## **Supplementary Information**

Table S1 Performance parameters of the amorphous WO<sub>3</sub>·2H<sub>2</sub>O film compared with those of WO<sub>3</sub> hydrate films reported in the literature

Crystalline   S9% at 1200   1.6~4.0   -   96.2   at   1200   nm,   13% at   (vs.   1200   nm,	Material	$\Delta T$	Operation	$t_{\rm c}/t_{\rm b}$	CE	Cycling stability
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			potential (V)	(s)	(cm <sup>2</sup> /C)	
Crystalline   90.4%   at   -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.4     -0.2~0.8     -0.2~0.5     -0.2~0.8     -0.2~0.8     -0.2~0.5     -0.2~0.8     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5   -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5     -0.2~0.5	Crystalline	59% at 1200	1.6~4.0	-	96.2 at	-
Crystalline	$WO_3 \cdot H_2O$	nm, 13% at	(vs.		1200 nm,	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Film [1]	550 nm	Li/Li <sup>+</sup> )		20.7 at 550	
MO3·2H <sub>2</sub> O   nanoplate film [2]   Ag/AgCl)   Ag/AgCl)   Amorphous   69% at 1100   -0.8~0.8   2.3/2.1 at   1100 nm   ΔT after 500 cycles   MO3·0.9H <sub>2</sub> O film   nm, 24% at   (vs.   1100 nm   1100 nm   ΔT after 12000   cycles at 1100 nm; retaining 87% after 1000 cycles at 550 nm   Ag/AgCl)   Amorphous   Ag/AgCl   Ag/AgCl   Amorphous   Ag/AgCl   Ag/AgCl   Amorphous   Ag/AgCl   Ag/AgCl   Ag/AgCl   Amorphous   Ag/AgCl					nm	
Amorphous	Crystalline	90.4% at	-0.2~0.4	-	322.6 at	Retaining 93.7% of
Amorphous   69% at 1100   -0.8~0.8   2.3/2.1 at   312   at   Retaining 97% of ΔT after 12000 cycles at 1100 nm; after 12000 cycles at 1100 nm; retaining 87% after 1000 cycles at 550 nm     Amorphous and crystalline   83.8% at -0.5~0.5   15.3/14.   22.8 at 633 color nm   Retaining 97% of ΔT after 12000 cycles at 1100 nm; retaining 87% after 1000 cycles at 550 nm     Amorphous and crystalline   72.5% at Ag/AgCl)   15.3/14.   22.8 at 633 color nm, 90.8 of ΔT at 633 nm and at 1050 nm   0 ΔT after 12000 cycles at 1500 nm     Crystalline   58% at 633 color nm   -1~3 (vs. nm)   9 at 633 nm, nm, 90.8 of ΔT at 633 nm after 500 cycles   -1.57.6.0 nm   -	$WO_3 \cdot 2H_2O$	1600 nm	(vs.		1600 nm	$\Delta T$ after 500 cycles
MO <sub>3</sub> ·0.9H <sub>2</sub> O film   nm, 24% at   (vs.   1100 nm   1100 nm   ΔT   after   12000   cycles at 1100 nm; retaining 87% after   1000   cycles at 550   nm   retaining 87% after   1000   cycles at 550   nm   retaining 87% after   1000   cycles at 550   nm   nm   at   1000   cycles at 550   nm     cys.   9 at 633   nm,   90.8   of ΔT   at 633 nm   and   doped   WO <sub>3</sub> ·2H <sub>2</sub> O   72.5%   at   Ag/AgCl)   nm,   at   1050   nm   after 500   cycles   at 1050   nm   after 500   cycles   at 1050   nm   after 500   cycles   at 1050   nm   after 500   cycles   at 1050   nm   at 1050   nm   at 1050   cycles   at 633   cys.   cy	nanoplate film [2]		Ag/AgCl)			
