Supporting information

Preparation of Nanostructured Ta_3N_5 Electrodes by Alkaline Hydrothermal Treatment Followed by NH_3-annealing and Their Improved Water Oxidation Performance

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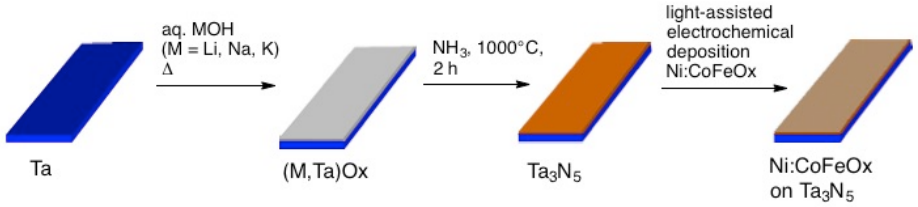

Figure S1. Schematic diagram of the steps of samples preparation.

Table S1. Water splitting PEC performance of catalyst-modified Ta_3N_5 nanostructures electrodes that recently reported.

Ta_3N_5 morphology	**Modifying layer**	**Onset potential (V_{RHE})**	**Initial current @1.23V_{RHE} (mA cm^{-2})@AM1.5G**	**Stability test: I_{final}/ I_{intial} ; Measuring time**	**Ref.**
nanoparticles	Ni:$CoFeO_x$	0.76	5.3 @ 100 mW/cm^2 (Xenon lamp)	90%, 7 h	This work
nanorods	Ni-Fe Layered Double Hydroxides (LHD)	0.9	1.7	90 %; 2h	**1**
nanorods	Co-Pi + Co(OH)x	0.8	5;	20 %; 2h	**1**
nanorods	IrO_3	0.8	3	20 %; 20 min	**2**
nanorods	Co-Pi	0.7	4 @ 0.9V	62 %; 20 min	**2,3**
nanorods	$Co(OH)_x$	0.85	3	93 %; 20 min	4
nanorods	Co-Pi	0.8	3.6	No stability test	5
nanorods	Co-Pi+Co(OH)x/NiFe LDH	0.7	7	71 %, 2 h	**1**
nanotubes	$Co(OH)_x$	0.7	6	96 %; 200 sec	**6**
nanotubes	Co_3O_4	0.8	5	20 %; 6 min	**7**
nanotubes	Co_3O_4	0.95	5	20 %; 1 h	8

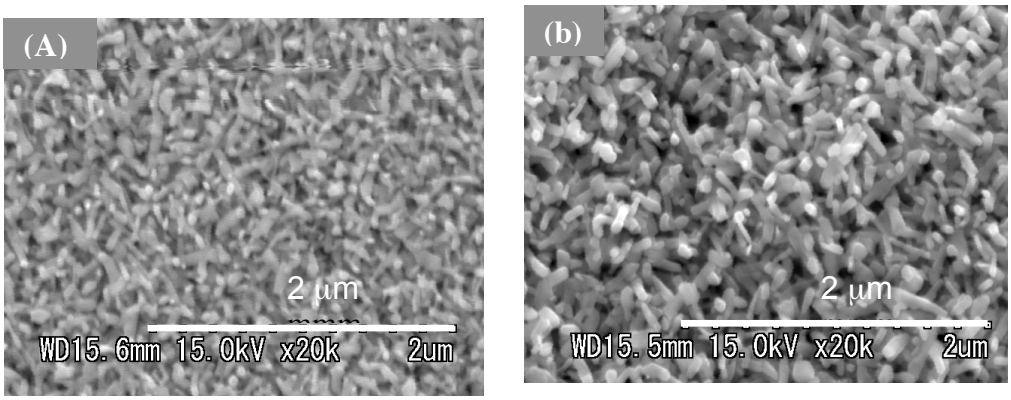

Figure S2. SEM images (top-view) of the Ta_3N_5 derived from $(Na,Ta)O_x$ grown in 23 wt% NaOH solution at (a) 200 ºC for 8 h and (b) 250 ºC for 5 h.

