Electronic Supplementary Information

Growth of porous $NiCoO_2$ nanowire network for transparent-to-brownish grey electrochromic smart windows with wide-band optical modulation

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Table. S1 Quantitative analysis of the NCO-105-350

Name	Position	Raw Area	Area/(RSF*T*MFP)	%At Conc
C 1s	284.25	110475	27448	21.70
O 1s	529.25	579919	53375.8	42.19
Ni 2p	854.25	1.20163e+006	22587.3	17.85
Co 2p	779.25	1.10112e+006	23098.1	18.26

Table. S2 Comparison of electrochromic properties of $NiCoO_2$ films at different hydrothermal reaction temperatures.

Samples	t_c	t_b	ΔT
90 ℃,1.5 h-350 ℃,2 h	2.2 s	2.4 s	36.8%
95 ℃,1.5 h-350 ℃,2 h	3.5 s	3.4 s	44.2%
100 ℃,1.5 h-350 ℃,2 h	5.7 s	5.2 s	53.7%
105 ℃,1.5 h-350 ℃,2 h	6.8 s	6.7 s	64.2%
110 ℃,1.5 h-350 ℃,2 h	7.3 s	7.6 s	48.6%

Table. S3 Comparison of electrochromic properties of $NiCoO_2$ films growing at 105 ℃ at different annealing temperatures.

Samples	t_c	t_b	ΔT
105 ℃,1.5 h-250 ℃,2 h	11.1 s	13.6 s	64.5%
105 ℃,1.5 h-300 ℃,2 h	12.2 s	12.2 s	69%
105 ℃,1.5 h-350 ℃,2 h	6.8 s	6.7 s	64.2%
105 ℃,1.5 h-400 ℃,2 h	16.0 s	18.4 s	63.8%

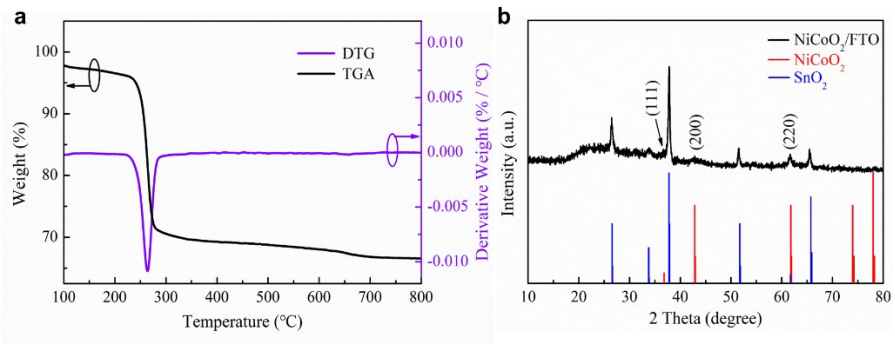

Fig. S1 (a) The TGA and DTG curve of $NiCo(OH)_2CO_3$. (b) The XRD of 105 ℃ hydrothermal reaction for 6 h followed by 2 h annealing in N_2 at 350 ℃.

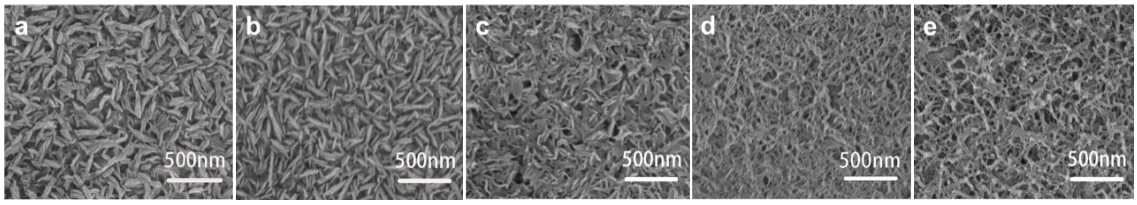

Fig. S2 FESEM images of $NiCo(OH)_2CO_3$ were hydrothermally grown at (a) 90, (b) 95, (c) 100, (d) 105 and (e) 110 ℃.

