Electronic Supplementary Material (ESI) for Materials Advances.

Supplementary Information

High performance NiO_x nanoplatelet based films by scrape-coating method for bifunctional electrochromic and energy storage devices

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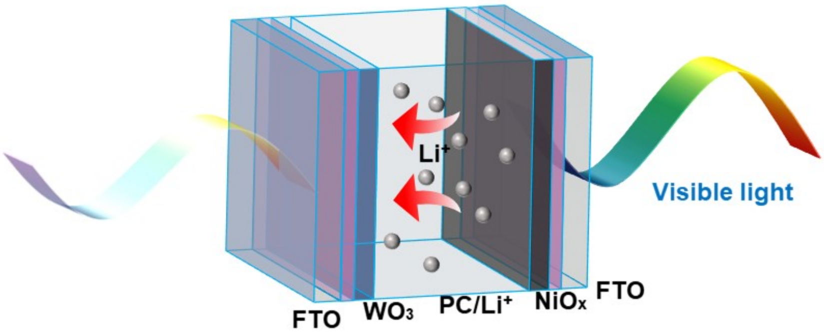

Fig.S1 Schematic diagram of the dynamics of electrochromic mechanism of NiO_x films in $PC/LiClO_4$.

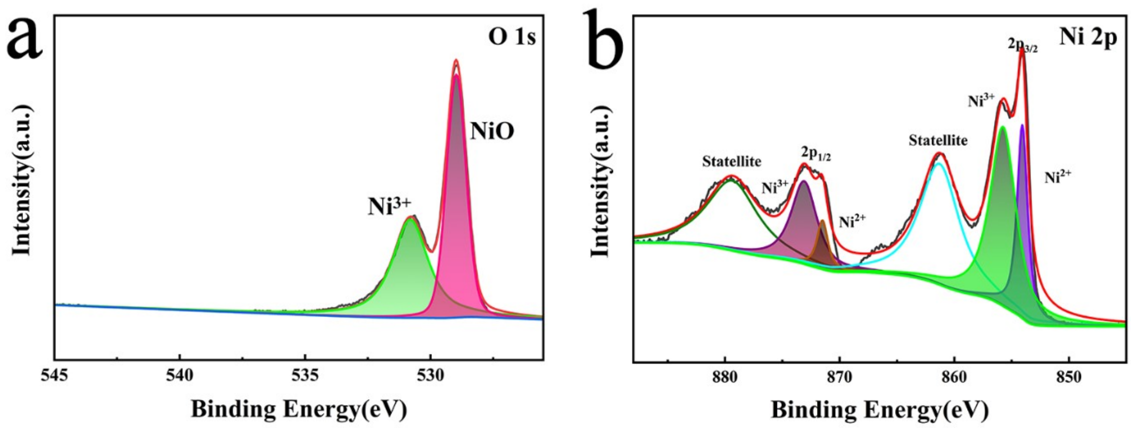

Fig.S2 XPS spectra of NiO_x NPs: (a) O 1s and (b) Ni 2p

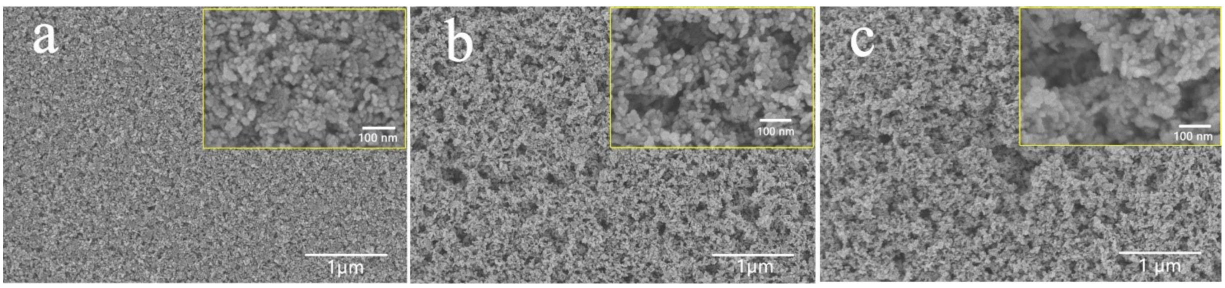

Fig.S3 SEM image of (a) NiO_x-0; (b) NiO_x-0.25 and (c) NiO_x-0.50 films.

