Supporting information

For

Effects of Ti-doping amount and annealing temperature on electrochromic performance of sol-gel derived WO₃

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Figure S1. SEM surface and cross-sectional images of (1st row) 4Ti-WO$_3$, (2nd row) 12Ti-WO$_3$, (3rd row) 16Ti-WO$_3$ and (4th row) 20Ti-WO$_3$ films annealed at 200, 250, 300, 350 and 400 °C from left to right, respectively.

Figure S2. XRD patterns of neat and respective TCA doped WO$_3$ films annealed at (a) 250 and (b) 350 °C. (The light blue and grey circles refer to monoclinic WO$_3$ and FTO substrate, respectively.)
**Figure S3.** Atomic ratios of P/W or Ti/W for xTi-WO$_3$-300 samples determined with EDS.
Figure S4. Cyclic voltammograms of various WO₃ films annealed at (a) 200, (b) 250, (c) 300, (d) 350, and (e) 400 °C, respectively.
Figure S5. Calculations of diffusion coefficients of various WO₃ films annealed at (a) 200, (b) 250, (c) 300, (d) 350, and (e) 400 °C, respectively.
Figure S6. Calculated diffusion coefficients of (a) 0Ti-WO₃, (b) 4Ti-WO₃, (c) 8Ti-WO₃, (d) 12Ti-WO₃, (e) 16Ti-WO₃, and (f) 20Ti-WO₃ at various annealing temperatures.
Figure S7. In-situ UV-Visible transmittance variations for (a) 0Ti-WO$_3$-200, (b) 4Ti-WO$_3$-200, (c) 8Ti-WO$_3$-200, (d) 12Ti-WO$_3$-200, (e) 16Ti-WO$_3$-200, and (f) 20Ti-WO$_3$-200, respectively.
Figure S8. In-situ UV-Visible transmittance variations for (a) 0Ti-WO$_3$-250, (b) 4Ti-WO$_3$-250, (c) 8Ti-WO$_3$-250, (d) 12Ti-WO$_3$-250, (e) 16Ti-WO$_3$-250, and (f) 20Ti-WO$_3$-250, respectively.
Figure S9. In-situ UV-Visible transmittance variations for (a) 0Ti-WO$_3$-350, (b) 4Ti-WO$_3$-350, (c) 8Ti-WO$_3$-350, (d) 12Ti-WO$_3$-350, (e) 16Ti-WO$_3$-350, and (f) 20Ti-WO$_3$-350, respectively.
Figure S10. In-situ UV-Visible transmittance variations for (a) 0Ti-WO$_3$-400, (b) 4Ti-WO$_3$-400, (c) 8Ti-WO$_3$-400, (d) 12Ti-WO$_3$-400, (e) 16Ti-WO$_3$-400, and (f) 20Ti-WO$_3$-400, respectively.
Figure S11. UV-Visible transmittance spectra of (a) 0Ti-WO$_3$, (b) 4Ti-WO$_3$, (c) 8Ti-WO$_3$, (d) 12Ti-WO$_3$, (e) 16Ti-WO$_3$, and (f) 20Ti-WO$_3$ at the pristine states under different annealing temperatures.
Figure S12. In situ optical response of the WO₃ films for 60 s per step measured at 550 nm annealed at (a) 200, (b) 250, (c) 300, (d) 350, and (e) 400 °C.
Figure S13. Optical density variation with respect to the charge density of WO$_3$ films annealed at (a) 200, (b) 250, (c) 300, (d) 350, and (e) 400 °C.
Figure S14. In-situ transmittance variation at $\lambda=550$ nm during cyclic tests for 8Ti-, 16Ti- and 20Ti-WO$_3$-films from left to right annealed at 200 (1$^{st}$ row), 250 (2$^{nd}$ row), 350 (3$^{rd}$ row) and 400 °C (4$^{th}$ row).