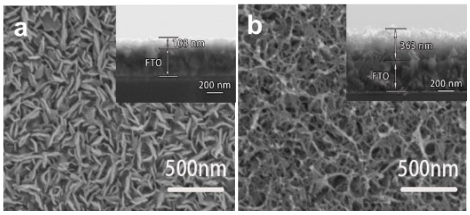

Fig. S3 FESEM images of (a) NCO-90 and (b) NCO-110 with the cross-section pattern inserted.

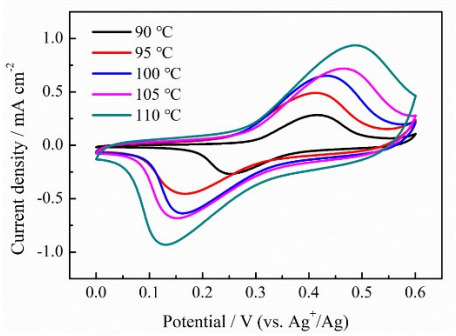

Fig. S4 The CV curve of $NiCoO_2$ films grown at different hydrothermal temperatures at the scan rates of 10 mV s^{-1} in the 1 M KOH electrolyte from 0 to 0.6 V (vs Ag^+/Ag).

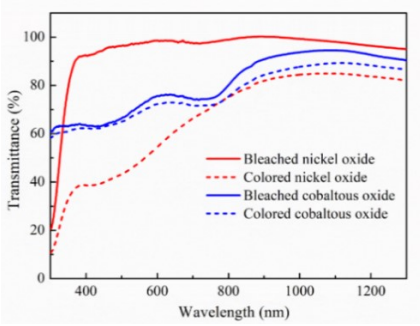

Fig. S5 The transmittance spectra of single nickel oxide and cobaltous oxide film in the colored (0.7 V vs Ag^+/Ag, dotted line) and bleached (-0.2 V vs Ag^+/Ag, full line) states.

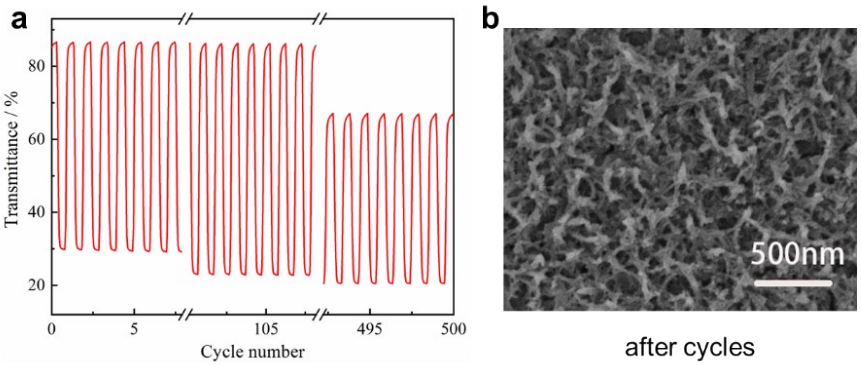

Fig. S6 (a) Durability measurement of $NiCoO_2$ film at 550 nm by chronoamperometry and In situ spectroscopic. (b) SEM image of the $NiCoO_2$ film after cycle measurement.

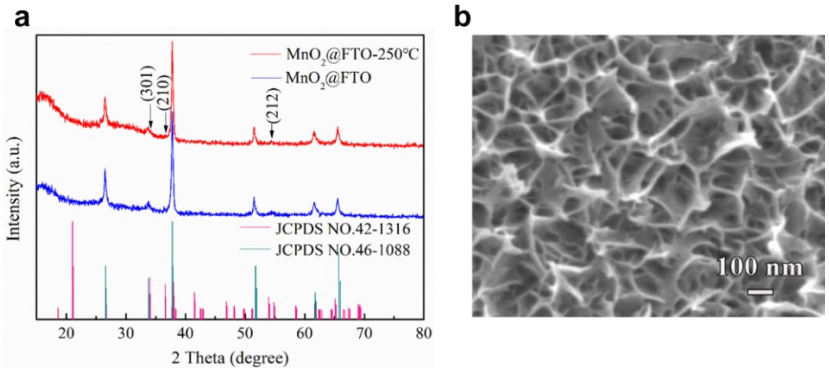

Fig. S7 XRD (a) and SEM (b) images of 400 s MnO_2 deposited by a constant voltage of 0.5 V.