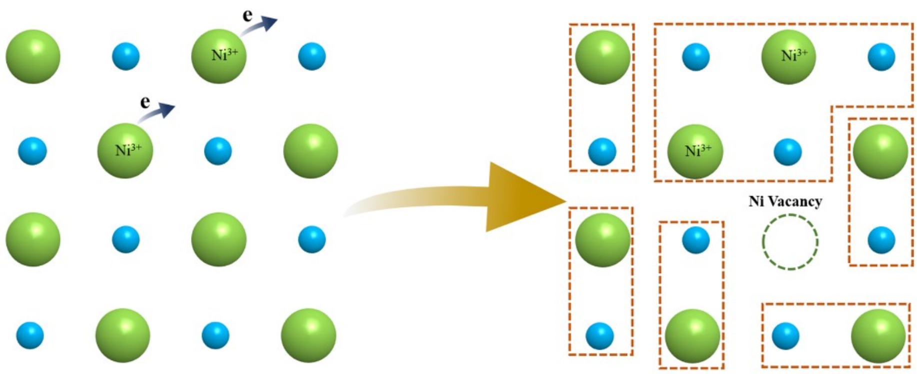

Fig.S4 Diagram of the mechanism of formation of Ni vacancies (Ni atoms in green, O atoms in blue).

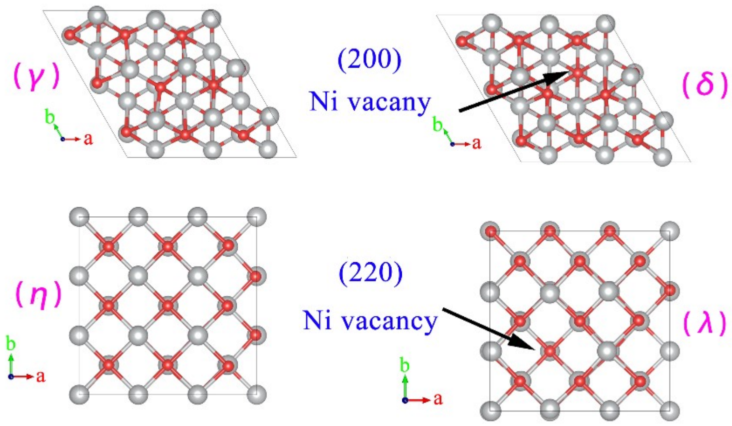

Fig.S5 Surface structures of NiO. Ball-and-stick model of the surface of NiO: γ (200) surface, δ (200) surface with a Ni vacancy, η (220) surface, λ (220) surface with a Ni vacancy. Here red ball is Oxygen atom and gray ball is Nickel atom.

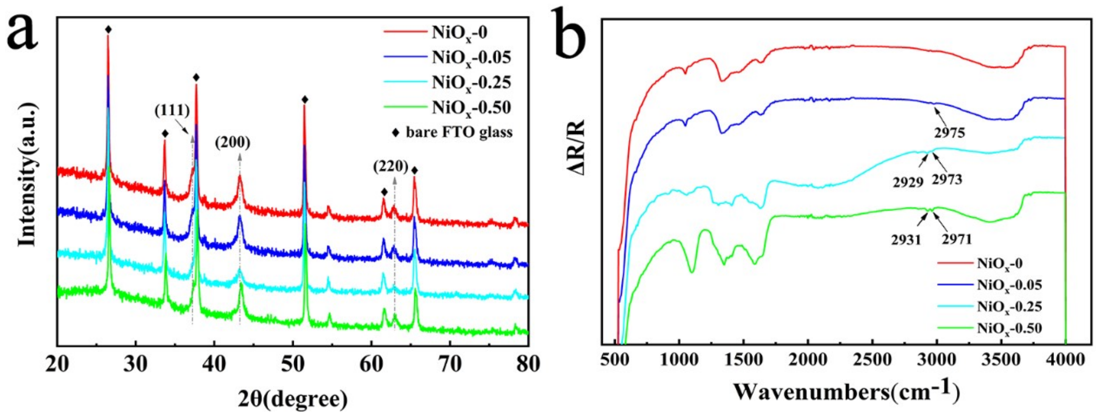

Fig.S6 (a) XRD and (b) FTIR spectra of NiO_x NPs films with different PEG4000 contens