Solution	Amorphous	69% at 1100	-0.8~0.8	2.3/2.1 at	312 at	Retaining 97% of
Amorphous   and crystalline   Ti-doped   WO <sub>3</sub> ·2H <sub>2</sub> O   72.5%   at   1050 nm   Ag/AgCl)   Amorphous   S8% at 633   -1~3 (vs.   9.6/5.1   38.2   -1.5~0.5   1.5~0.5	WO <sub>3</sub> ·0.9H <sub>2</sub> O film	nm, 24% at	(vs.	1100 nm	1100 nm	$\Delta T$ after 12000
Amorphous and crystalline Ti- d33 nm, doped WO <sub>3</sub> ·2H <sub>2</sub> O   72.5% at 1050 nm   1050 nm   1050 nm   26% at 1050 nm   1050 nm   1050 nm   26% at 1050 nm   26%	[3]	550 nm	Ag/AgCl)			cycles at 1100 nm;
Amorphous and crystalline Tidoped WO <sub>3</sub> ·2H <sub>2</sub> O   83.8% at respect to the state of t						retaining 87% after
Amorphous and crystalline Tidoped WO <sub>3</sub> ·2H <sub>2</sub> O   83.8% at crystalline Tidoped WO <sub>3</sub> ·2H <sub>2</sub> O   at crystalline (vs. part of the part of						1000 cycles at 550
crystalline   Ti-doped   633   nm, doped   (vs. Ag/AgCl)   9 at 633 nm, nm, nm, at 1050 nm   of ΔT at 633 nm and at 1050 nm at 1050 nm after 500 cycles     Crystalline   58% at 633 -1~-3 (vs. nm)   9.6/5.1   38.2   -     Crystalline WO <sub>3</sub> ·H <sub>2</sub> O nanoplates film [5]   MO <sub>2</sub> (O <sub>2</sub> )H <sub>2</sub> O·1.66   32% at 632 -1.5~0.5 (vs. nm)   7.8/1.7   5.74   -     WO <sub>2</sub> (O <sub>2</sub> )H <sub>2</sub> O·1.66 H <sub>2</sub> O nanocrystal film [6]   Ag/AgCl)   Ag/AgCl)   -   -     3WO <sub>3</sub> ·H <sub>2</sub> O nanoplate film [7]   38% at -0.3~0.3 (vs. Ag/AgCl)   4.3/1.4   112.7   -     Amorphous WO <sub>3</sub> ·2H <sub>2</sub> O film (this work)   92% at 633 -0.5~0.5   18.1/17. 204.2   retaining 94% of ΔT at 633 nm and at 1050 nm after 500 cycles at 633 nm nm after 500 cycles a						nm
doped WO <sub>3</sub> ·2H <sub>2</sub> O   72.5% at loso nm   Ag/AgCl)   nm, at loso loso nm   26% at loso nm after soo cycles     Crystalline WO <sub>3</sub> ·H <sub>2</sub> O nanoplates film [5]   58% at 633 loso nm loso nm   -1~-3 (vs. loso loso nm loso nm loso nm   3.5/16.0 loso nm lo	Amorphous and	83.8% at	-0.5~0.5	15.3/14.	22.8 at 633	Retaining 52.3%%
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	crystalline Ti-	633 nm,	(vs.	9 at 633	nm, 90.8	of $\Delta T$ at 633 nm and
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	doped WO <sub>3</sub> ·2H <sub>2</sub> O	72.5% at	Ag/AgCl)	nm,	at 1050	26% at 1050 nm
Crystalline   58% at 633   -1~-3 (vs. particles)   9.6/5.1   38.2   -     WO₃'H₂O   nm   Ag/AgCl)   38.2   -     manoplates film [5]   WO₂(O₂)H₂O·1.66   32% at 632   -1.5~0.5   7.8/1.7   5.74   -     H₂O nanocrystal film [6]   nm   (vs. particles)   4.3/1.4   112.7   -     3WO₃'H₂O nanoplate film [7]   633nm   (vs. particles)   4.3/1.4   112.7   -     nanoplate film [7]   633nm   (vs. particles)   4.3/1.4   112.7   -     Ag/AgCl)   Nm   Ag/AgCl)   5 at 633   cm²/C at particles)   after 2000 cycles     (this work)   86% at 1100 particles   Ag/AgCl)   nm, particles   1100 nm, particles   10000 cycles at 633     1100 nm   cm²/C at particles   nm; retaining 18% particles   633 nm   of ΔT after 10000	film [4]	1050 nm		3.5/16.0	nm	after 500 cycles
