Electronic Supplementary Information

Enhanced Oxygen Evolution on Visible Light Responsive TaON Photocatalysts Co-loaded with Highly Active Ru Species for IO_3^- Reduction and Co Species for Water Oxidation

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Preparation of $Ru(OH)_x$ particles.

$Ru(OH)_x$ particles were prepared according to a previously reported method[1] as follows. An aqueous solution of $RuCl_3$ (8.3 mM) was adjusted to pH 13.2 by addition of an aqueous solution of NaOH (1 M), and the resulting solution was stirred at room temperature for 24 h. The precipitates were filtered off, washed with Milli-Q water, and dried in vacuo to afford $Ru(OH)_x$.

Preparation of $Ru(OH)_x$-TaON particles.

TaON particles were added to an aqueous solution of $RuCl_3$ (1.1 mM, 1.0 wt% calculated as metallic Ru with respect to TaON). The solution was adjusted to pH 12.7 by addition of an aqueous solution of NaOH (1 M), and the resulting solution was stirred at room temperature for 2 h under dark conditions. The powder samples were collected, washed with Milli-Q water, and dried in vacuo to afford $Ru(OH)_x$-TaON particles.

Reference

1 K. Yamaguchi, T. Koike, J. W. Kim, Y. Ogasawara and N. Mizuno, *Chem. Eur. J.*, 2008, **14**, 11480.

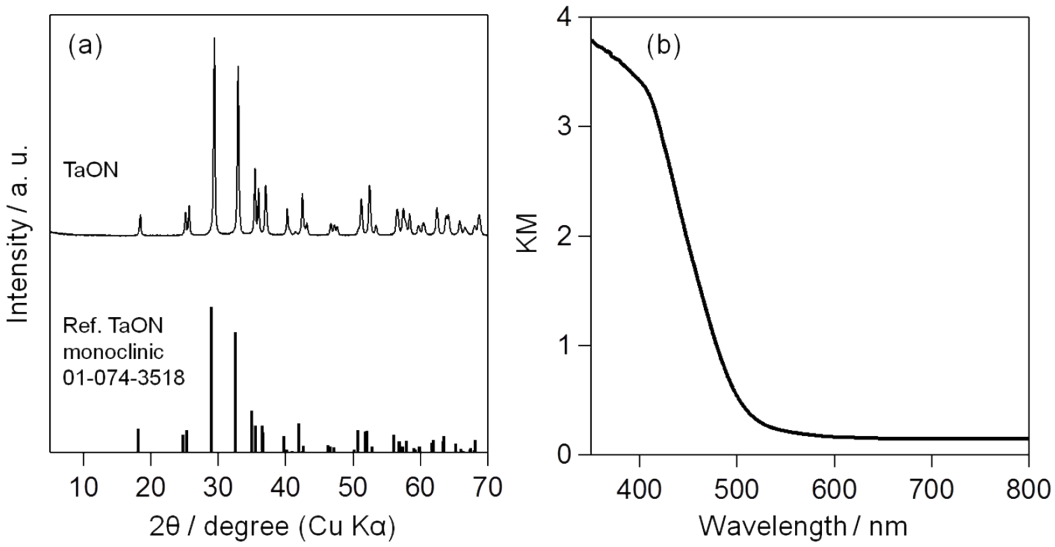

Figure S1. (a) XRD pattern and (b) diffuse reflectance spectrum of the TaON sample.

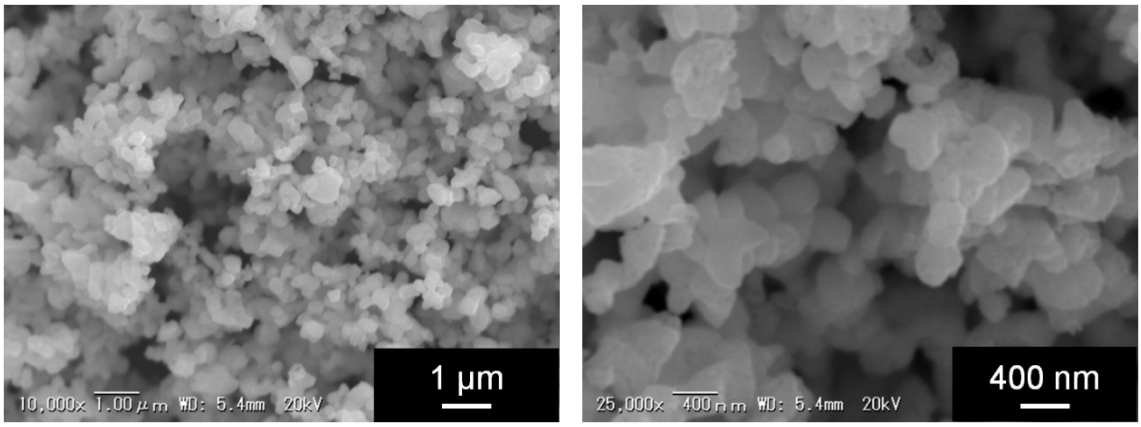

Figure S2. SEM images of TaON sample.

