Electronic Supplementary Information

Rapid Fabrication of Oxygen Defective $\alpha$-Fe$_2$O$_3$(110) for Enhanced Photoelectrochemical Activities

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**Figure S1.** XPS survey spectra of Fe₂O₃(110) and Oᵥ_Fe₂O₃(110).

**Figure S2.** TEM images of (a) Fe₂O₃(110) and (b) Oᵥ_Fe₂O₃(110). The circles show the presence of oxygen vacancies in crystal lattice.

**Crystallite size calculation**

The following Scherrer equation was used for the calculation of crystallite size, D:

\[
D = \frac{K\lambda}{\beta \cos \theta}
\]  

(Eq. S1)

where K is the shape factor with a value of 0.9, λ is the wavelength of X-ray, β is the full-width at half maximum (FWHM) of the XRD peak and θ is the Bragg angle.
Transient time calculation

Figure S3. Ln D vs. time graph for the determination of transient time of Fe$_2$O$_3$(110) and O$_{v}$Fe$_2$O$_3$(110) samples.

Figure S2 was derived from Figure 5(b) using the following equations:

\[ D = \frac{I_t - I_f}{I_i - I_f} \quad (Eq. \ S2) \]
\[ \tau = - t \ln D \quad (Eq. \ S3) \]

where \( \tau \) is the transient time constant at which \( \ln D = -1 \); \( I_t \) is the current at time \( t \); \( I_i \) and \( I_f \) are the initial current (i.e. maximum current right after light is on) and final current (i.e. minimum current right before light is off), respectively.
Figure S4. Current-time ($I$-$t$) graph of photoelectrochemical cells for $O_{\nu}Fe_2O_3(110)$ photoanode measured at 1.2 $V_{Ag/AgCl}$ bias voltage under light illumination.

Figure S5. Photoelectrochemical performance of four different samples of (a) Fe$_2$O$_3$(110) and (b) $O_{\nu}Fe_2O_3(110)$ measured from front under light illumination.
Figure S6. AFM images of Fe$_2$O$_3$ (110) film deposited via AACVD for (a) 10 min, (b) 20 min, (c) 40 min and (d) 60 min.

Figure S7. FESEM images of Fe$_2$O$_3$ (110) deposited for (a) 10 min and (b) 40 min. Prolonging the deposition time converts the structure of α-Fe$_2$O$_3$ film from nanoflakes to nanoflowers.