and BiVO_4 are indispensable to split water.

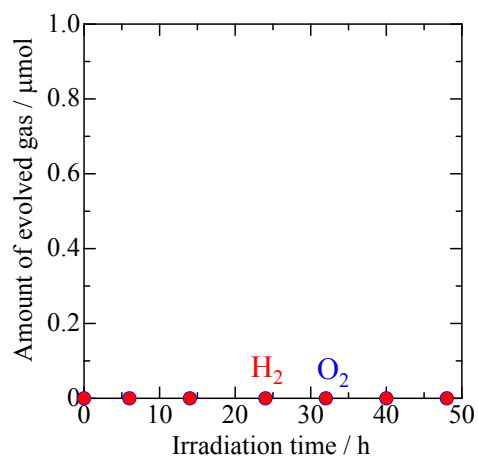


Fig. S3 Time courses of H_2 (red circles) and O_2 (blue circles) evolution from water in the presence of directly connected ZnRh_2O_4 and BiVO_4 under irradiation with visible light ($> 420 \text{ nm}$, Xe lamp + Y-44 filter).

ESI-4) XRD patterns of $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$, $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$, and $\text{ZnRh}_2\text{O}_4/\text{ran-Au}/\text{BiVO}_4$ (Fig. S4).

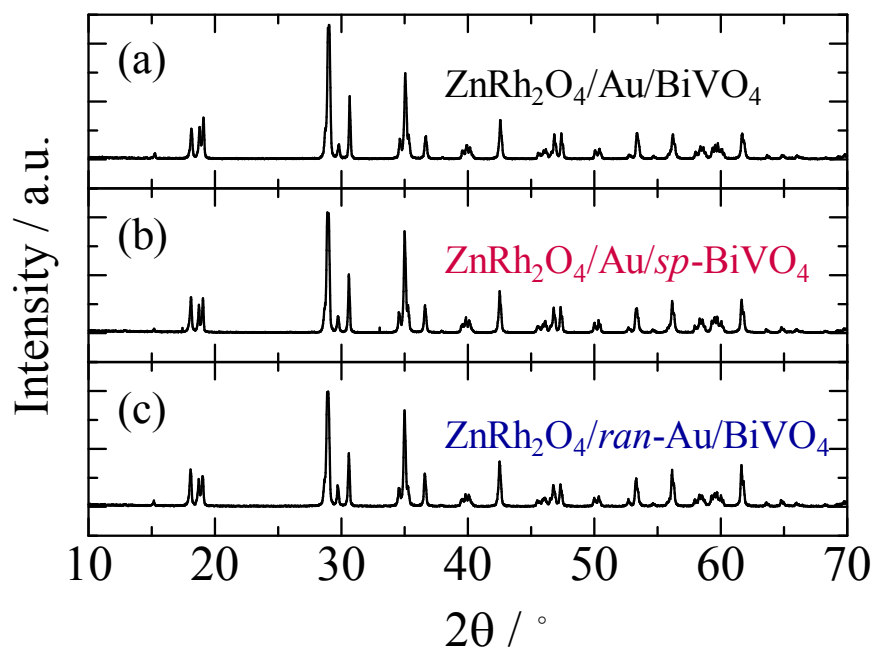


Fig. S4 XRD patterns of (a) $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$, (b) $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$, and (c) $\text{ZnRh}_2\text{O}_4/\text{ran-Au}/\text{BiVO}_4$.

ESI-5) SEM images of $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$ and $\text{ZnRh}_2\text{O}_4/ran\text{-Au}/\text{BiVO}_4$ (Fig. S5).

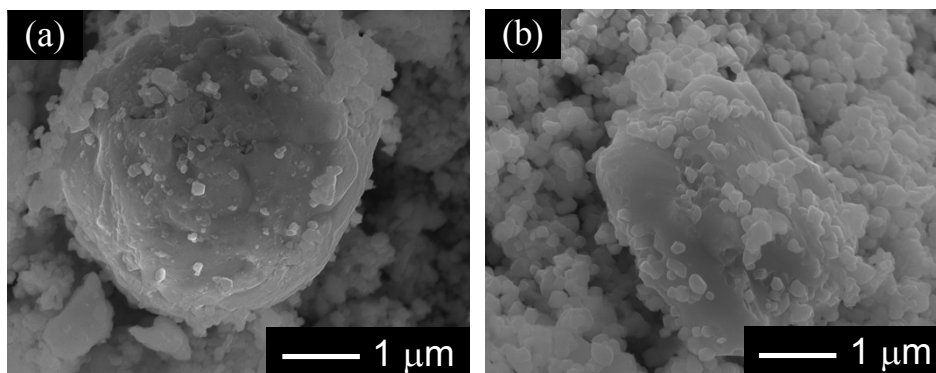


Fig. S5 SEM images of (a) $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$ and (b) $\text{ZnRh}_2\text{O}_4/ran\text{-Au}/\text{BiVO}_4$.