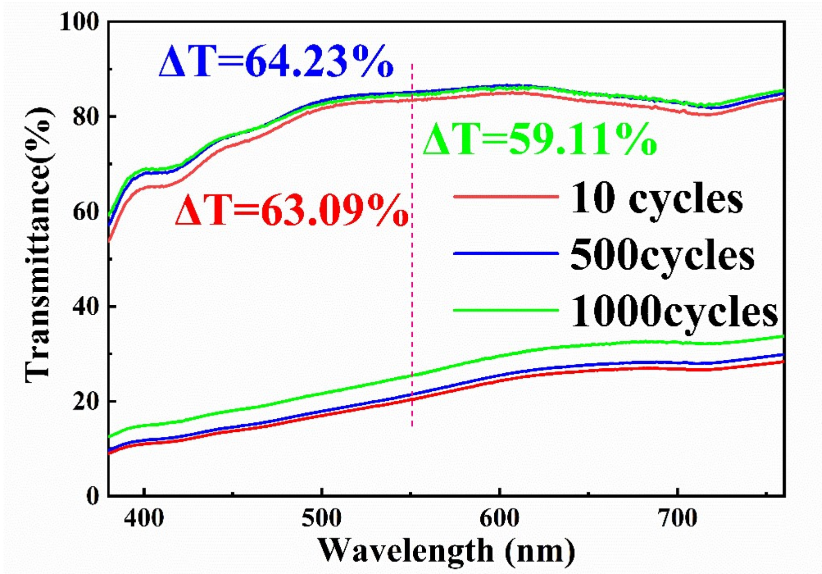

Fig.S7 The maximum transmittance spectra of NiO_X-0.05 films after different number of cycles.

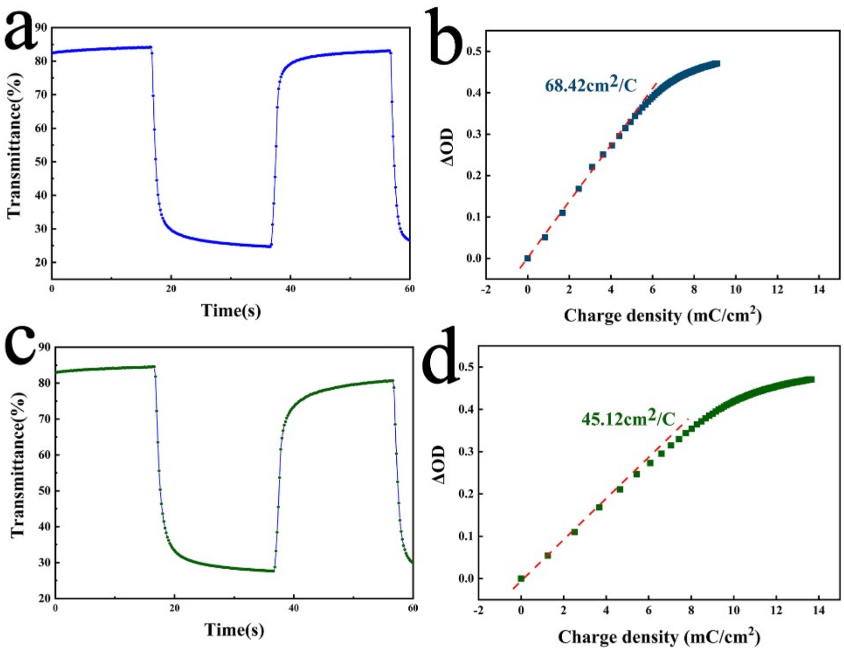

Fig.S8 Dynamic transmittance spectra and colouring efficiency plots of NiOx-0.05 films. (a) and (b) after 500 cycles; (c) and (d) after 1000 cycles.

