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Supporting Information

Bulk and Interfacial Engineering of Ta_3N_5 Nanotube Arrays by Sn(IV) Doping, Proper Passivation and Co-Catalyst for Efficient Solar Water Oxidation

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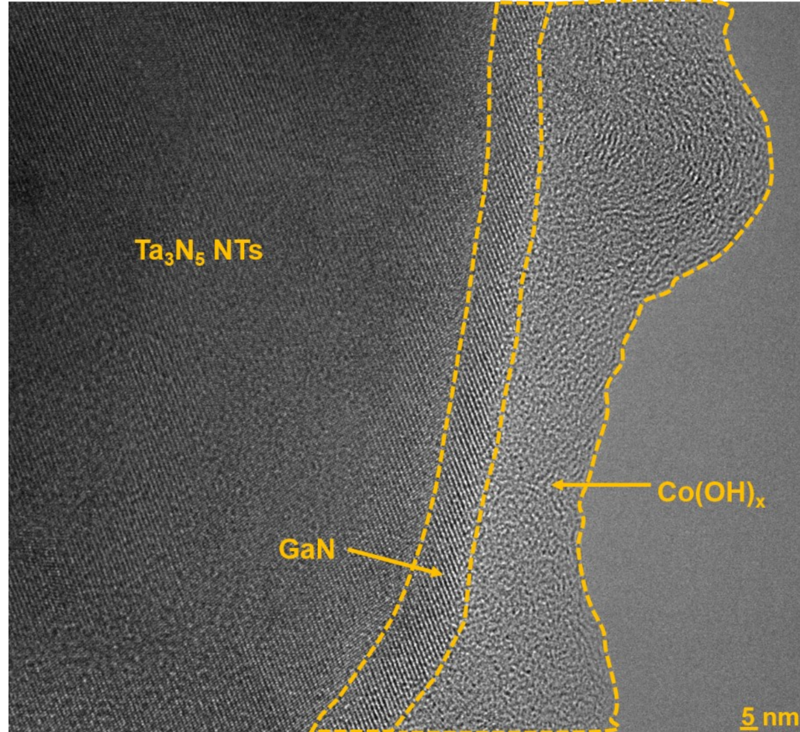

Figure S1. Bright-field (HAADF-TEM) image representing the interfaces in the $Co(OH)_X$/GaN/Sn doped Ta_3N_5 NTs film.

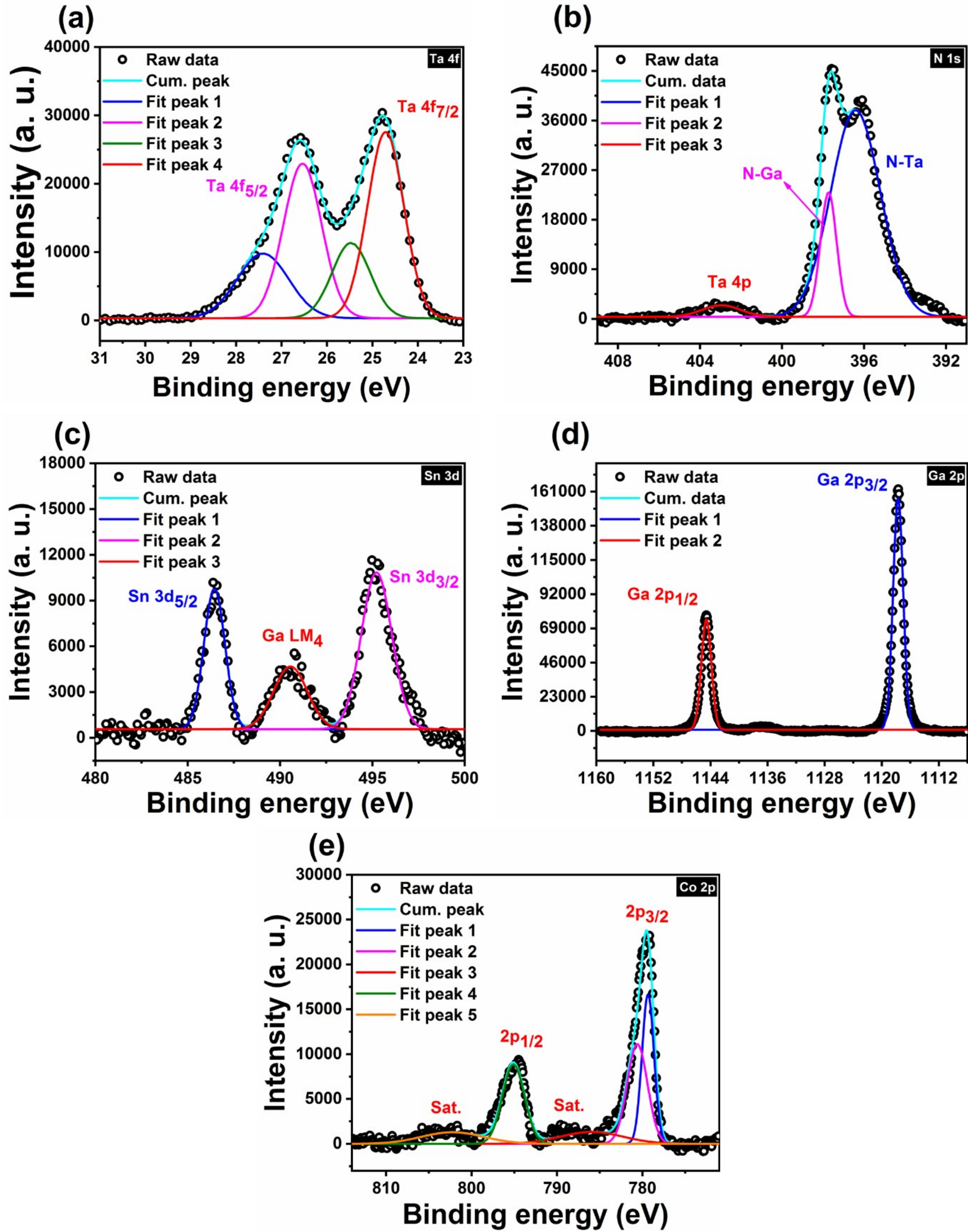

Figure S2. Core-level XPS spectra of (a) Ta*4f*, (b) N*1s*, (c) Sn*3d*, (d) Ga*2p*, and (e) Co*2p* of $Co(OH)_X$/GaN/Sn doped Ta_3N_5 NTs film after the PEC test.