ESI-6) UV-vis absorption spectra of of $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$, $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$, and $\text{ZnRh}_2\text{O}_4/ran\text{-Au}/\text{BiVO}_4$ (Fig. S6).

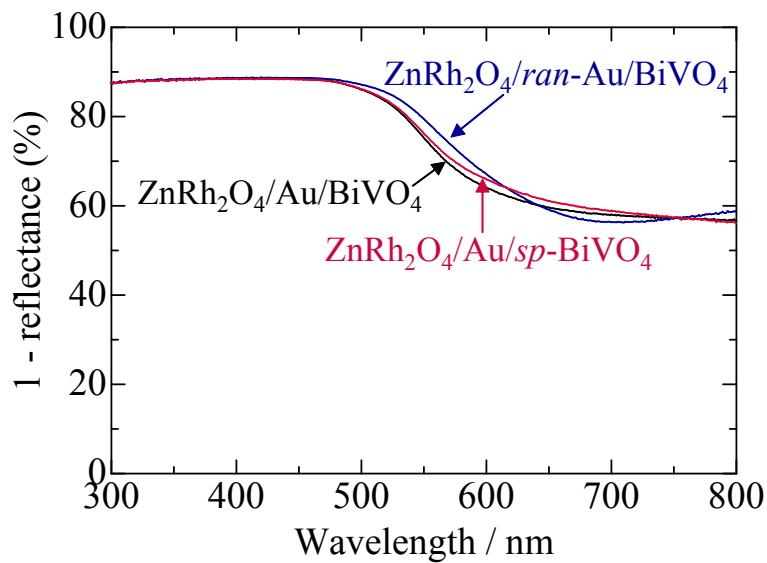


Fig. S6 UV-vis absorption spectra of of $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$, $\text{ZnRh}_2\text{O}_4/\text{Au}/sp\text{-BiVO}_4$, and $\text{ZnRh}_2\text{O}_4/ran\text{-Au}/\text{BiVO}_4$.

ESI-7) XPS spectra of of $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$ before and after the water-splitting experiment (Fig. S7).

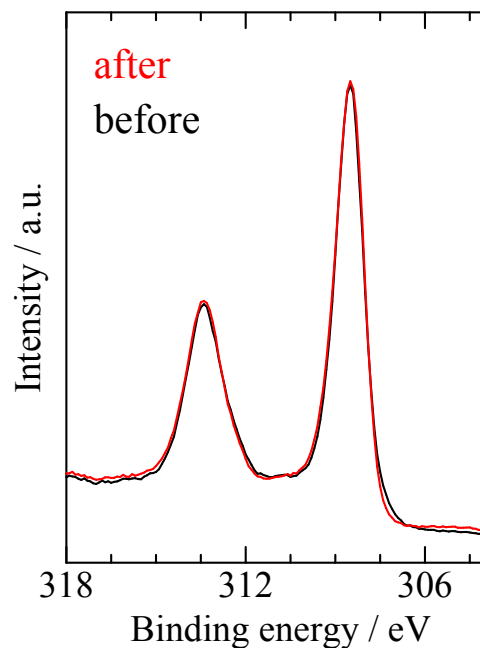


Fig. S7 XPS spectra of Rh 3d region measured for $\text{ZnRh}_2\text{O}_4/\text{Au}/\text{BiVO}_4$ before (black line) and after (red line) the water-splitting experiment.

ESI-8) Complementary Table for water-splitting tests under monochromic LED lights (Table S1).

Table S1 Light intensity, O₂ and H₂ generation rates, and AQE values in the presence of ZnRh₂O₄/Au/BiVO₄

Light source	Light intensity / mW cm ⁻²	Incident photon rate / h ⁻¹	O ₂ generation rate / μmol h ⁻¹	H ₂ generation rate / μmol h ⁻¹	AQE(%)
420 nm LED	6.76	1.04×10^{17}	4.34×10^{-2}	1.07×10^{-1}	5.56×10^{-2}
470 nm LED	13.7	2.34×10^{17}	8.97×10^{-2}	2.01×10^{-1}	5.12×10^{-2}
505 nm LED	12.8	2.39×10^{17}	4.68×10^{-2}	1.22×10^{-2}	2.62×10^{-2}
545 nm LED	19.7	3.98×10^{17}	3.52×10^{-3}	7.38×10^{-3}	1.18×10^{-3}