Electronic Supplementary Materials

Fast fabrication of $WO_3 \cdot 2H_2O$ thin film with improved electrochromic properties

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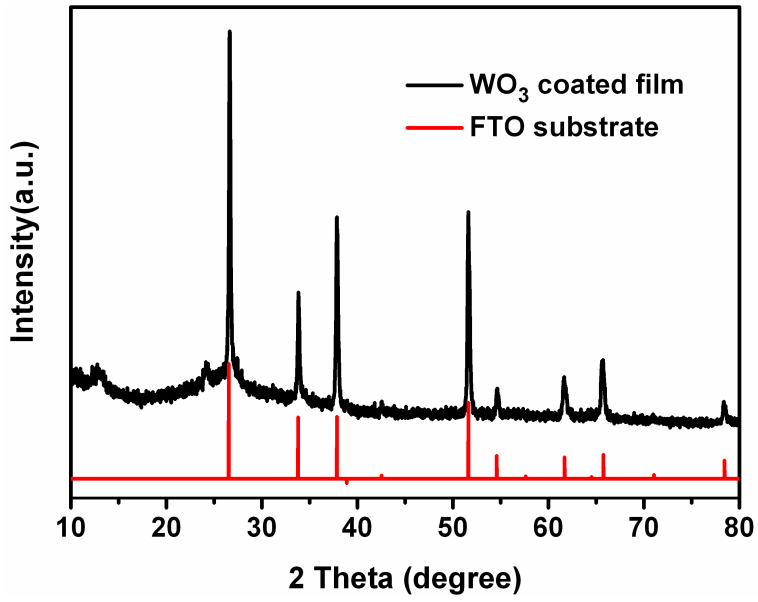

Fig. S1 the XRD pattern of the compared film coated on unactivated FTO substrate after annealed at 300 °C for 1 h in air.

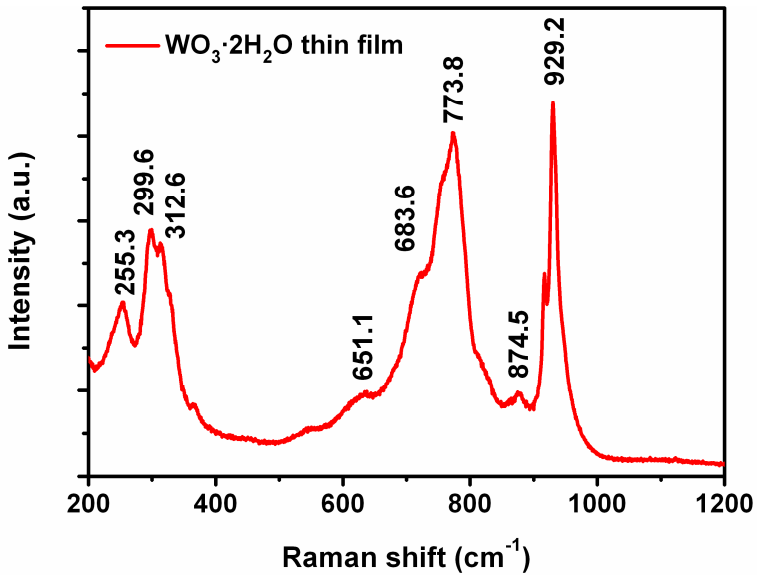

Fig. S2 the Raman spectrum of the $WO_3 \cdot 2H_2O$ thin film.

Fig. S2 displays a Raman spectrum of the $WO_3 \cdot 2H_2O$ 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.[1,2] The bands at 255.3 and 312.6 cm^{-1} origin 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 region of the spectrum, are the characteristic of the low temperature monoclinic phase.

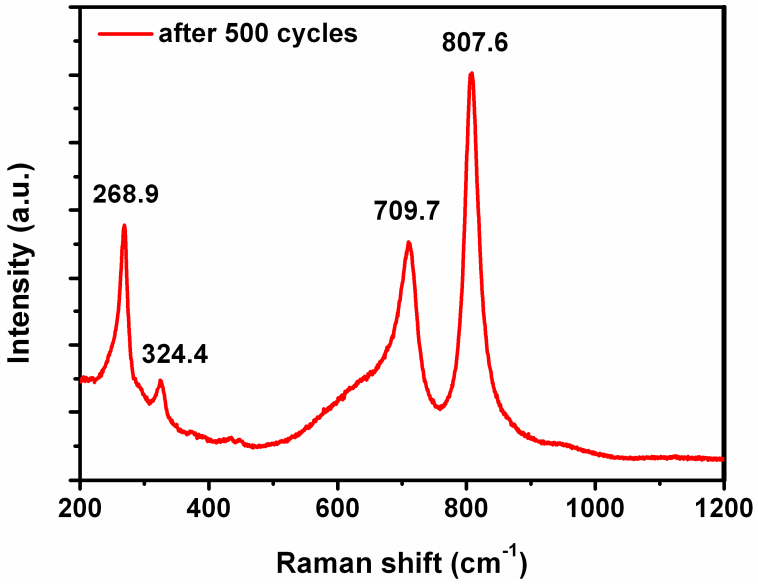

Fig. S3 the Raman spectrum of the $WO_3 \cdot 2H_2O$ thin film after CV measurement for 500 cycles.

Fig. S3 reveals the Raman spectrum of the $WO_3 \cdot 2H_2O$ 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 $WO_3 \cdot 2H_2O$ 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 arised from $W\text{-}OH_2$ and W=O modes are sharply decreased to unconspicuous, indicating a slowly dehydration process from $WO_3 \cdot 2H_2O$ phase to WO_3 phase during the 500 CV cycles.

References:

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2. Y. S. Huang, Y. Z. Zhang, X. T. Zeng and X. F. Hu, *Appl. Surf. Sci.*, 2002, **202**, 104.

3. O. pyper, A. Kaschner and C. Thomsen, *Sol. Energy Mater. Sol. cells*, 2002, **71**, 511.