Electronic Supplementary Information: Enhanced Photoelectrochemical Water Splitting via SILAR-Deposited Ti-Doped Hematite Thin Films with an FeOOH Overlayer

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**Figure S1:** (a) JV curves for 45 nm thick Ti:Fe$_2$O$_3$ samples at various Ti/(Ti+Fe) solution ratios. (b) Average current density versus voltage (JV) curves for 5 s% Ti/(Ti+Fe) at various film thicknesses. SILAR cycle number corresponds to approximately twice the film thickness in nm. (c) Current density at two bias voltages as a function of thickness for the sample types in (b).
Figure S2: Stability of 5% Ti:Fe$_2$O$_3$ with and without an FeOOH overlayer under 1-sun illumination at 1.23 V$_{RHE}$.

Figure S3: Detail spectra for Sn 3d and Ti 2p peaks. Peaks correspond to Sn$^{4+}$ and Ti$^{4+}$ oxidation state.

Figure S4: Top and side-view scanning electron microscope images of SILAR-deposited Fe$_2$O$_3$ and varying Ti% Ti:Fe$_2$O$_3$ after 90 cycles. Images reveal conformal coating (planar on FTO) and growth rate of ~5 Å/cycle.
Figure S5: Charge separation (sep %) vs. applied voltage curves for carrying Ti% Ti:Fe$_2$O$_3$ generated by $\eta_{sep} = \frac{J_{H_2O_2}}{J_{abs}}$ where $J_{ph}$ is the photocurrent density under 1-sun illumination in 1 M NaOH | 0.5 M H$_2$O$_2$ (hole scavenging) electrolyte and $J_{abs}$ is the current density assuming perfect charge collection from absorbed photons.

Figure S6: Incident photon-to-current conversion efficiency data for Fe$_2$O$_3$, 5 s% Ti:Fe$_2$O$_3$ with and without an FeOOH overlayer in hole scavenging electrolyte (0.5 M H$_2$O$_2$ and 1 M NaOH in DI water). IPCE divided by absorption is APCE, which is plotted in Fig. 5(a) in the main text.
Figure S7: (a) $R_{\text{rec}}$ data for $\text{Fe}_2\text{O}_3$, 5 s% Ti:Fe$_2$O$_3$ with and without an FeOOH overlayer. (b) $R_{\text{ct,ss}}$ data for the same sample types; color scheme follows that in (a). The similarity in resistances between the Ti:Fe$_2$O$_3$ samples indicates that FeOOH has no surface catalytic effect. Color scheme for each panel follows that in (b).

Figure S8: Absorption in the depletion region for (a) $\text{Fe}_2\text{O}_3$ and (b) 5 s% Ti:Fe$_2$O$_3$. Note the ~4x difference in scale. Different colors represent different applied voltages that correspond to different depletion widths. Depletion width ($W_D$) is given in nm.

Figure S9: (a) Photograph of 90 SILAR cycle 5 s% Ti:Fe$_2$O$_3$ sample.