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				at 1050		
WO <sub>3</sub> ·H <sub>2</sub> O   nm   Ag/AgCl)   Ag/AgCl)     WO <sub>2</sub> (O <sub>2</sub> )H <sub>2</sub> O·1.66   32% at 632   -1.5~0.5   7.8/1.7   5.74   -     H <sub>2</sub> O nanocrystal film [6]   Ag/AgCl)   -   Ag/AgCl)   -   -     3WO <sub>3</sub> ·H <sub>2</sub> O nanoplate film [7]   633nm   (vs.   -   -   -   -   -     nanoplate film [7]   633nm   (vs.   Ag/AgCl)   -<				nm		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Crystalline	58% at 633	-1~-3 (vs.	9.6/5.1	38.2	-
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$WO_3 \cdot H_2O$	nm	Ag/AgCl)			
H2O nanocrystal film [6] nm (vs. Ag/AgCl) 4.3/1.4 112.7 -   3WO <sub>3</sub> ·H <sub>2</sub> O nanoplate film [7] 38% at -0.3~0.3 (vs. Ag/AgCl) 4.3/1.4 112.7 -   Amorphous WO <sub>3</sub> ·2H <sub>2</sub> O film (this work) 92% at 633 (vs. Ag/AgCl) 18.1/17. 204.2 (retaining 94% of $\Delta T$ after 2000 cycles at 633 cm²/C at after 2000 cycles (this work) 5 at 633 cm²/C at after 2000 cycles at 633 (rd²/C) at after 2000 cycles at 633 (rd²/C) at after 10000 cycles at 633 (rd²/C) at af	nanoplates film [5]					
film [6] Ag/AgCl) Ag/AgCl) Image: contract of the proof o	WO <sub>2</sub> (O <sub>2</sub> )H <sub>2</sub> O·1.66	32% at 632	-1.5~0.5	7.8/1.7	5.74	-
3WO <sub>3</sub> ·H <sub>2</sub> O 38% at namoplate film [7] -0.3~0.3 4.3/1.4 112.7 -   Amorphous WO <sub>3</sub> ·2H <sub>2</sub> O film (this work) 92% at 633 -0.5~0.5 18.1/17. 204.2 retaining 94% of ΔT   86% at 1100 Ag/AgCl) nm 1100 nm and 76% after   7.1/5.0 at 72.3 10000 cycles at 633   1100 nm cm²/C at nm; retaining 18% of ΔT after 10000	H <sub>2</sub> O nanocrystal	nm	(vs.			
nanoplate film [7] 633nm (vs. Ag/AgCl) Ag/AgCl) retaining 94% of $\Delta T$ Amorphous 92% at 633 -0.5~0.5 18.1/17. 204.2 retaining 94% of $\Delta T$ WO <sub>3</sub> ·2H <sub>2</sub> O film nm and (vs. 5 at 633 cm²/C at after 2000 cycles   (this work) 86% at 1100 Ag/AgCl) nm, 1100 nm, and 76% after   nm 7.1/5.0 at 72.3 10000 cycles at 633   1100 nm cm²/C at nm; retaining 18% of $\Delta T$ after 10000	film [6]		Ag/AgCl)			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	3WO <sub>3</sub> ⋅H <sub>2</sub> O	38% at	-0.3~0.3	4.3/1.4	112.7	-
Amorphous WO <sub>3</sub> ·2H <sub>2</sub> O film (this work) 92% at 633 nm -0.5~0.5 (vs. scale) 18.1/17. 204.2 scale (vs. scale) retaining 94% of ΔT after 10000 scycles at 633 nm; retaining 94% of ΔT after 10000	nanoplate film [7]	633nm	(vs.			