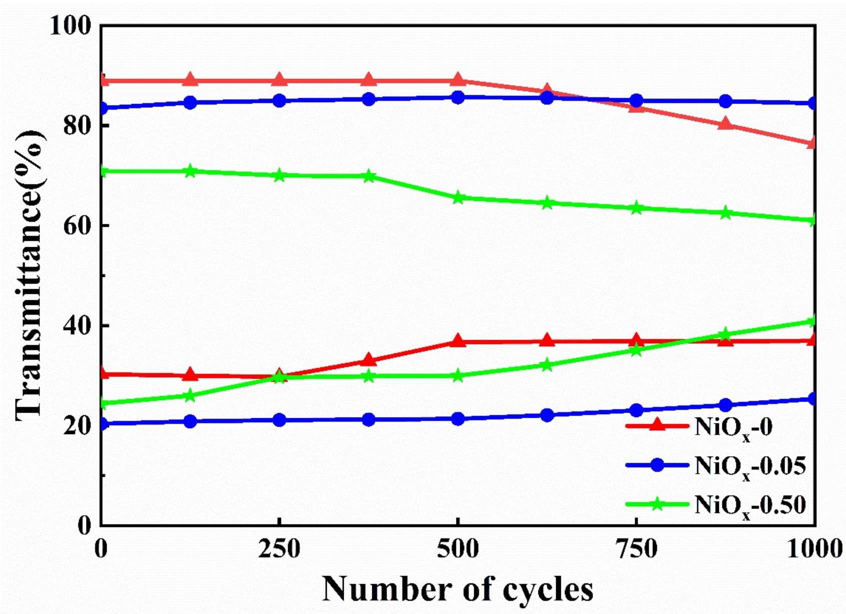

Fig.S9 Cycling stability of NiO_x-0, NiO_x-0.05 and NiO_x-0.50 films in 1 M PC/$LiClO_4$ solutio.

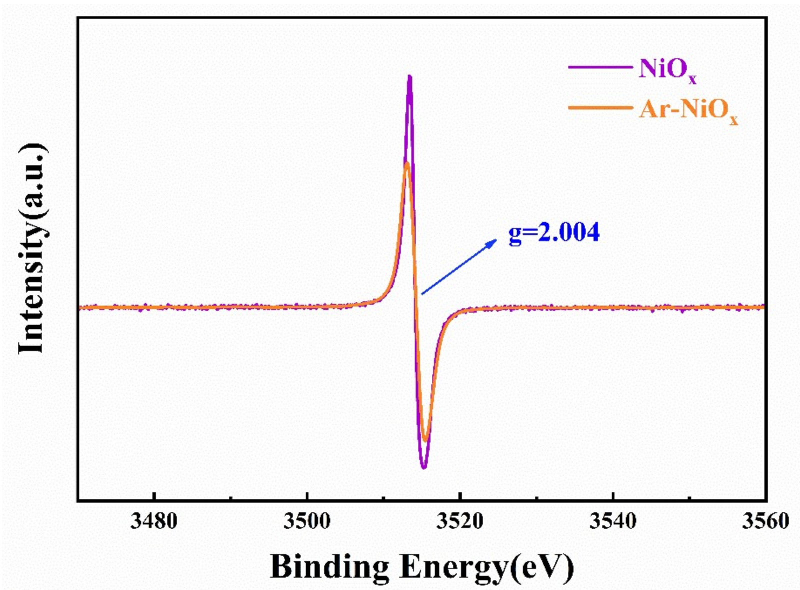

Fig.S10 EPR spectra of NiO_x NPs and Ar-NiO_x NPs.

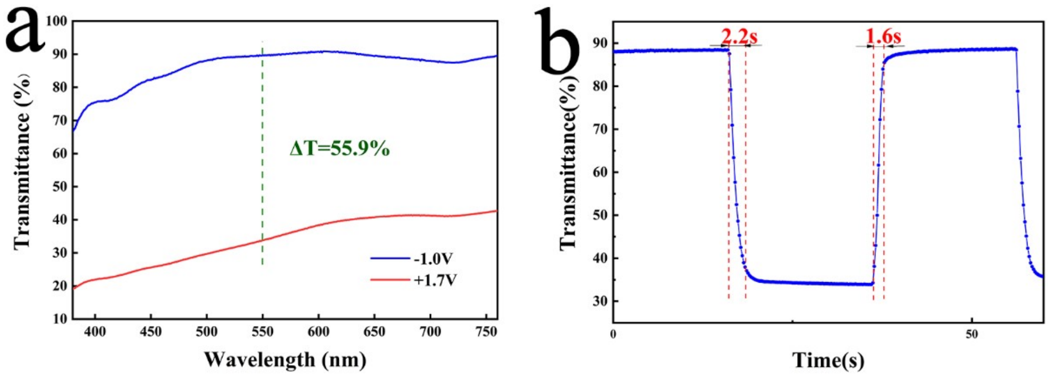

Fig.S11 Electrochromic properties of Ar-NiO_x films. (a) transmission spectra and (b) dynamic transmittance spectra.