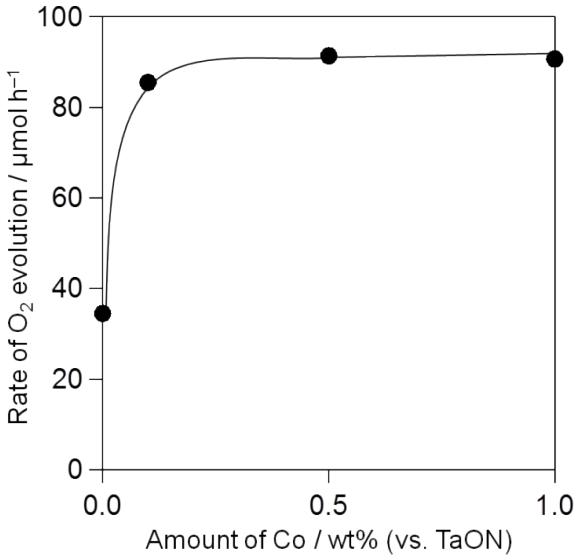

Figure S3. Influence of the loading amount of Co species on the rate of O_2 evolution on TaON photocatalysts (50 mg) suspended in an aqueous solution (100 mL) containing $AgNO_3$ (20 mM) under visible light ($\lambda > 400$ nm). All samples were calcined at 100 °C in the air.

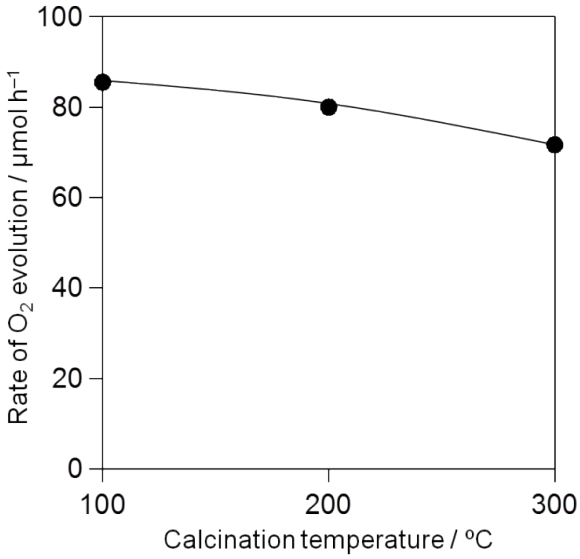

Figure S4. Influence of the calcination temperature of Co species (0.1 wt% as metal) on the rate of O_2 evolution on TaON photocatalysts (50 mg) suspended in an aqueous solution (100 mL) containing $AgNO_3$ (20 mM) under visible light ($\lambda > 400$ nm).

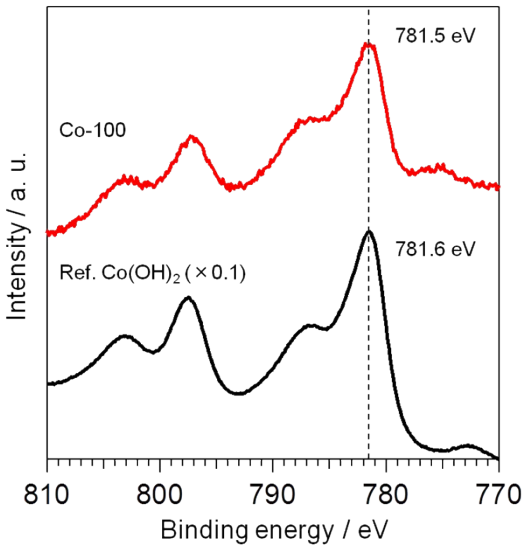

Figure S5. XPS spectrum of TaON sample loaded with Co species and that of $Co(OH)_2$ (Co2p region). The binding energy of the deposited Au was adjusted to 84.0 eV.

