Electronic Supplementary Materials

Fast fabrication of WO$_3$·2H$_2$O thin film with improved electrochromic properties

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**Fig. S1** the XRD pattern of the compared film coated on unactivated FTO substrate after annealed at 300 °C for 1 h in air.
Fig. S2 the Raman spectrum of the WO$_3$·2H$_2$O thin film.

Fig. S2 displays a Raman spectrum of the WO$_3$·2H$_2$O thin film. The bands at 773.8 and 874.5 cm$^{-1}$ arise from the O-W-O stretching vibrations of the bridging oxygen atoms, and can be traced their origin back to the two strongest peaks at 714 and 808 cm$^{-1}$ in the Raman spectrum of crystalline WO$_3$. The bands at 255.3 and 312.6 cm$^{-1}$ originate back to the W-O-W bending vibrations, and the bands at 299.6 and 929.2 cm$^{-1}$ can be assigned to the stretching of W-OH$_2$ and W=O, respectively. The peaks at 651.1 and 683.6 cm$^{-1}$, appeared as shoulders in various regions of the spectrum, are the characteristic of the low temperature monoclinic phase.

Fig. S3 the Raman spectrum of the WO$_3$·2H$_2$O thin film after CV measurement for 500 cycles.
Fig. S3 reveals the Raman spectrum of the WO$_3$·2H$_2$O thin film after 500 CV cycles. The spectrum shows two peaks at 709.5 and 807.6 cm$^{-1}$, due to the O-W-O stretching vibrations. Another two bands located at 268.9 and 324.4 cm$^{-1}$ belong to W-O-W bending modes. Compared with the WO$_3$·2H$_2$O thin film (before CV measurement) shown in Fig. S2, there are distinct changes in the Raman spectra. As shown in Fig. S3, the peaks at 299.6 and 929.2 cm$^{-1}$ respectively arose from W-OH$_2$ and W=O modes are sharply decreased to inconspicuous, indicating a slowly dehydration process from WO$_3$·2H$_2$O phase to WO$_3$ phase during the 500 CV cycles.

References: