Supporting information

Novel tunneled phosphorus-doped WO_3 films achieved by ignited red phosphorus for stable and fast switching electrochromic performance

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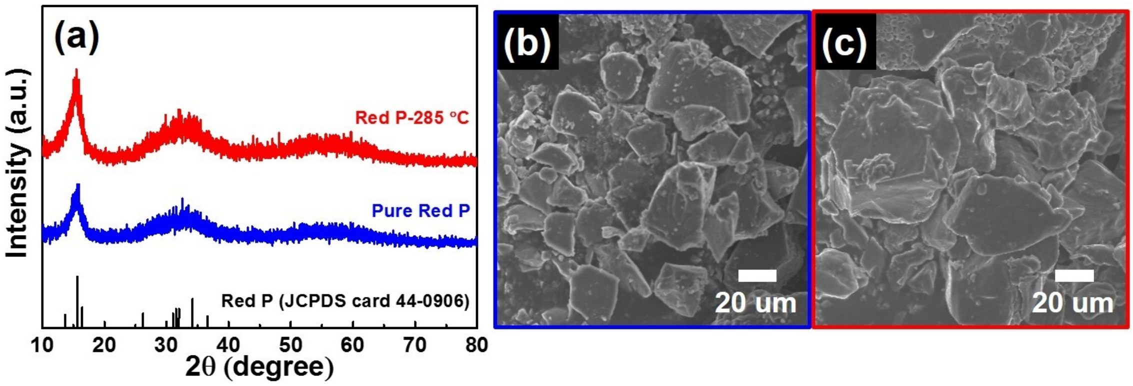

Fig. S1 (a) XRD patterns of pure red P particles (blue line) and red P particles annealed at 285 °C (red line) and their resultant SEM images ((b) and (c), respectively).

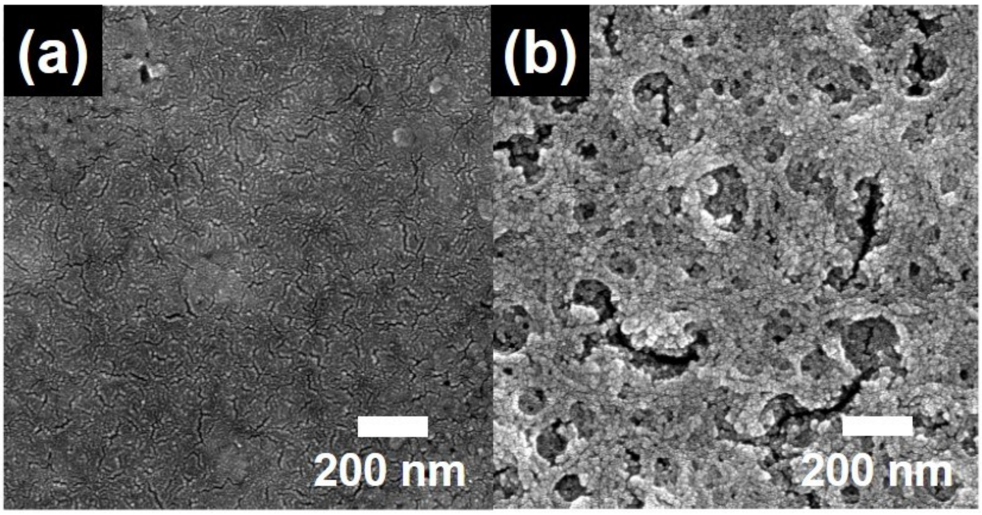

Fig. S2 Top-view SEM images of WO_3-1RP annealed at (a) 240 °C and (b) 340 °C.

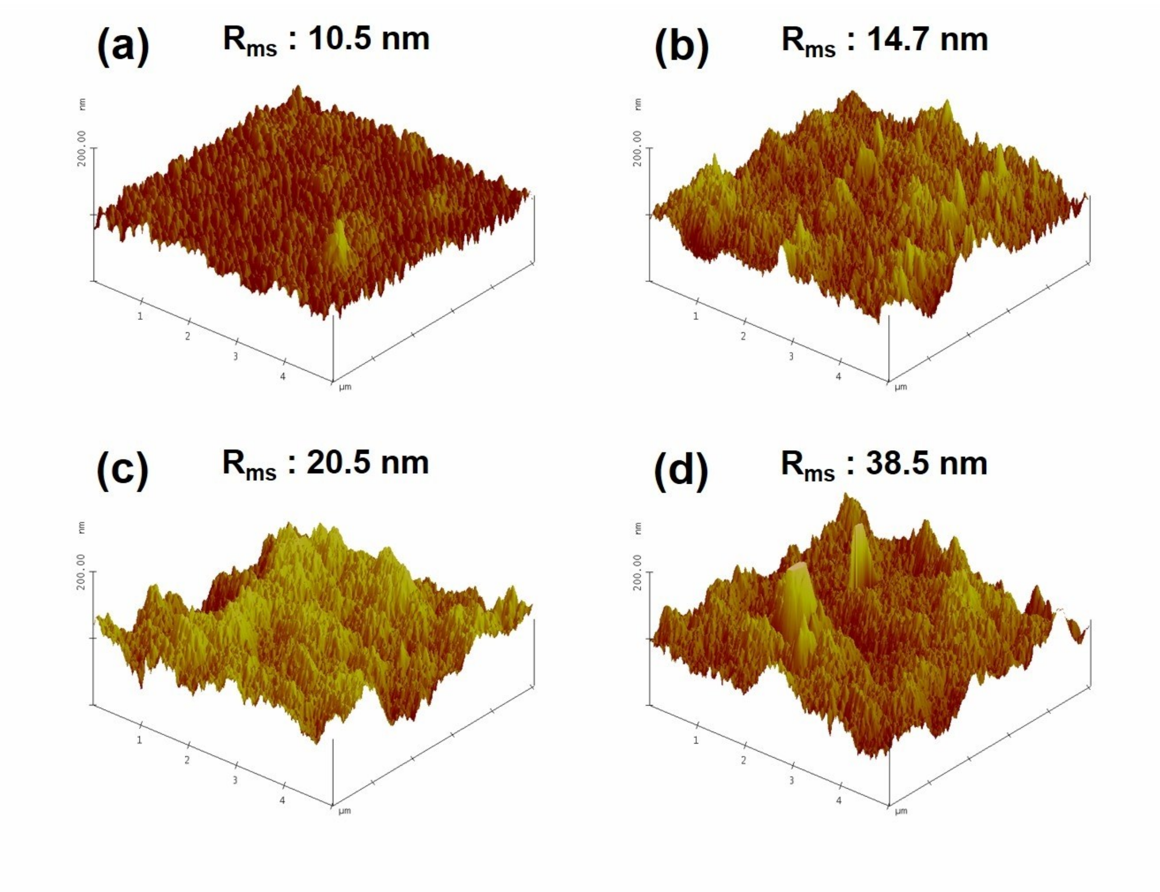

Fig. S3 AFM images obtained from (a) bare WO_3, (b) WO_3-0.5RP, (c) WO_3-1RP, and (d) WO_3-5RP.

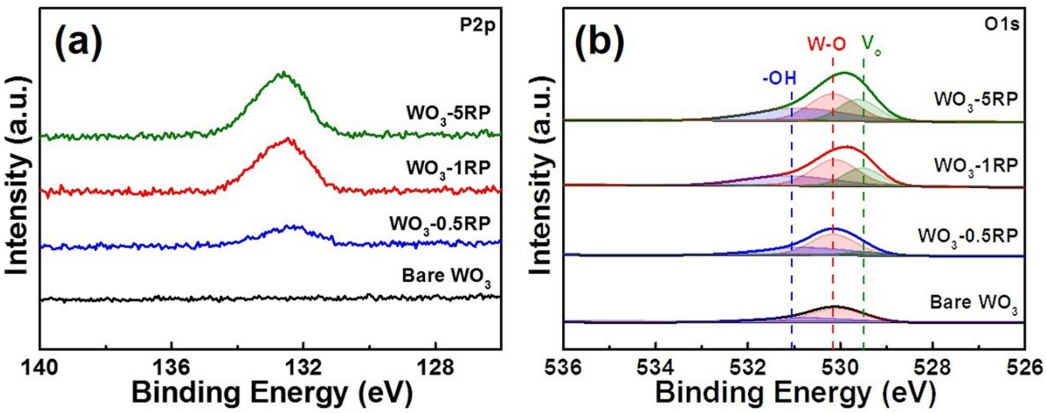

Fig. S4 XPS core-level spectra of (a) P 2*p* and (b) O 1*s* obtained from all samples.

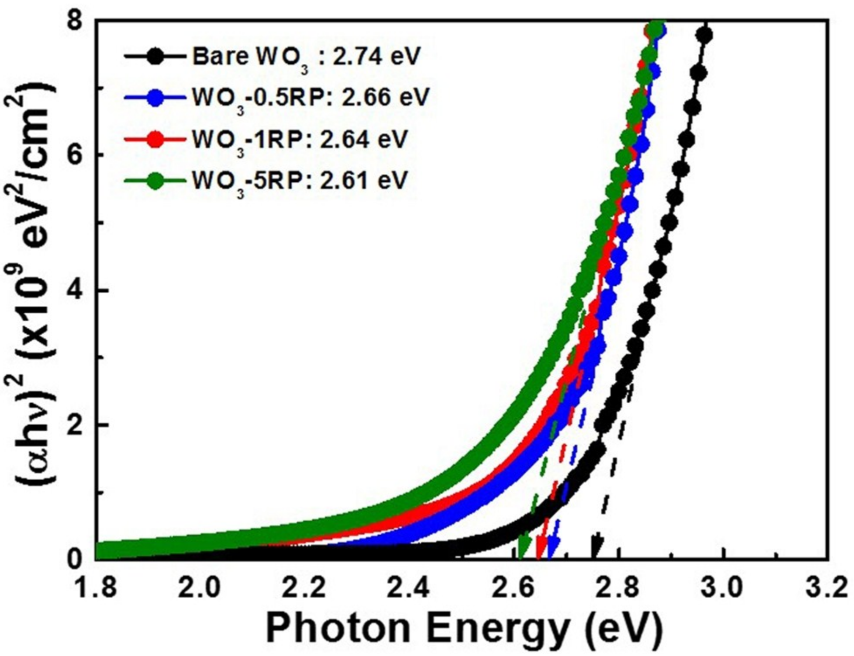

Fig. S5 Plots of $(ahv)^2$ versus photon energy for all samples.

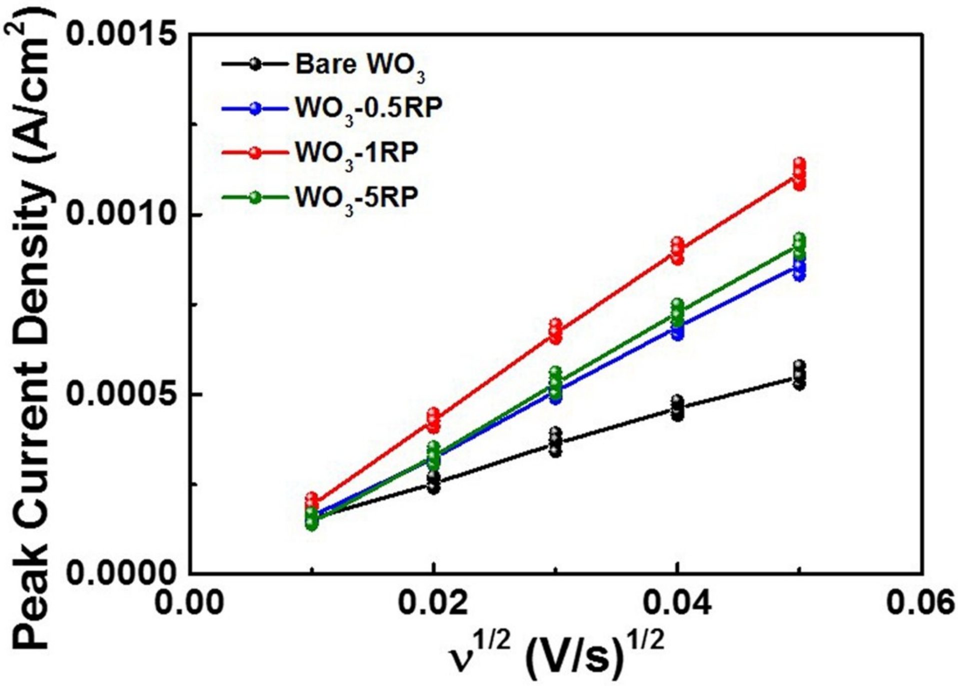

Fig. S6 Plots of peak current density as a function of the scan rates for all samples.

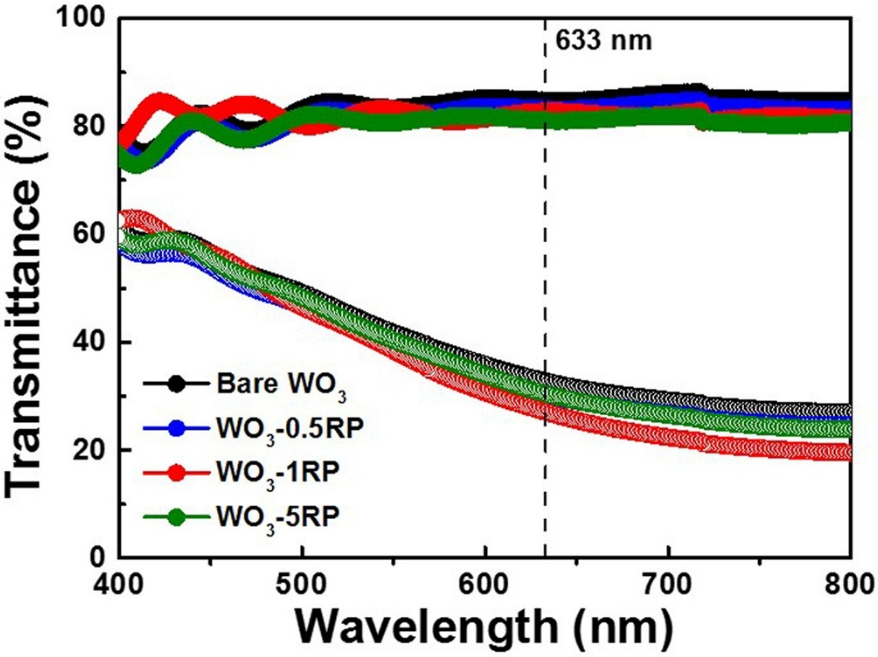

Fig. S7 Transmittance spectra of all samples measured at different working states (–0.7 V for coloration state (dotted line) and 1.0 V for bleached state (solid line)).

Table S1 EC performance comparison of previously reported WO_3-based materials.

Material	Coloration speed (s)	Bleaching speed (s)	CE (cm^2/C)
Porous WO_3 films[1]	37.0	5.0	36.0
Porous WO_3 films[2]	-	-	38.0
Macroporous WO_3 films[3]	5.1	8.7	50.1
Cylinder-like WO_3 nanorod arrays[4]	6.0	5.0	61.0
Mesoporous WO_3 films[5]	10.0	10.0	50.0
Disordered porous semicrystalline WO_3 films[6]	4.2	5.5	32.3
WO_3 nanotree films[7]	-	-	43.6
Vertically aligned Ni-doped WO_3 films[8]	7.8	6.0	60.5
Hydrogenated WO_3 nanosheet[9]	8.3	6.8	-
Stacked WO_3 nanosheet[10]	-	-	32.0
Our study	6.1	2.5	55.9

Notes and references

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