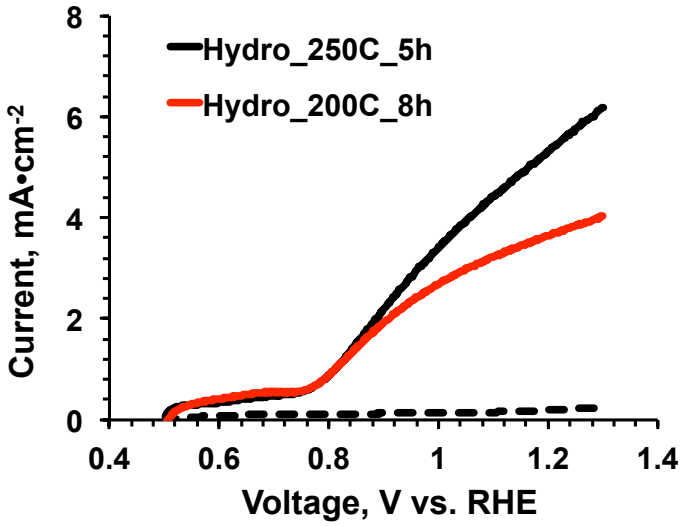

Figure S3. Current-voltage curves of Ni:$CoFeO_x$-loaded Ta_3N_5 whose precursor electrodes grown in 23 wt% NaOH solution at 250 ^{o}C for 5 h (black), 200 ^{o}C for 8 h (red) under dark (broken line) and light (solid line) conditions (100 mW•cm^{-2}) in 1 M NaOH (pH 13.6) electrolyte.

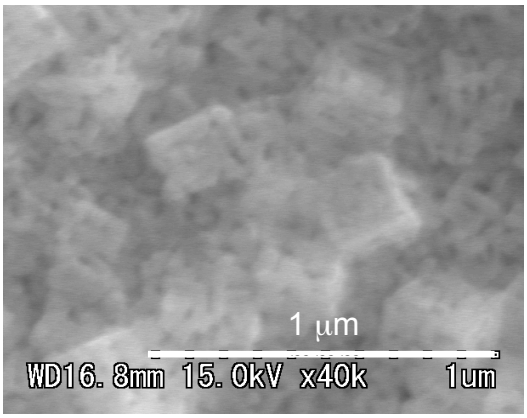

Figure S4. SEM image (top-view) of the Ta_3N_5 derived from $(Na,Ta)O_x$ grown in 16 wt% NaOH solution at 250 ºC for 5 h.

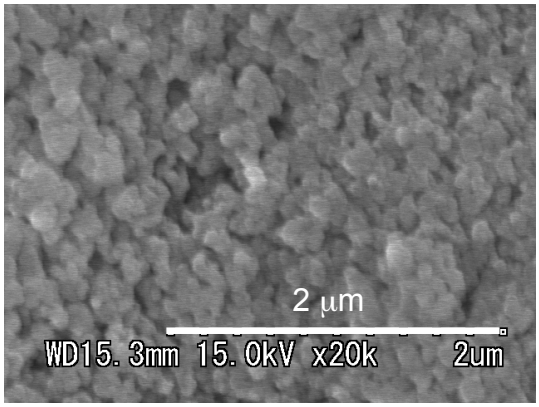

Figure S5. SEM image (top-view) of the Ta_3N_5 derived from $NaTaO_3$ grown in 23 wt% NaOH solution at 250 ºC for 3 h.

