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Electronic supplementary information (ESI)

Multifunctional hydrogel enables extremely simplified electrochromic devices for smart window and ionic writing board

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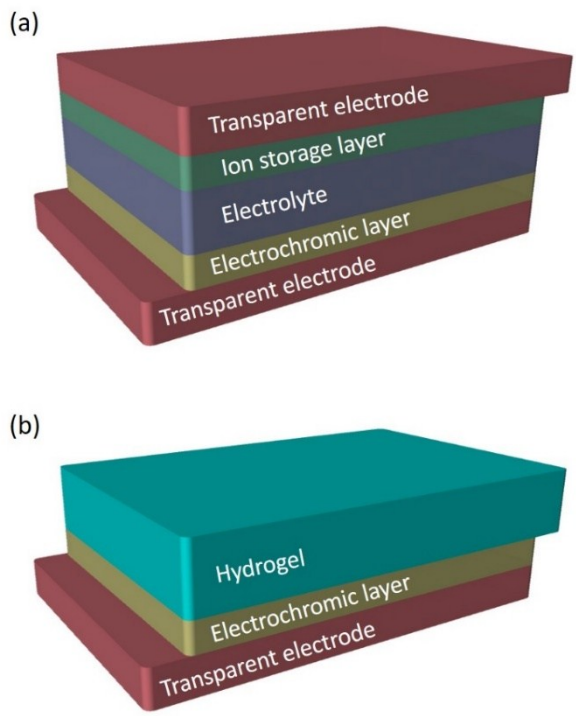

Fig. S1 Schematic structures of (a) The traditional electrochromic device with five layers. (b) The new electrochromic device with a multifunctional hydrogel layer.

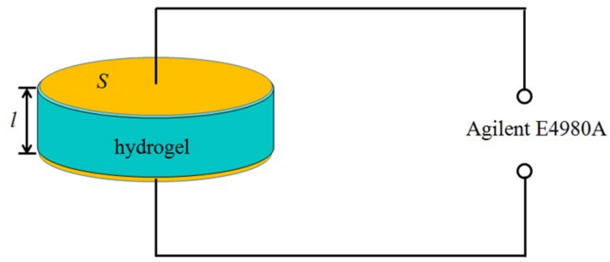

Fig. S2 The conductivity measurements of hydrogels.

The conductivity measurements were carried out using an impedance analyzer of Agilent E4980A, as shown in Fig S2. The conductivity σ is calculated by $\sigma = l / RS$, where l and S represent the thickness and cross-section area of the sample, respectively, and R is the resistance measured by Agilent E4980A. The distance between two electrodes is 2 mm, which is the thickness of hydrogel. The conductivity of PAAm-LiCl hydrogel with 6 mol/L LiCl electrolyte is found to be ~ 8 S/m.

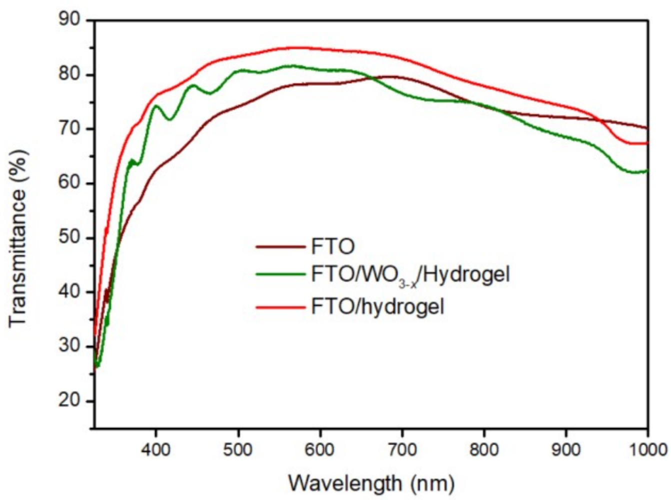

Fig. S3 The transmittance of FTO glass, the whole device and FTO/hydrogel.

The green line in Fig S3 is the transmittance spectra of the whole device. At the bleached state, the average transmittance in the visible region is about 80%, slightly higher than the bare FTO glass (wine line). To understand this abnormal increase in transmittance, we carefully studied the optical properties of FTO glass.

