Electronic Supplementary Information (ESI)

Enhanced water splitting through two-step photoexcitation by sunlight using tantalum/nitrogen-codoped rutile titania as a water oxidation photocatalyst

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Table S1. Physicochemical properties of TiO_2:Ta specimens prepared at different temperatures.

Entry	Amount of doped Ta / mol%	FWHM[a] / degree		Specific surface area[b] / $m^2\ g^{-1}$
		Before nitridation	After nitridation	
1	0	0.549	0.303	15
2	0.1	0.543	0.296	9
3	0.3	0.545	0.288	15
4	0.5	0.558	0.312	14
5	0.7	0.546	0.277	10
6	1.0	0.550	0.314	10
7	1.5	0.556	0.302	-

[a] Full width at half maximum for the (101) peak (2θ = 36.0 degree) in the XRD patterns. [b] The specific surface areas were measured by using after nitridation samples.

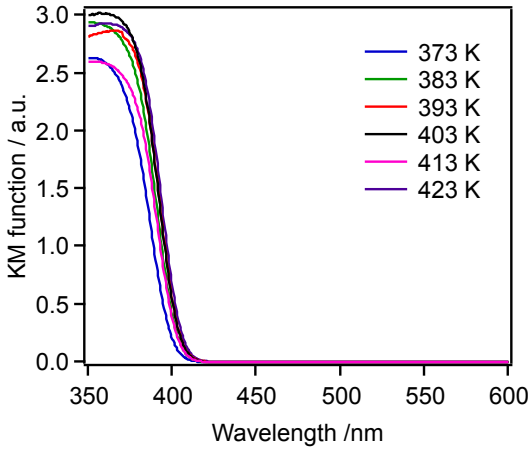

Fig. S1. DRS spectra of TiO_2:Ta samples prepared at different temperatures.

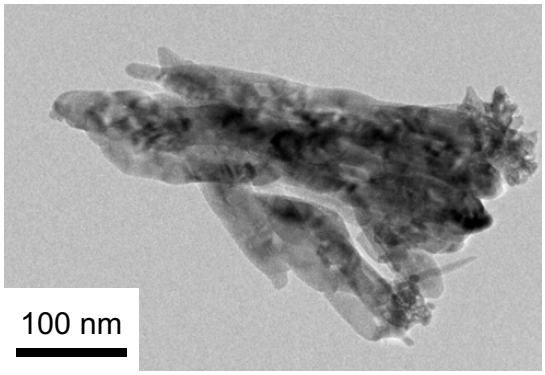

Fig. S2. TEM image of TiO_2:Ta,N (Ta 1.0 mol%).

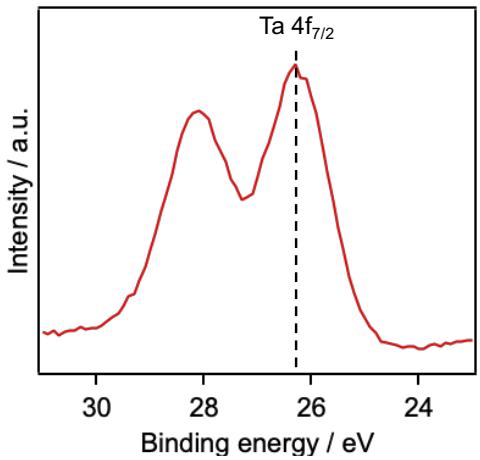

Fig. S3. Ta 4f XPS spectrum for TiO_2:Ta,N powder (Ta 0.7 mol%).

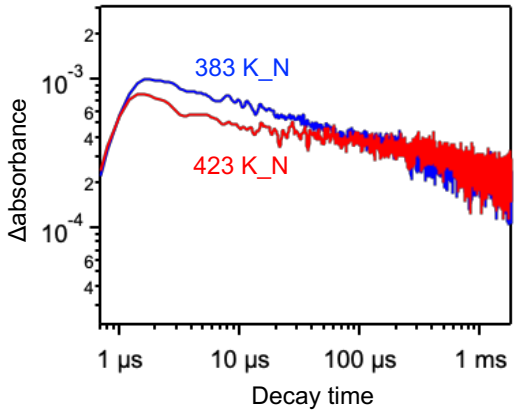

Fig. S4. Time profiles of differential absorbance at 2000 cm^{-1} for TiO_2:Ta,N prepared at two temperatures. Transmittance and reflectance were measured below and above 6000 cm^{-1}, respectively, after visible light (450 nm) laser pulses under vacuum. The pump energy was 1 mJ per pulse with a repetition rate of 1 Hz.