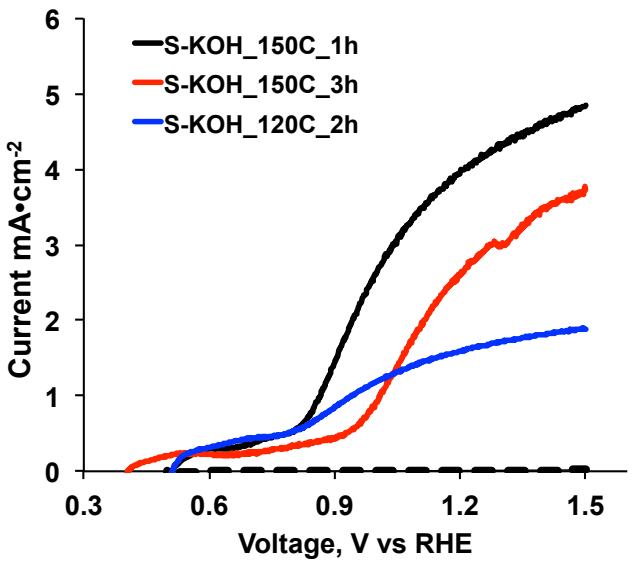

Figure S6. Current-voltage curves of Ni:$CoFeO_x$-loaded Ta_3N_5 whose precursor electrodes grown in 16 wt% KOH solution at 150 ^oC for 1 h (black), 150 ^oC for 3 h (red), 120 ^oC for 2 h (blue) under dark (broken line) and light (solid line) conditions (100 mW•cm^{-2}) in 1 M NaOH (pH 13.6) electrolyte.

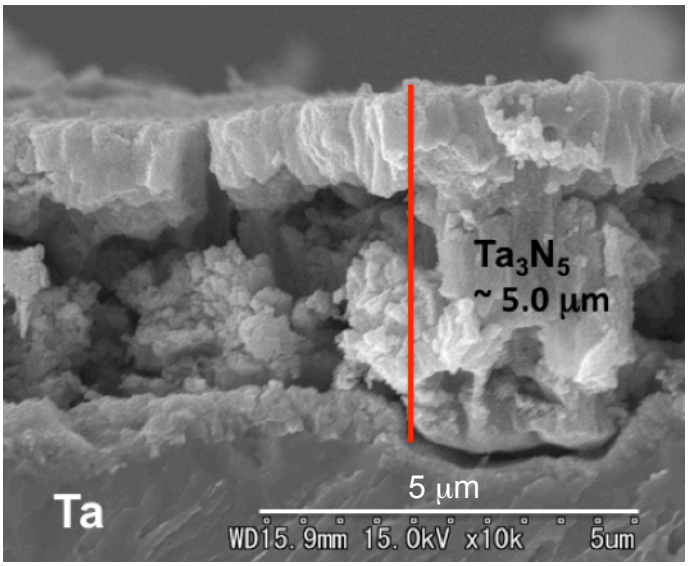

Figure S7. SEM image (cross-sectional view) of the Ta_3N_5 derived from (K, Ta)O_x grown in 16 wt% KOH solution at 150 ºC for 3 h.

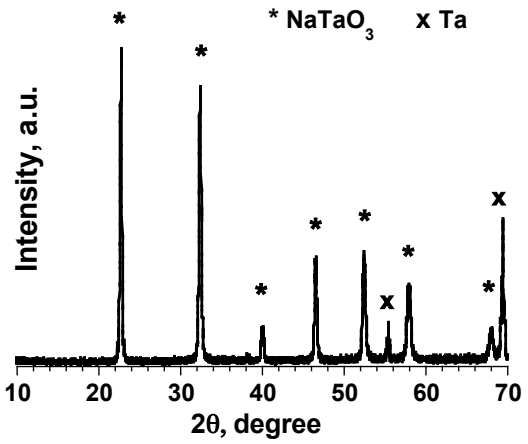

Figure S8. XRD pattern of the $NaTaO_3$ precursor electrode grown in 23 wt% NaOH solution at 250 ^{o}C for 5 h.

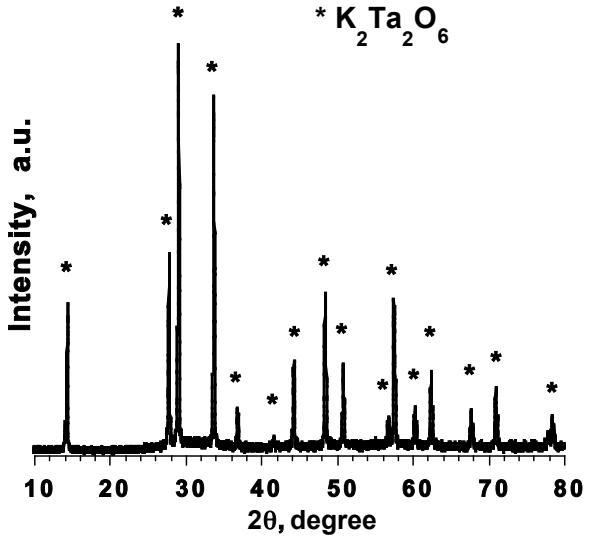

Figure S9. XRD pattern of the $K_2Ta_2O_6$ precursor electrode grown in 16 wt% KOH solution at 150 ^{o}C for 3 h.