WO <sub>3</sub> ·2H <sub>2</sub> O film (this work) nm and (vs. 86% at 1100 Ag/AgCl) nm, 1100 nm, and 76% after 10000 cycles at 633 nm; retaining 18% of ΔT after 10000			Ag/AgCl)			
(this work) 86% at 1100 nm Ag/AgCl) nm, 7.1/5.0 at 1100 nm, 10000 cycles at 633 nm 1100 nm, 10000 cycles at 633 nm; retaining 18% of ΔT after 10000	Amorphous	92% at 633	-0.5~0.5	18.1/17.	204.2	retaining 94% of $\Delta T$
nm $7.1/5.0 \text{ at}   72.3   10000 \text{ cycles at } 633   1100 \text{ nm}   \text{cm}^2/\text{C}   \text{at}   \text{of } \Delta T \text{ after } 10000   \Delta T \text{ after } 10000   \Delta T \text{ at } \text{ of } \Delta T \text{ after } 10000   \Delta T \text{ at } \text{ of } \Delta T \text{ at } \Delta T \text{ at } \text{ of } \Delta T \text{ at } \text{ of } \Delta T \text{ at } \Delta$	$WO_3 \cdot 2H_2O$ film	nm and	(vs.	5 at 633	cm <sup>2</sup> /C at	after 2000 cycles
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	(this work)	86% at 1100	Ag/AgCl)	nm,	1100 nm,	and 76% after
633 nm of $\Delta T$ after 10000		nm		7.1/5.0 at	72.3	10000 cycles at 633
				1100 nm	cm <sup>2</sup> /C at	nm; retaining 18%
					633 nm	of $\Delta T$ after 10000
						cycles at 1100 nm.

- [1] J. Fortunato, B.Z. Zydlewski, M. Lei, N.P. Holzapfel. M. Chagnot, J.B. Mitchell, H. Lu, D. Jiang, D.J. Milliron, V. Augustyn. Dual-band electrochromism in hydrous tungsten oxide, ACS Photonics, 10 (2023) 3409-3418.
- [2] Z. Wang, W. Gong, X. Wang, Z. Chen, X. Chen, J. Chen, H. Sun, G. Song, S. Cong, F. Geng, Z. Zhao. Remarkable near-infrared electrochromism in tungsten oxide driven by interlayer water-induced battery-to-pesedocapacitor transition. ACS Appl. Mater. Interfaces, 12 (2020) 33917-33925.
- [3] W. Zhao, J. Wang, B. Tam, H. Zhang, F. Li, A. Du, W. Cheng. Structural water in amorphous tungsten oxide hydrate enables fast nad ultrastable regulation of near-infrared light transmittance, Adv. Opt, Mater., 11 (2023) 2202774.
- [4] X. Sun, D. Wang, W. Wu, X. Zhao, Z. Zhang, B. Wang, X. Rong, G. Wu, X. Wang. Amorphous and crystalline Ti-doped WO<sub>3</sub>·2H<sub>2</sub>O for dual-band electrochromic smart windows, ACS Sustain. Chem. Eng., 12 (2024) 5459-5467.
- [5] C.Y. Ng, K.A. Razak, Z. Lockman. Effect of annealing on acid-treated WO<sub>3</sub>·H<sub>2</sub>O nanoplates and their electrochromic properties, Electrochim. Acta, 178 (2015) 673-681.
- [6] S. Wang, K. Dou, Y. Zou, Y. Dong, J. Li, D. Ju, H. Zeng. Assembling tungsten oxide hydrate nanocrystal colloids formed by laser ablation in liquid into fast-response electrochromic films, J. Colloid Interf. Sci., 489 (2017) 85-91.
- [7] Z. Jiao, X. Wang, J. Wang, L. Ke, H.V. Kemir, T. W. Koh, X. Sun. Efficient synthesis of plate-like crystalline hydrated tungsten trioxide thin films with highly improved electrochromic performance, Chem. Commun., 48 (2012) 365-367.