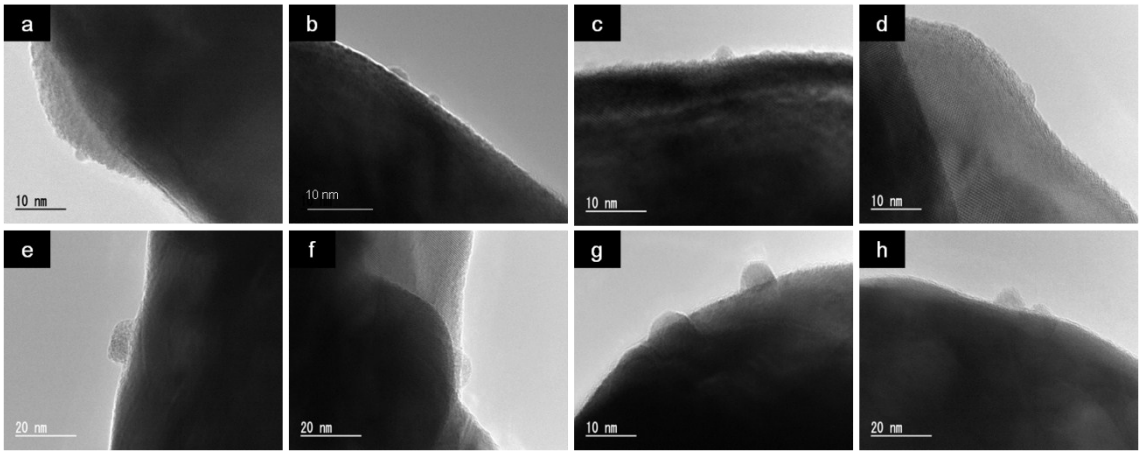

Figure S6. TEM images of the Ru-loaded TaON samples prepared at different calcination temperatures (amount of Ru: 1.0 wt% as metal). (a), (b): Ru-150, (c), (d): Ru-200, (e), (f): Ru-250, (g), (h): Ru-300.

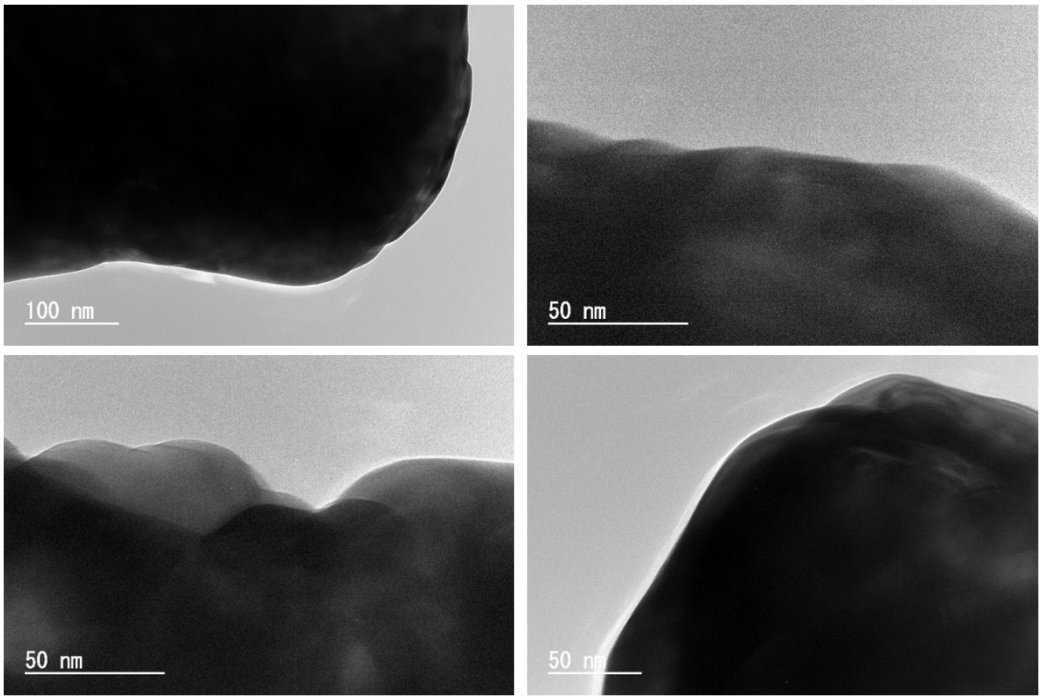

Figure S7. TEM images of the unmodified TaON sample.

