Supporting Information

ALD-based hydrothermal facile synthesis of dense WO$_3$@TiO$_2$-Fe$_2$O$_3$ nanodendrite array with enhanced photoelectrochemical properties

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Figure S1. The digital photo of electrochemical measurement set-up
**Figure S2.** SEM images of as-obtained (a) pure WO$_3$ nanosheets and (b) WO$_3$@TiO$_2$(11 nm) core shell nanosheets array. Inset in (a) is the digital photograph of pure WO$_3$ nanosheets array; inset in (b) is the high-magnification SEM image of WO$_3$@TiO$_2$(11 nm) core shell nanosheets array.
Figure S3. Digital photographs of as-prepared (a) WO$_3$@TiO$_2$(11 nm) core-shell nanosheets array and (b) WO$_3$@TiO$_2$(11 nm)-Fe$_2$O$_3$ nanotrees array.

Figure S4. XPS full spectra of the different samples including pure WO$_3$ nanosheets arrays, WO$_3$@TiO$_2$(11 nm) core-shell nanosheets, and WO$_3$@TiO$_2$(11 nm)-Fe$_2$O$_3$ nanotrees arrays.
Figure S5. (a) XPS W 4f spectrum of WO$_3$ nanosheets; (b) XPS Ti 2p spectrum of WO$_3$@TiO$_2$ (11 nm); (c) XPS Fe 2p spectrum and (d) XPS O 1s spectrum of WO$_3$@TiO$_2$ (11 nm)-Fe$_2$O$_3$. 
Figure S6. (a-c) Low-magnification SEM images of the obtained WO$_3$@TiO$_2$ core-shell nanosheets sample (a) WO$_3$@TiO$_2$ (5 nm), (b) WO$_3$@TiO$_2$ (11 nm) and (c) WO$_3$@TiO$_2$ (30 nm). Inset in panel a-c are corresponding high-magnification SEM images of the obtained WO$_3$@TiO$_2$ core-shell nanosheets.
Figure S7. SEM images of WO$_3$@TiO$_2$-Fe$_2$O$_3$ obtained after 3 h hydrothermal reaction with different thicknesses of the TiO$_2$ ALD layer: (a-b) 5 nm; (c-d) 11 nm; (e-f) 30 nm.
Figure S8. (a) The dark current densities of the different samples including pure WO$_3$ nanosheets arrays, WO$_3$@TiO$_2$(11 nm) core-shell nanosheets and WO$_3$@TiO$_2$(11 nm)-Fe$_2$O$_3$ nanotrees arrays; (b) chronoamperometric I-t curves for WO$_3$@TiO$_2$(11 nm)-Fe$_2$O$_3$ nanotrees arrays photoanode collected at 1.23 V vs. RHE with repeated on-off cycles.
Figure S9. The XPS valence band spectra of the (a) WO$_3$@TiO$_2$ (11 nm)-Fe$_2$O$_3$, (b) WO$_3$@TiO$_2$ (11 nm) and (c) WO$_3$ nanosheets.