**Supporting Information**

**Fig. S1** The as-synthesized WO$_x$ sol-gel solution and placed in ambient conditions for 3 month.
**Fig. S2** The SEM images of (a) surface morphology, (b) the W element mapping, (c) the O element mapping, and (d) the mapping of combined W and O elements.
**Fig. S3** The (a) EL spectra and (b) normalized EL spectra of the UV OLED with HIL of PEDOT:PSS+WO$_x$=20:1 (Device D) at different voltages.