Supporting Information

Nanofilament array embedded tungsten oxide for highly efficient electrochromic supercapacitor electrodes

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**Fig. S1** Top-view field-emission scanning electron microscopy (FE-SEM) images for (a) the pristine WO$_3$ and (b) NFA-embedded WO$_3$ films. (c) Cross-sectional FE-SEM image of the WO$_3$ film. FE-SEM image showing the thickness of the WO$_3$ film. (d) Rutherford backscattering spectroscopy (RBS) profiles of the WO$_3$ film. (e) SAED patterns measured after the electroforming process.
Fig. S2 XPS spectra for O1s peaks in (a) the pristine WO$_3$ and (b) NFA-embedded WO$_3$ films.
**Fig. S3** Two-probe $I-V$ characteristics with contacts the WO$_3$ film and the conducting ITO substrate. (a, b) The measured $I-V$ curves for the pristine WO$_3$ and NFA-embedded WO$_3$ electrodes. The insets show magnified views of the $I-V$ curves. (c, d) The resistance as a function of the point number at 0.1 V read voltage. The resistance ratio between the pristine WO$_3$ and NFA-embedded WO$_3$ electrodes more than 6 orders of magnitude.
Fig. S4 (a) Distribution of electroforming voltage for the NFA-embedded WO₃ electrode. The inset shows the electroforming voltage. (b) Retention characteristic of the NFA-embedded WO₃ electrode at room temperature and 0.1 V read voltage with almost stable current value. (c) Cycling performance for 10000 cycles at a scan rate of 150 mV s⁻¹. (d) Determination of the $b$-value at scan rates from 5 to 100 mV s⁻¹.
Fig. S5 (a) Photograph showing the asymmetric supercapacitor. The galvanostatic charge–discharge profiles of (b) the pristine WO$_3$/C and (c) NFA-embedded WO$_3$/C asymmetric supercapacitor devices at various current densities.
**Fig. S6** Energy density vs. power density for the pristine WO$_3$/C and NFA-embedded WO$_3$/C asymmetric supercapacitors.
Fig. S7 (a, b) Optical modulation and (c) coloration efficiency for the pristine WO$_3$ and NFA-embedded WO$_3$ electrodes.
Table S1 Percentages of different chemical states of W for pristine WO₃ and NFA-embedded WO₃ films.

<table>
<thead>
<tr>
<th>Chemical states</th>
<th>Percentages of W (%)</th>
<th>Percentages of W (%)</th>
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<tbody>
<tr>
<td>W⁰ (Metallic W)</td>
<td>0</td>
<td>12.3</td>
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<tr>
<td>W⁴⁺ (WO₂)</td>
<td>0</td>
<td>33.6</td>
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<tr>
<td>W⁵⁺ (W₂O₅)</td>
<td>32.2</td>
<td>10.9</td>
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<tr>
<td>W⁶⁺ (WO₃)</td>
<td>67.8</td>
<td>43.2</td>
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