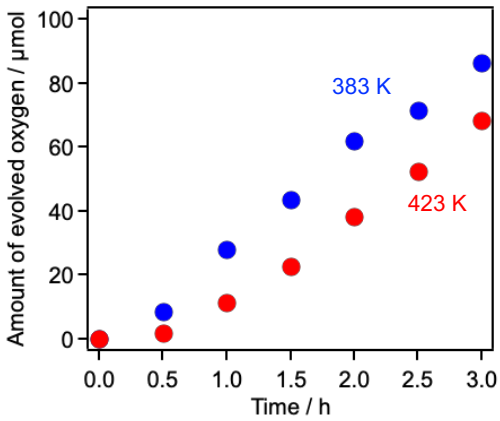

Fig. S5. Time course for O_2 evolution over RuO_2/TiO_2:Ta,N samples prepared at two temperatures under visible light irradiation (λ > 400 nm). Reaction conditions: catalyst = 50 mg (cocatalyst = RuO_2 at 0.8 wt%); reactant solution = aqueous $AgNO_3$ (10 mM, 100 mL); light source = Xe lamp (300 W) with a cold mirror (CM-1) and a cutoff filter (L42).

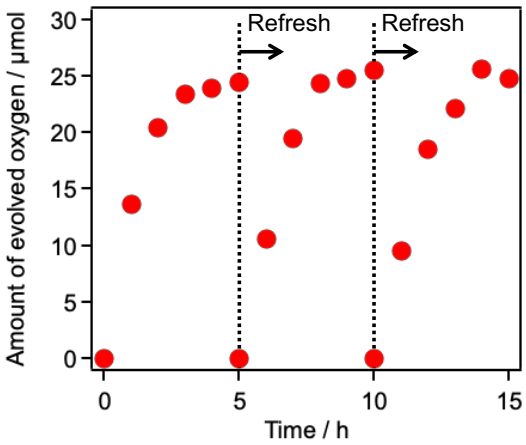

Fig. S6. Time course for O_2 evolution over an IrO_2/TiO_2:Ta,N sample prepared at 423 K under visible light irradiation ($\lambda > 400$ nm). Reaction conditions: catalyst = 50 mg (cocatalyst = IrO_x at 1.0 wt%); reactant solution = aqueous $FeCl_3$ (1 mM, 100 mL); light source = Xe lamp (300 W) with a cold mirror (CM-1) and a cutoff filter (L42).

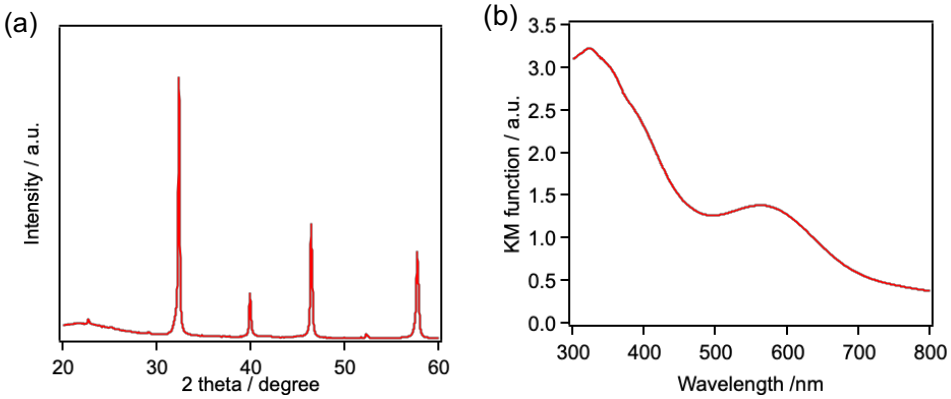

Fig. S7. (a) XRD pattern and (b) UV-visible DRS spectrum for $SrTiO_3$:Rh.

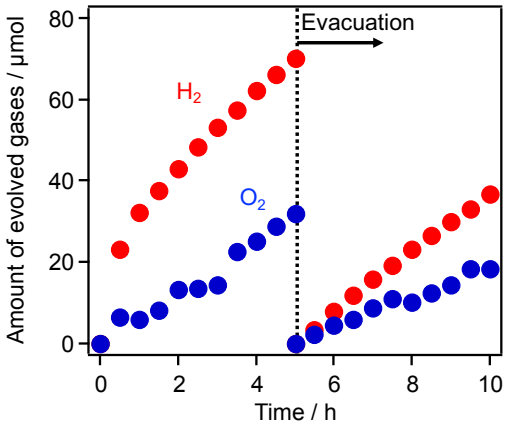

Fig. S8. Time courses for water splitting reaction over IrO_2/TiO_2:Ta,N and Ru/$SrTiO_3$:Rh under visible light irradiation ($\lambda > 400$ nm). Reaction conditions: catalysts = IrO_2/TiO_2:Ta,N, 50 mg and Ru/$SrTiO_3$:Rh, 25 mg; reactant solution = aqueous $[Co(bpy)_3]^{2+}$ (0.5 mM, 100 mL); light source = Xe lamp (300 W) with a cold mirror (CM-1) and a cutoff filter (L42).