Supplementary Material (ESI) for Journal of Materials Chemistry


# Electronic Supplementary Information

## Hydrothermally synthesized $WO_3$ nanowire arrays with highly improved electrochromic performance

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### 1. Seed layer

Before hydrothermal deposition, a 20 nm-thick seed layer was formed on the substrate through a sol-gel method. $WO_3$ sol was prepared according to literature method,[1] then the sol was cast onto FTO-coated glass through spin-coating technology, followed by annealing at 400 °C for 30 min to form a seed layer. SEM images of the seed layer are shown in Fig. S1. The particle size is 12~26 nm, which is estimated from the plan-view SEM image.

### 2. Specific surface area

Brunauer-Emmet-Teller (BET) surface area was studied using nitrogen adsorption at 77 K using an Autosorb-1-C analyzer (Quantachrome). The nitrogen isotherms are plotted in Fig. S2. It is found that the $WO_3$ nanowires have a BET surface area of 116.5 $m^2 g^{-1}$. This value is comparable to the $WO_3$ nanowires prepared by microwave-assisted hydrothermal method.[2]

**3. Fitting of EIS plots**

According to the equivalence circuit, $R_e$ designates the solution resistance; $R_{sl}$ (*i*) and $C_{sl}$ (*i*) (*i*= 1, 2) denote the migration of lithium ions and capacity of the layer, respectively. $R_{ct}$ and $C_{dl}$ represent the charge-transfer resistance and a double-layer capacitance. $Z_W$ is the Warberg impedance. These parameters can be calculated using ZView software, and the results are shown in Table S1. It is found that the nanowire array film shows much lower $R_{sl}$ and $Z_W$ than the micro-brick one, indicating that the porous and well-aligned structure is more favorable for charge transfer and $Li^+$ ion diffusion than the compact structure, resulting in higher reactivity and reaction kinetics.

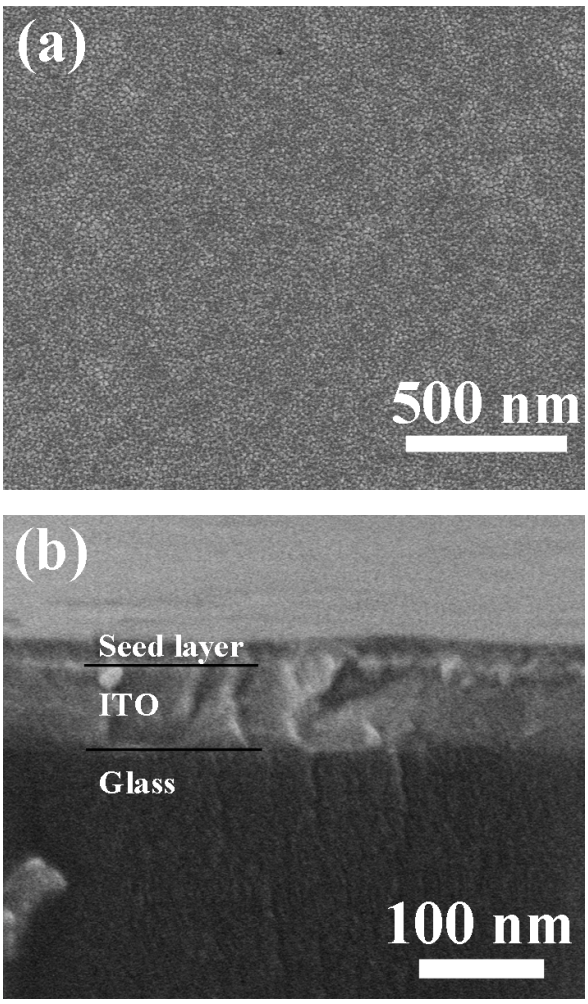


**Fig. S1**. SEM images of the seed layer. (a) plan-view; (b) sectional view.

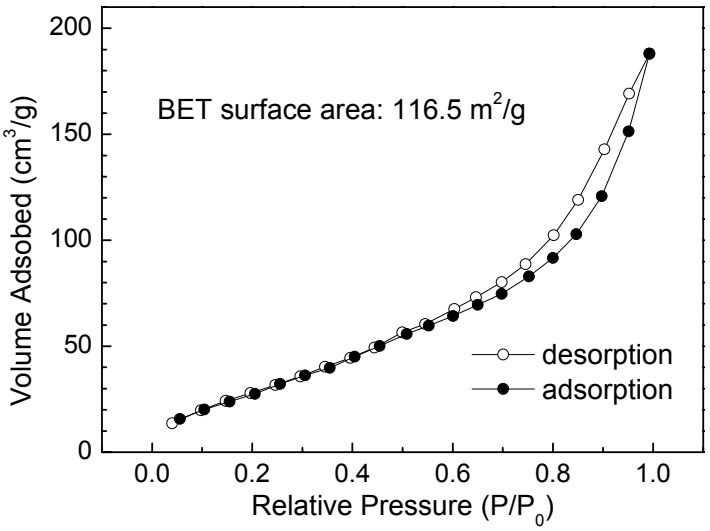


**Fig. S2**. Nitrogen adsorption and desorption isotherms of $WO_3$ nanowires at 77 K.

**Table S1**. Fitting parameters of EIS plots

| | $R_e$ /Ω | $R_{sl}(1)$ /Ω | $R_{sl}(2)$ /Ω | $R_{ct}$ /Ω | $Z_W$ /S $s^{1/2}$ $cm^{-2}$ |
|---|---|---|---|---|---|
| Nanowire array film | 15.6 | 1135 | 68.10 | 0.008 | $2.63\times10^{-5}$ |
| Micro-brick film | 35.8 | 4802 | 536.6 | 0.010 | $1.04\times10^{-4}$ |

## References

1. Z. H. Jiao, X. W. Sun, J. M. Wang, L. Ke and H. V. Demir, *J. Phys. D: Appl. Phys.*, 2010, **43**, 285501.

2. A. Phuruangrat, D.J. Ham, S.J. Hong, S. Thongtem and J.S. Lee, *J. Mater. Chem.*, 2010, **20**, 1683.