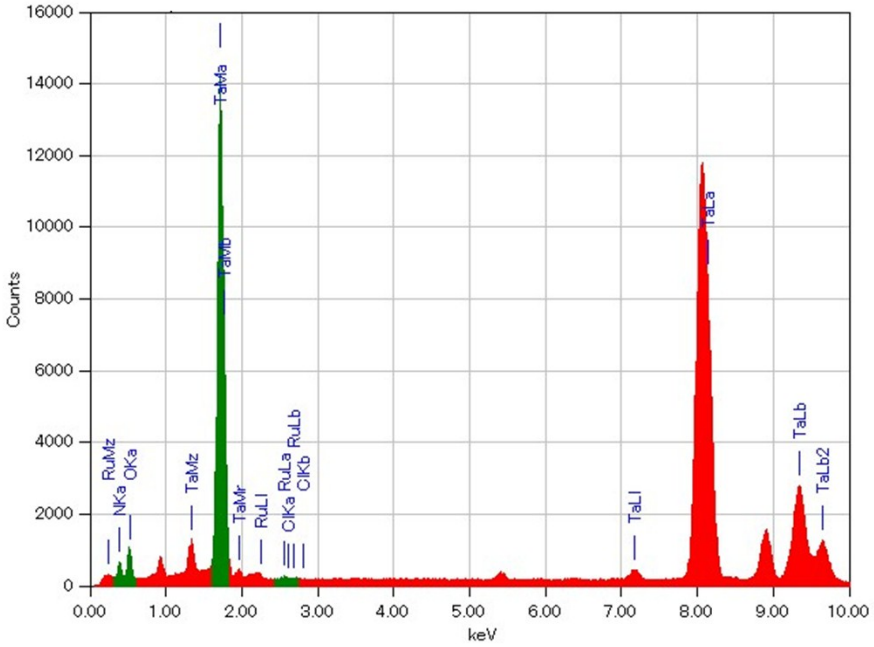

Figure S8. EDS spectrum of the Ru-200 sample shown in Fig. 2.