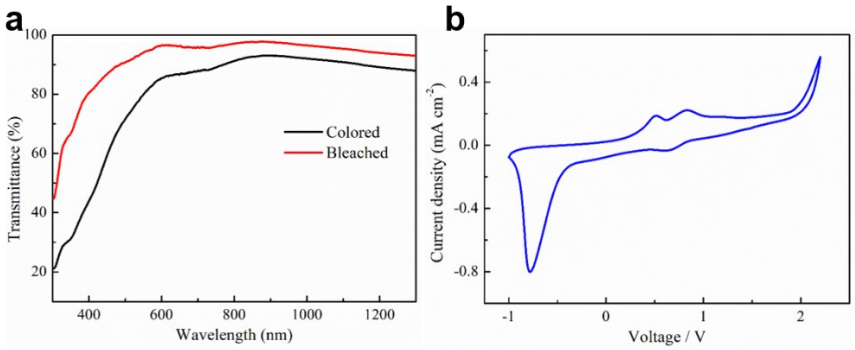

Fig. S8 (a) The transmittance spectra of MnO_2 prepared by electrodeposition in the colored (0.3 V) and bleached (-0.5 V) states. (b) The CV property of the assembled device was carried out at 10 mVs^{-1} from -1.0 to 2.2 V.

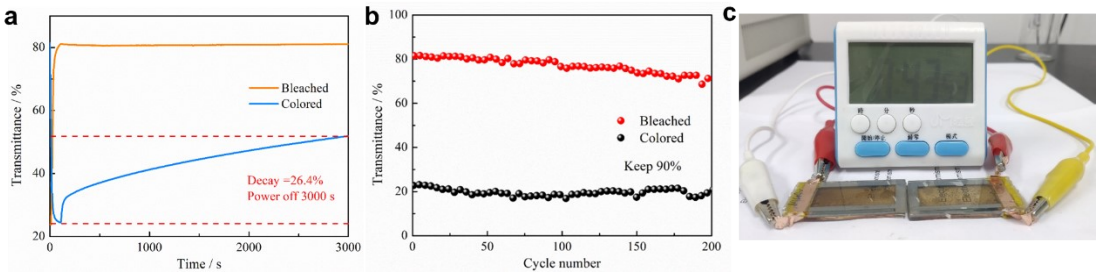

Fig. S9 (a) Durability measurement of the electrochromic device at 550 nm by applying a square wave voltage of -1 and 2.2 V. (b) Transmittance at 550 nm of the electrochromic device under stimulation voltage of -1 and 2.2 V for 100 s, power off for 3,000 s. (c) A display of powering a digital watch by serial EESD.

Table. S4 A summary table of the electrochromic and energy storage properties of the $NiCoO_2$ film and other related works.

Electrochromic material	Optical modulation	Switching speed t_c/t_b	Optical memory	Capacitance	Ref.
NiO	41.8% (650 nm)	1.6/1.9 s	Not shown	Not shown	19
NiO	68% (580 nm)	7.1/6.5 s	Not shown	Not shown	17
NiO	63.6% (550 nm)	11.5/9.5 s	Not shown	192 mAh g^{-1} at 1 A g^{-1}	20
NiO	40% (632.8 nm)	2.7/1.8 s	Not shown	Not shown	S1
Ni-BTA	61.3% (500 nm)	1.8/5 s	2400 s	168.1 mAh g^{-1} at 1.7 A g^{-1}	47
Co_3O_4	34% (633 nm)	1.8/1.4 s	Not shown	Not shown	21
Co_3O_4	Not shown	Not shown	Not shown	6.5 mAh g^{-1} 0.5 A g^{-1}	S2
Co_3O_4	42% (633 nm)	2.5/2.0 s	Not shown	Not shown	16
rGO–$Co_{(1-x)}Ni_x(OH)_2$	60% (500 nm)	22.1/22.1 s	Not shown	188.7 mAh g^{-1} at 1 A g^{-1}	S3
$Co(OH)_2$/$Ni(OH)_2$	50% (500 nm)	1.5/1.1 s	Not shown	170.4 mAh g^{-1} at 2 A g^{-1}	S4
$NiCoO_2$	64.2% (550 nm), 41.8% (1000 nm)	6.8/6.7 s	24000 s	31.4 mAh g^{-1} at 1 A g^{-1}	This work

(Some greater capacity have been achieved only on the metal based current collector).

Notes and references

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