Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Construction of 3DV_2O_5/hydrogenated-WO_3Nanotrees on Tungsten Foil for High-performance Pseudocapacitors

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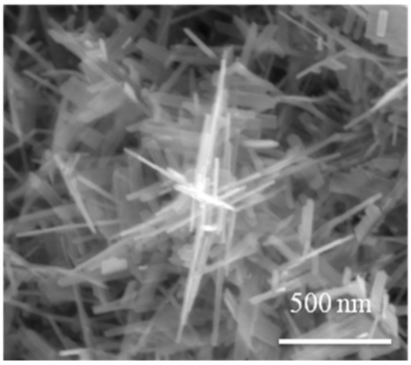

Fig. S1. SEM image of the WO3 nanotrees on W foil after hydrogenation at 450 °C.

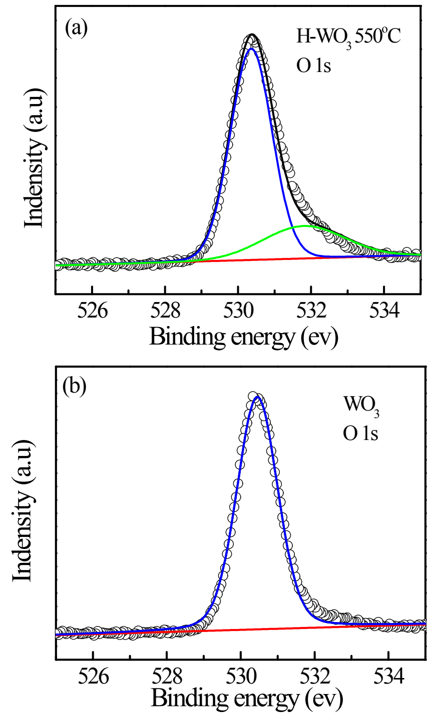

Fig. S2. High-resolution O1s XPS spectra of pristine WO_3 and WO_3 prepared at 550 °C.

Areal capacitance calculated from CV curves

The areal capacitances of electrodes measured by cyclic voltammetry (CV) method were calculated based on the following equation: [1, 2]

$$C_a = \frac{1}{SV(E_c - E_a)} \int_{E_a}^{E_c} I(E)dE \qquad \text{(S1)}$$

Where C_a (mF cm^{-2}) is the areal capacitance, V is the potential scan rate (mV s^{-1}), E_a is the anodic potential (V), E_c is the cathodic potential (V), $I(E)$ is the response current (A), E is the potential (V) and S (cm^{-2}) is the effective area of the working electrode.

Areal and specific capacitance of V_2O_5/H-WO_3 composites calculated from discharge curves

The areal and specific capacitances of electrodes measured by galvanostatic charge/discharge (GCD) method were calculated based on the following equation:[3]

$$C_a = \frac{I\ \Delta t}{S\Delta E} \qquad \text{(S2)}$$

$$C_s = \frac{I\Delta t}{1000 * m\Delta E} \qquad \text{(S3)}$$

Where C_a (mF cm^{-2}) and C_s (F/g) are the areal capacitance and specific capacitance, I (mA) is the constant discharging current, △t (s) is the discharging time, △E (V) is the potential window, S (cm^{-2}) and m (g) are the surface area and the mass of V_2O_5.

The calculation of the device

The volumetric capacitances of the device measured by galvanostatic charge/discharge (GCD) method were calculated based on the following equation

$$C_V = \frac{I\Delta t}{V\Delta E} \qquad \text{(S4)}$$

Where C_v (mF cm^{-3}) volumetric capacitance, I (mA) is the constant discharging current, △t (s) is the discharging time, △E (V) is the potential window, V (cm^{-3}) is the volume of all solid-stated device.

The energy and power density of the device were calculated from the following equation: [4-6]

$$E = \frac{C_V \Delta E^2}{2} \qquad \text{(S5)}$$

$$P = \frac{E}{t} \qquad \text{(S6)}$$

Where C_v is the volumetric capacitance of the device, △E is the cell voltage, t is the discharge time.