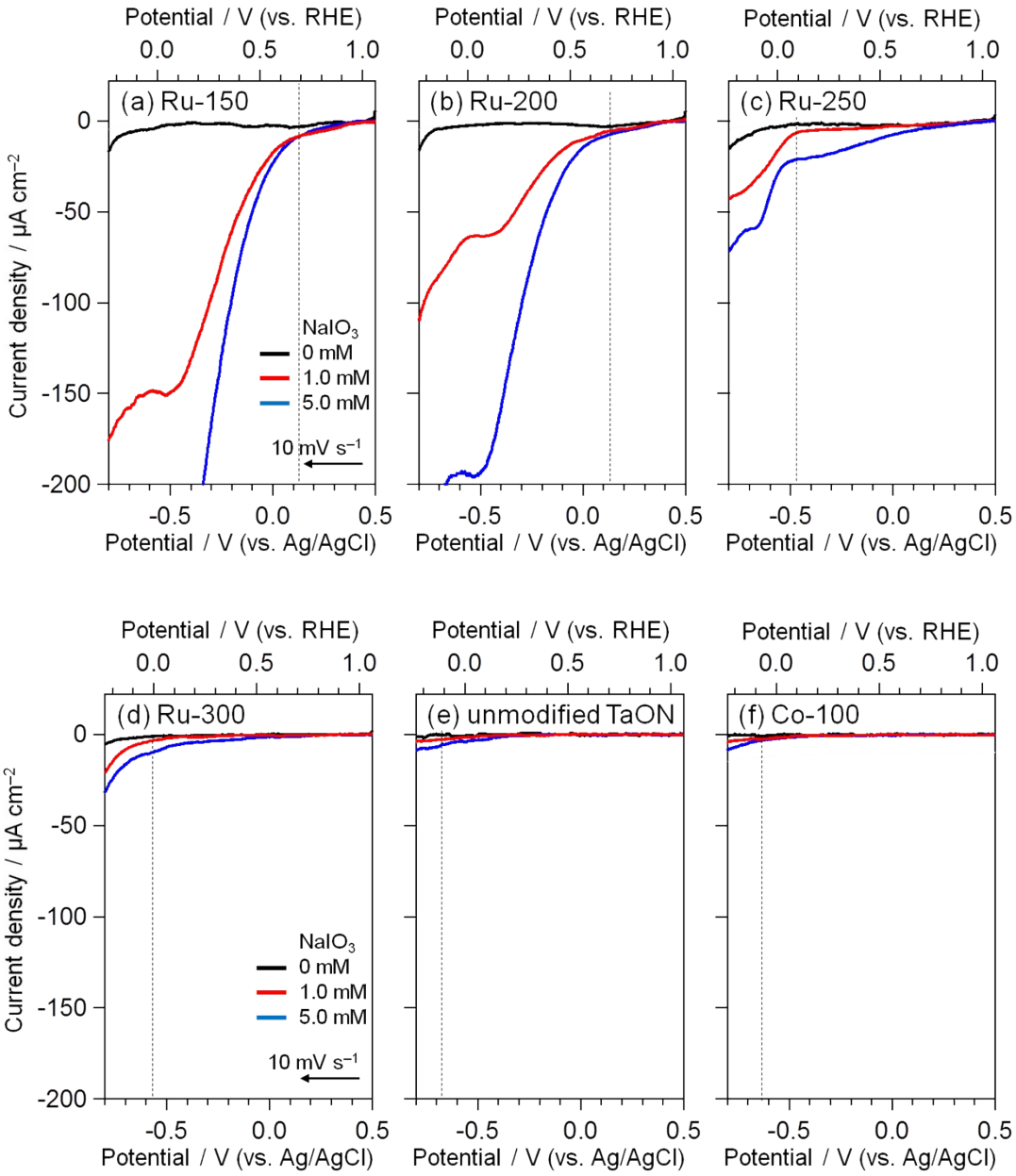

Figure S9. Current-potential curves of TaON electrodes loaded with Ru or Co species and an unmodified TaON electrode in a Na_2SO_4 aqueous solution (0.1 M) containing $NaIO_3$ (0, 1.0, or 5.0 mM) under dark conditions.

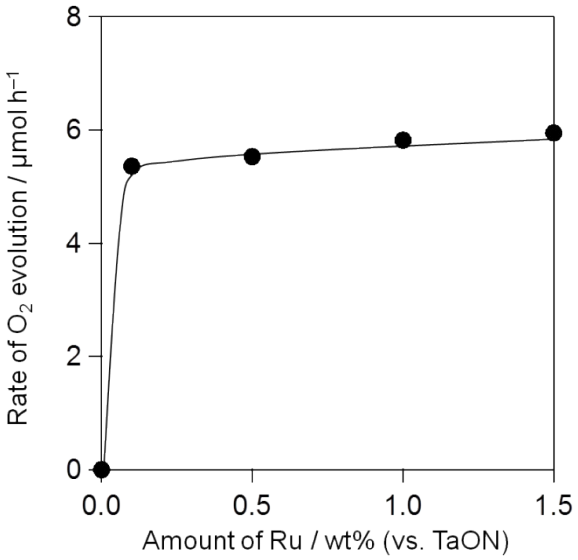

Figure S10. Influence of the loading amount of Ru species on the rate of O_2 evolution on TaON photocatalysts (50 mg) suspended in an aqueous solution (250 mL) containing $NaIO_3$ (1.0 mM) under visible light ($\lambda > 400$ nm). All samples were calcined at 300 °C in the air.

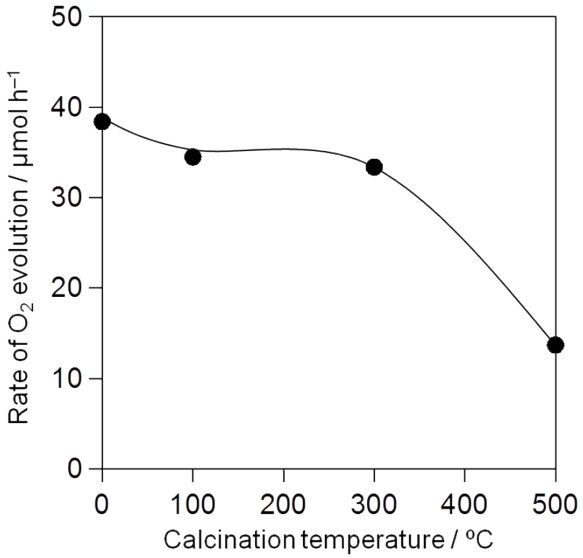

Figure S11. The rate of O_2 evolution over TaON photocatalysts (50 mg) calcined at different temperatures and suspended in an aqueous solution (100 mL) containing $AgNO_3$ (20 mM) under visible light ($\lambda > 400$ nm).