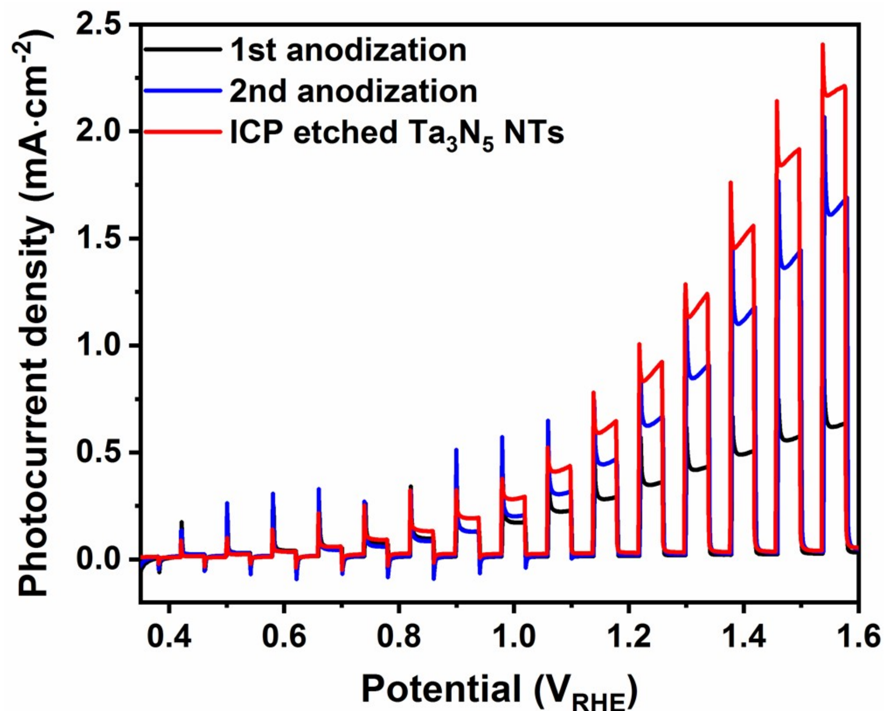

Figure S3. Chopped LSV curves of 1st and 2nd anodization and ICP etched of bare Ta_3N_5 NTs films.

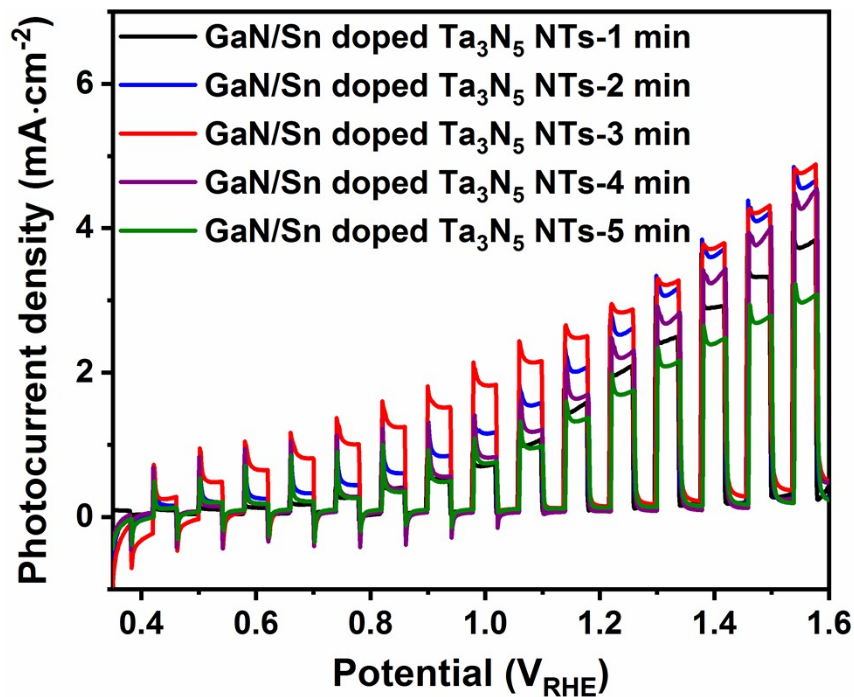

Figure S4. Chopped LSV curves of GaN/Sn doped Ta_3N_5 NTs films at different electrodeposition times from 1min to 5min by chronoamperometric method.