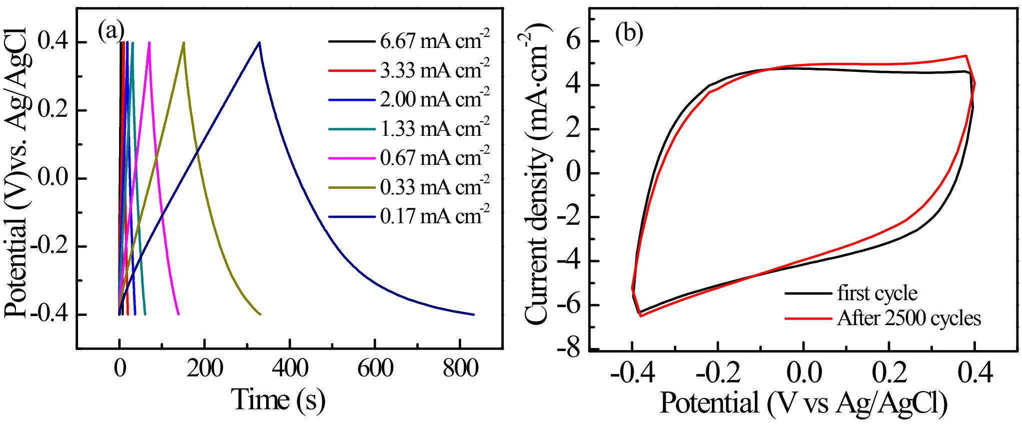

Fig. S3. (a) Galvanostatic charge/discharge curves of H-WO_3 (450 °C) electrode at various current density. The effective area of electrode is 1.5 cm^2. (b) CV curves of the H-WO_3 electrode at the 1st and 2500th cycles at a scan rate of 100 mV s^{-1}.