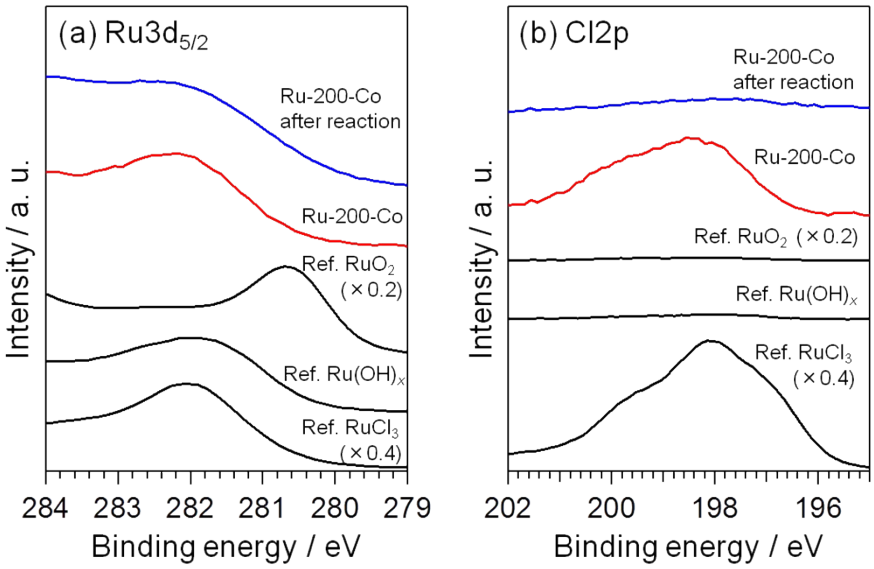

Figure S12. XPS spectra of Ru-200-Co sample before and after O_2 evolution ((a)Ru3d$_{5/2}$ region and (b)Cl2p region). The binding energy of the Au deposited was adjusted to 84.0 eV.

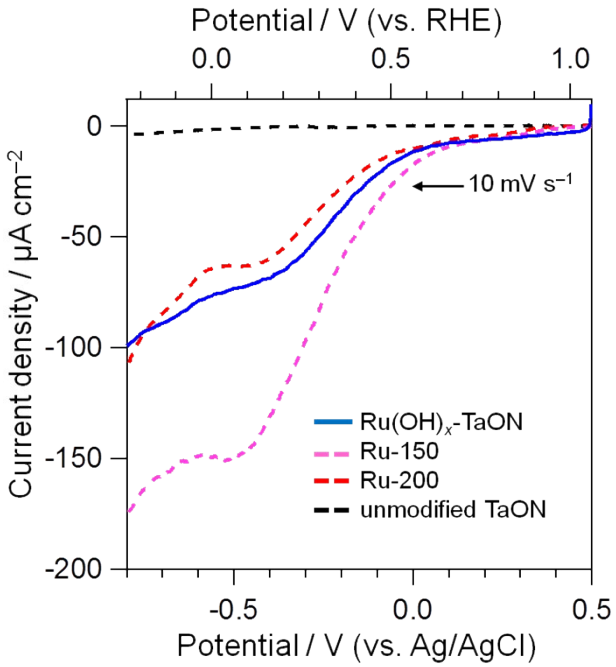

Figure S13. Current-potential curve of Ru(OH)$_x$-TaON electrode, along with Ru-200 and Ru-150 electrodes in a Na_2SO_4 solution (0.1 M) containing $NaIO_3$ (1.0 mM) under dark conditions.

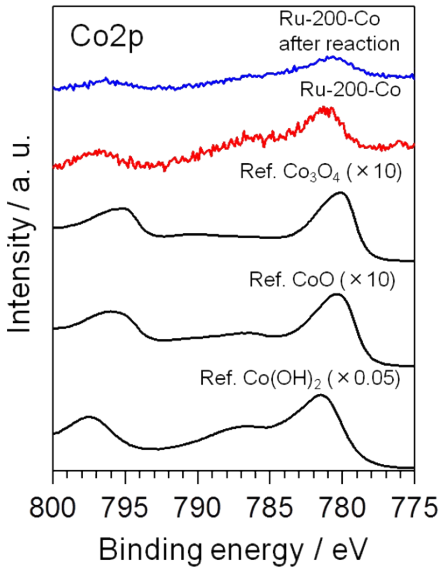

Figure S14. XPS spectra of Ru-200-Co sample before and after O_2 evolution (Co2p region). The binding energy of the Au deposited was adjusted to 84.0 eV.