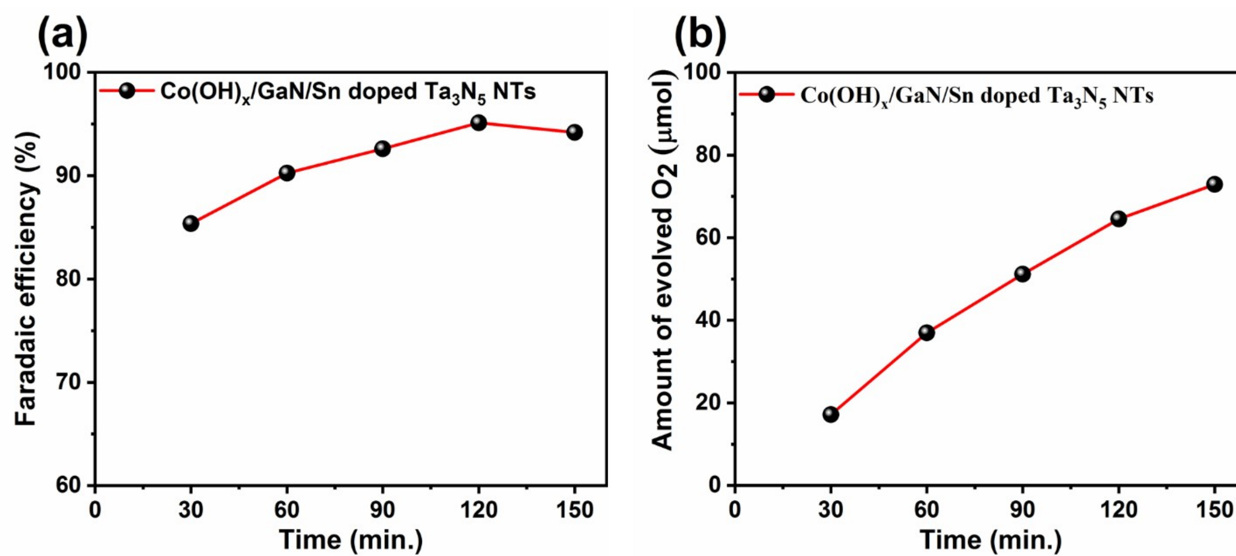

Figure S5. (a) Faradaic efficiency and (b) quantities of the detected O_2 gas in a PEC system from the $Co(OH)_x$/GaN/Sn doped Ta_3N_5 NTs photoanode as the working electrode under applied voltages of 1.23 V_{RHE} in 0.5 M NaOH solution at pH 12.5.

Table S1. The previous reported Ta_3N_5-based photoanodes are compared in below Table.

Material	Fabrication Method	Surface Modification	IPCE & J (mA/cm^2) at 1.23 V_{RHE}	Ref.
Ba doped Ta_3N_5	Mask anodization and nitridation of Ta foil	Co-Pi	6.7 mA cm^{-2} (0.5 M KPi)	41
Mg-Zr codoped Ta_3N_5	Particle transfer	FeO_x + CoO_x	2.3 mA cm^{-2} (0.1 M Na_2SO_4)	79
Ta_3N_5	Hydrothermal and nitridation of Ta foil	$Co(OH)_2/Co_3O_4$	3.64 mA cm^{-2} (1 M NaOH)	80
Ta_3N_5	Hydrothermal and nitridation of Ta foil	$Co(OH)_x$	2.8 mA/cm^2 (1 M NaOH)	81
Ta_3N_5	Sputtering and nitridation of TaO_δ on Ta substrate	GaN/Co-Pi	8 mA cm^{-2} at 1.2 V_{RHE} (0.5 M KPi)	52
Ta_3N_5	Electrophoretic deposition	$Co_3O_4/Co(OH)_x$	3.18 mA/cm^2 at 1.2 V_{RHE} (1 M NaOH)	82
Ta_3N_5	Anodization and nitridation of Ta foil	$MgO/Co(OH)_x$	5.5 mA cm^{-2} (1 M NaOH)	83
Ta_3N_5	Anodization, hydrothermal and nitridation of Ta foil	$Ni(OH)_x$/Fh/TiO_x	12.1 mA cm^{-2} (1 M NaOH)	49
Ta_3N_5	Sputtering (magnetron GLAD system)	$FeNiO_x$	9.95 mA cm^{-2} at 1.05 V_{RHE} (0.5 M K_2HPO_4)	53
In:GaN/Ta_3N_5/ Mg:GaN	Electron beam evaporation, atomic layer deposition and nitridation	NiCoFe-B_i	9.3 mA cm^{-2} (1 M KOH)	54
Mg doped Ta_3N_5	Electron beam evaporation and nitridation	NiCoFe-B_i	8.5 mA cm^{-2} (1 M KOH)	84
Sn doped Ta_3N_5	**Anodization and nitridation of Ta foil, electrodeposition**	**GaN/$Co(OH)_x$**	**39%, 4.58 mA cm^{-2} (0.5 M NaOH)**	**This work**