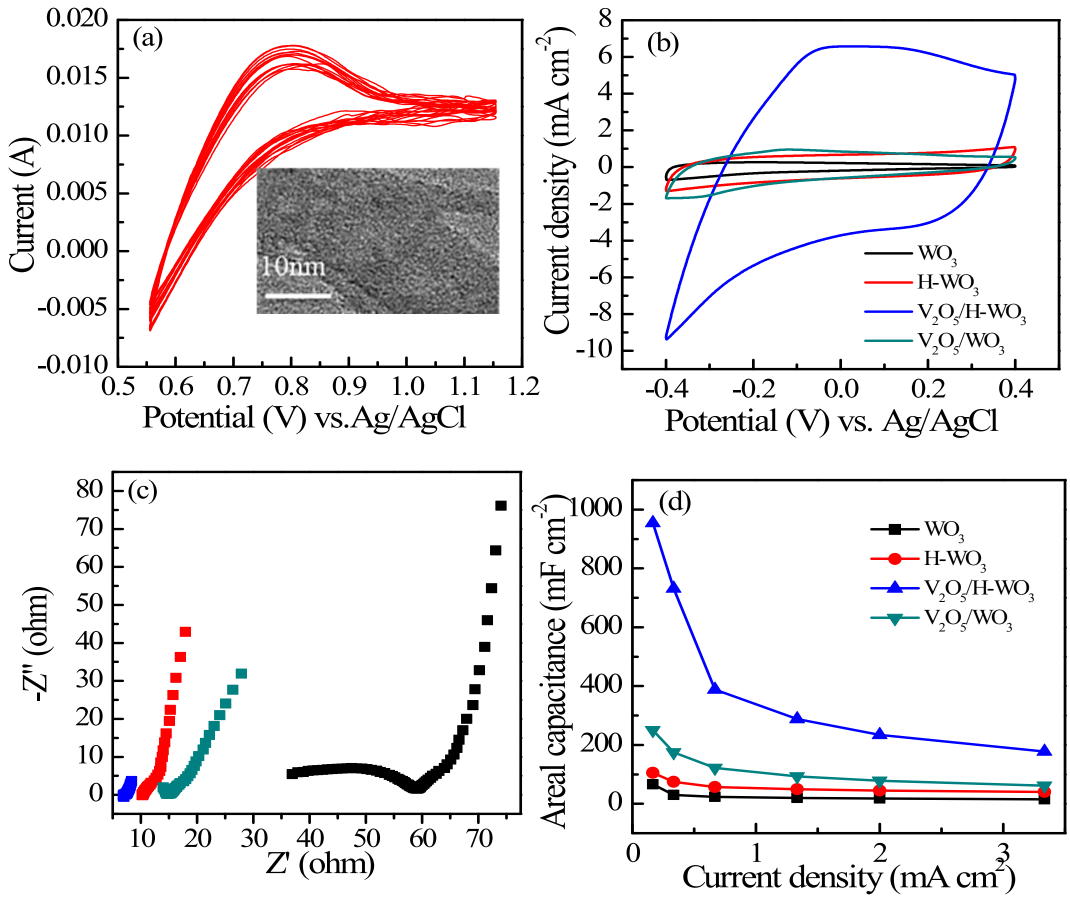

Fig. S4. (a) Cyclic voltammograms of the sample with 15 cycles of V_2O_5 electrodeposition (the inset is HRTEM of V_2O_5 film). (b) CV curves collected at a scan rate of 10 mV s^{-1} for WO_3, H-WO_3, V_2O_5/WO_3 and V_2O_5/H-WO_3 samples. (c) EIS spectra of WO_3, H-WO_3, V_2O_5/WO_3 and V_2O_5/H-WO_3 electrodes. (d) Areal capacitances calculated for WO_3, H-WO_3, V_2O_5/WO_3 and V_2O_5/H-WO_3 electrodes as a function of current densities.

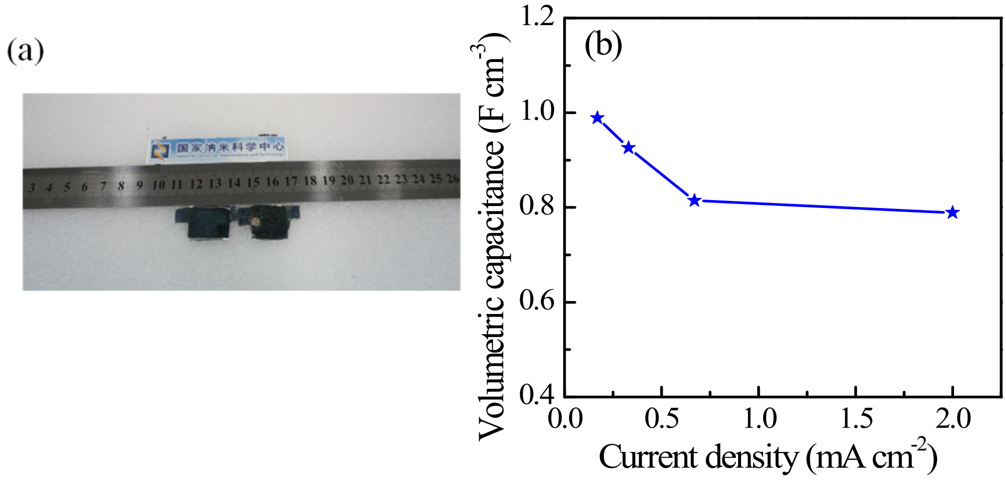

Fig. S5. (a)The photo of the solid-state devices with the effective areal of 1.5 cm^2. (b) Volumetric capacitances calculated from the galvanostatic charge-discharge curves as a function of current densities.

Table S1. Comparison of the specific capacitance, energy density and power density of our single electrode with the literature values (only based on mass of V_2O_5). "-" means that the data was not given in the reference. ($E = \frac{C_s \Delta E^2}{2}$, $P = \frac{E}{t}$, C_s is the specific capacitance of the single electrode, which is measured in three-electrode system)

Electrode	Specific capacitance (C_s/ F g^{-1})	Energy density (E,/ Wh kg^{-1})	Power density (P/ W kg^{-1})	Reference
$V_2O_5 \cdot 0.6H_2O$	180.7	20.3	2000	[7]
V_2O_5 film	1308	45	156	[8]
V_2O_5 nanosheets	451	107	9400	[9]
V_2O_5/rGO	320	-	-	[10]
V_2O_5 nanotube	-	11.6	1200	[11]
V_2O_5/H-WO_3	1101	98	1538	Our study

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