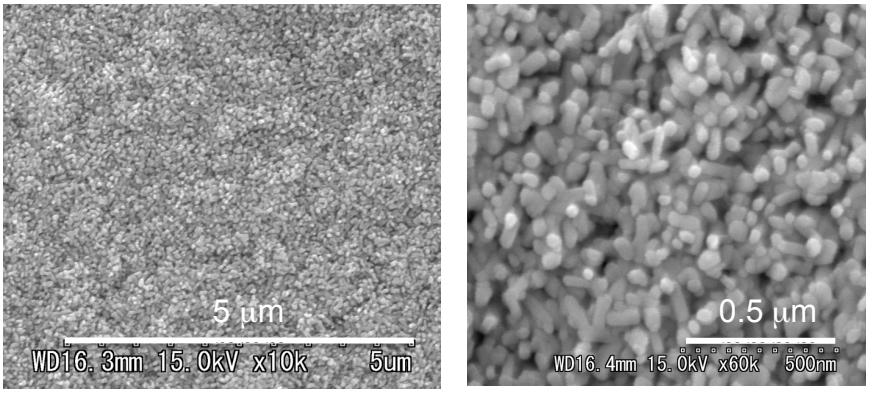

Figure S10. SEM images (top-view) of the Ta_3N_5 derived from $NaTaO_3$ grown in 23 wt% NaOH solution at 250 ºC for 5 h.

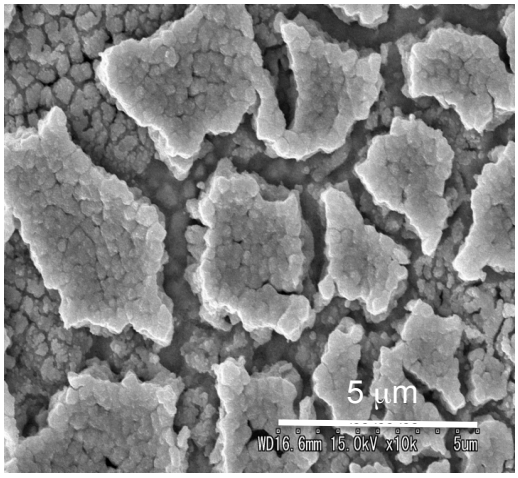

Figure S11. SEM image (top-view) of the Ta_3N_5 derived from $K_2Ta_2O_6$ grown in 16 wt% KOH solution at 150 ºC for 1h.