As we know, transmittance is defined as the intensity ratio of transmitted light to the incident light. In the transmittance test, a parallel beam with constant intensity is used as the incident light. A photodetector is used to detect the intensity of the transmitted light, as shown in Fig S4a. It is found that the commercial FTO we use is a polycrystalline film. The SEM image in Fig S4b shows the rough surface of FTO. This morphology leads to a part of the transmitted light that deviates from the original direction of the incident light, known as the haze. This part of transmitted light can not be detected by the photodetector, as shown in Fig S4c. After attaching the hydrogel on FTO glass, there is less transmitted light that deviates from the original direction of the incident light (see Fig S4d). Consequently, the detected transmitted light is stronger. Indeed, as shown in Fig S3, the transmittance of FTO/hydrogel is higher than the bare FTO. Fig S4e is a photograph of FTO, where the hydrogel-attached area appears to be more transparent. As a result, we think that the abnormal increase in the transmittance of the whole device is due to the haze effect.

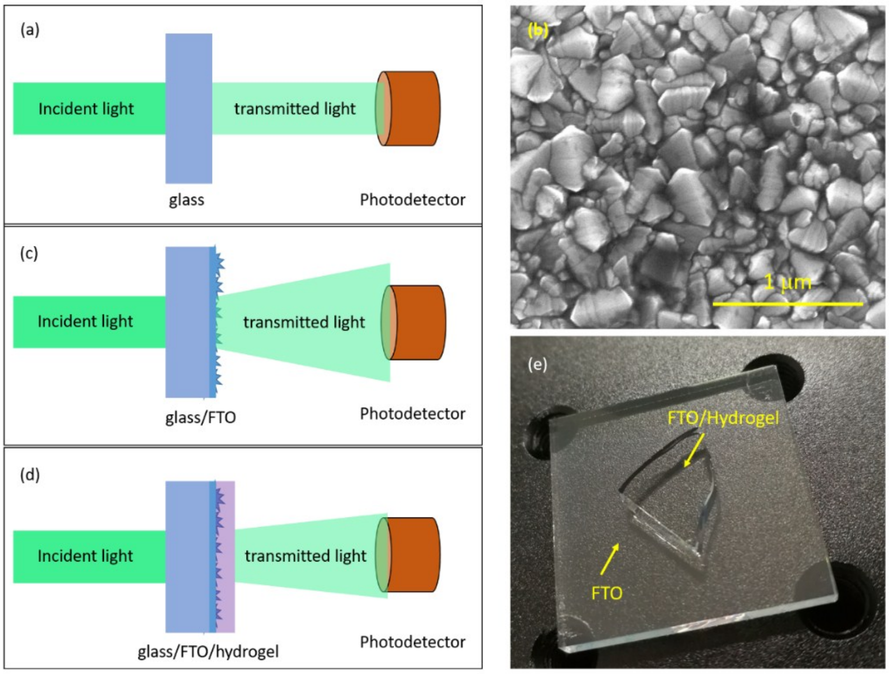

Fig. S4 (a) (c) (d) The principle of transmittance test. (b) SEM image of a bare FTO glass. (e) the photograph of FTO attached with hydrogel.

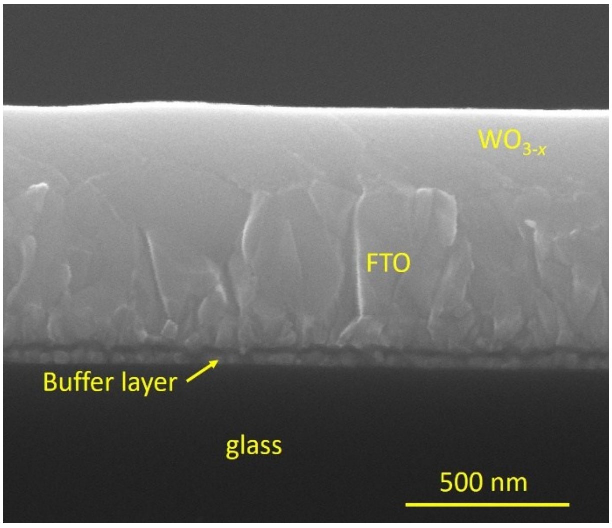

Fig. S5 The cross-sectional SEM of WO_{3-x} film on FTO glass.

As shown in Fig S5, the interface between FTO and WO_{3-x} film appears to seamless. Such a good interface thus ensures the electrical contact between FTO/ WO_{3-x} films.

Video S1. The coloring-bleaching process of a three-layered electrochromic device.

Video S2. Writing letters on the ionic writing board.