Table S1 Values in Nyquist plots for different films at room temperature (25°C) and calculated results

Sample	R_e**(Ω)**	R_{ct}**(Ω)**	C_{dl}**(Ω)**	Z_w**(Ω)**	C_l**(Ω)**	**Result(Ω)**
NiO_x-0	12.68	65.45	5.88×10^{-8}	1.74×10^{-2}	5.28×10^{-3}	12.69
NiO_x-0.05	10.35	51.90	8.44×10^{-8}	2.11×10^{-2}	4.37×10^{-3}	10.35
NiO_x-0.25	15.87	63.44	6.42×10^{-6}	1.51×10^{-2}	4.26×10^{-3}	18.88
NiO_x-0.50	18.52	66.94	8.29×10^{-8}	6.69×10^{-3}	4.14×10^{-3}	18.53

Table S2 Summary of the electrochromic properties of different films.

Films	**ΔT (%)**	t_c **(s)**	t_b **(s)**	**CE (cm²/C)**
NiO_x-0	58.7	2.0	2.0	70.9
NiO_x-0.05	63.1	1.7	1.5	83.8
NiO_x-0.25	53.6	2.1	2.0	75.3
NiO_x-0.50	46.2	2.1	1.9	69.0

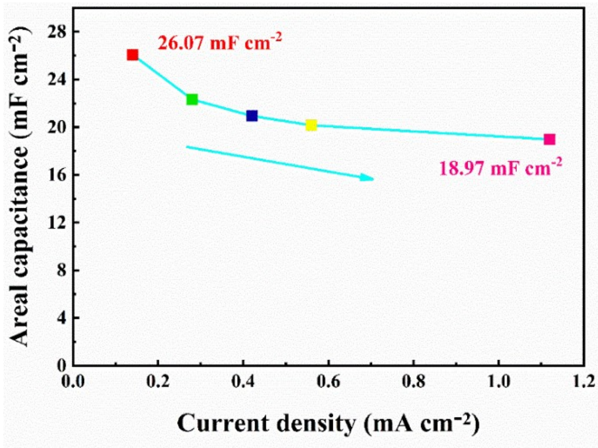

Fig.S12 Areal capacitance as a function of current density.

S13

Preparation of WO_3 electrochromic films

Highly transparent WO_3 films were prepared by a simple sol-gel method and spin-coating method, with Triton X-100 used as a surfactant to improve the switching speed of the films. Dissolve 1 g of WCl_6 powder in 20 ml of anhydrous ethanol and slowly add 2 ml of acetic acid, stirring mix thoroughly until the solution becomes pure black in colour; add 2ml of H_2O_2, at which point the solution turns pale yellow; Triton X-100 was added at a volume ratio of 1:50 and stirring was continued for 1 h to obtain the WO_3 precursor solution.

The WO_3 precursor solution was uniformly spin-coated onto the FTO substrate and annealed at 250°C for 30 min to obtain WO_3 electrochromic films. The FTO substrates were first treated in acetone, ethanol, DI water and a UV cleaner in sequence before use. The properties of the WO_3 films can be controlled by the number of spin coats, each of which needs to be individually annealed at 300°C for 30min. In order to obtain highly transparent WO_3 films, we spin-coated only three layers. The Fig.S11 shows the transmission spectra and dynamic transmittance spectra of the spin-coated 3-layer WO_3 film. The film exhibits >95% transmission of the bleached state and a fast switching speed (4.0s/0.8s), making it suitable for use in devices.

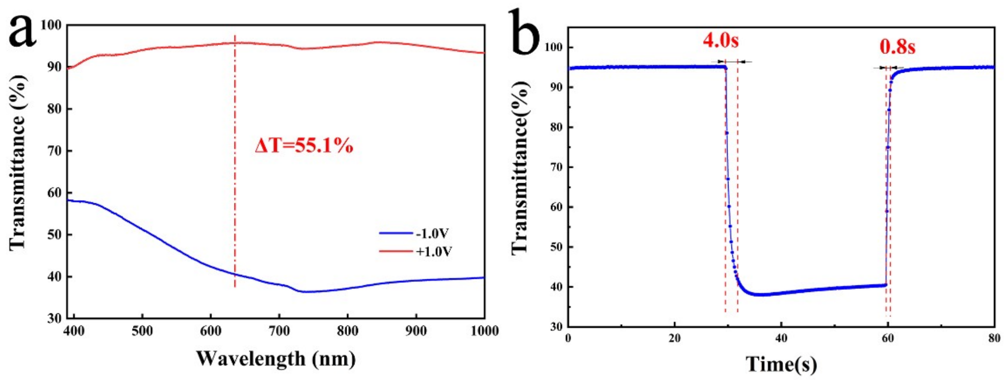

Fig. S13 Electrochromic properties of WO_3 films in 1M PC/$LiClO_4$ solution. (a) transmission spectra and (b) dynamic transmittance spectra.