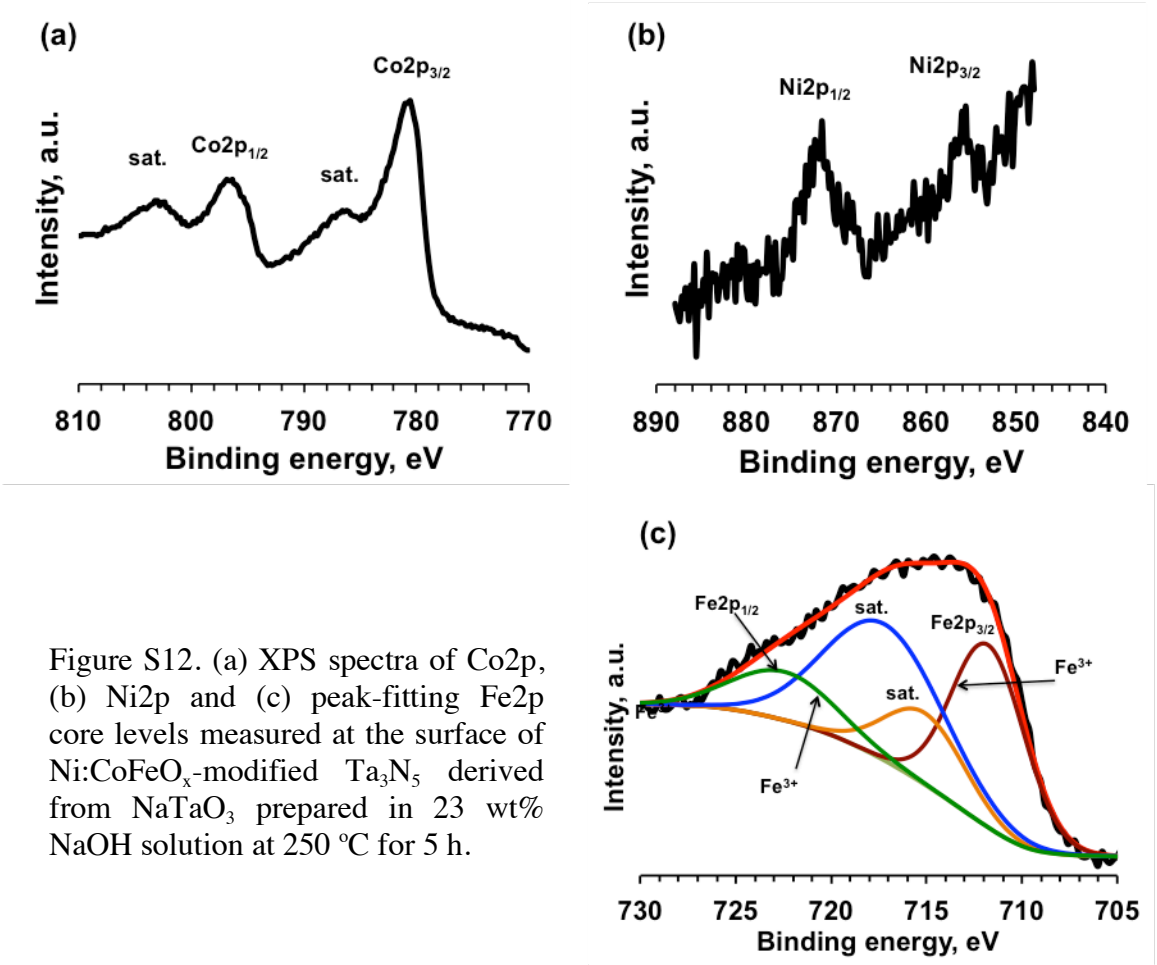

Figure S12. (a) XPS spectra of Co2p, (b) Ni2p and (c) peak-fitting Fe2p core levels measured at the surface of Ni:$CoFeO_x$-modified Ta_3N_5 derived from $NaTaO_3$ prepared in 23 wt% NaOH solution at 250 ºC for 5 h.

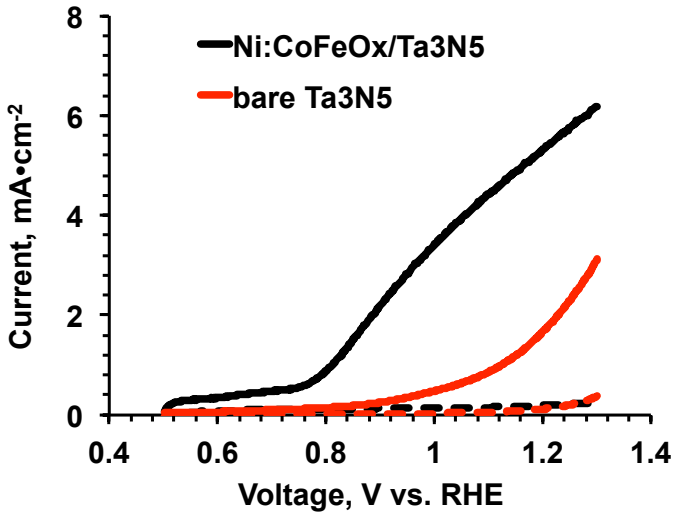

Figure S13. Current-voltage curves of Ni:$CoFeO_x$-loaded Ta_3N_5 (black) and bare Ta_3N_5 (red), whose precursor electrodes grown in 23 wt% NaOH solution at 250 ^oC for 5 h, under dark (broken) and light (solid) conditions (100 mW•cm^{-2}) in 1 M NaOH (pH 13.6) electrolyte.

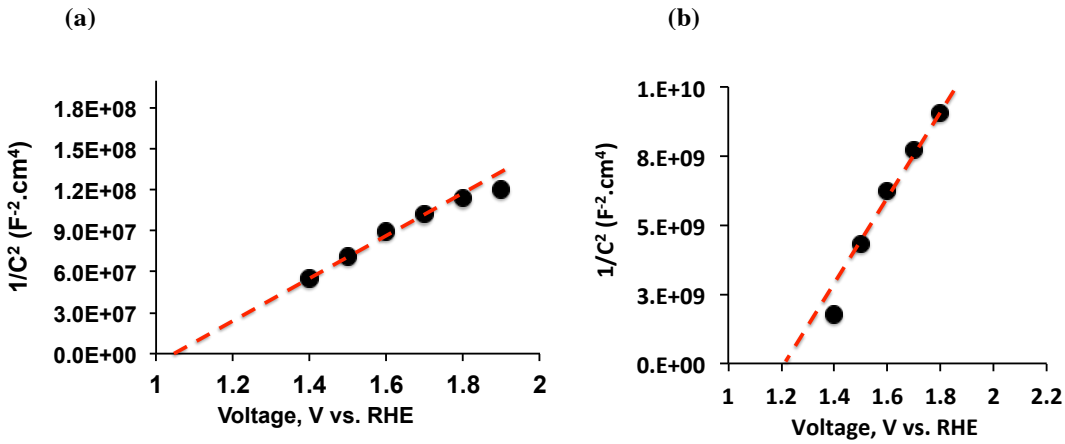

Figure S14. Mott-Schottky plots of (a) bare S-NaOH and (b) bare S-KOH. The experiments were conducted under dark condition in 1 M NaOH solution (pH 13.6) as the electrolyte, a Pt wire as the counter electrode, and Ag/AgCl as a reference electrode.

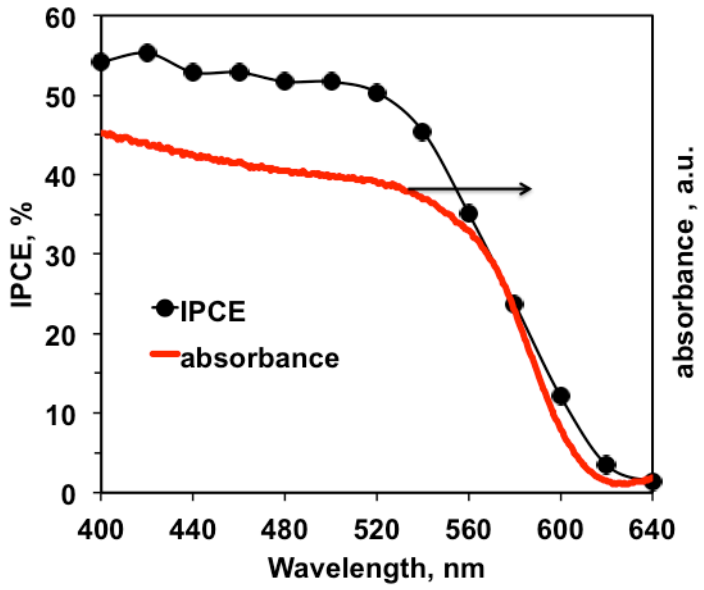

Figure S15. IPCE values (black) of Ni:$CoFeO_x/Ta_3N_5$ photoanode at 1.23 V_{RHE} potential under irradiation of Xenon light (100 $mW.cm^{-2}$) and the optical absorbance (red) of the bare Ta_3N_5. The precursor $NaTaO_3$ was grown in 23 wt% NaOH solution at 250 °C for 5 h.

References

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