Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

Electronic Supplementary Information

Nanosized MnO_2 Spines on Au Stems for High-Performance Flexible Supercapacitor Electrodes

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Table S1. Charges applied and MnO_2 masses loaded on Au NWs at different plating time.

Figure S1. Low and high magnification (insets) SEM images of the nanostructures on flexible PET substrates: (a) Au NWs, (b) – (e) NMSAS with MnO_2 plating time 10 min, 15 min, 20 min, and 30 min, respectively. TEM images of the nanostructures: (f) Au NWs, (g) – (j) NMSAS with MnO_2 plating time 10 min, 15 min, 20 min, and 30 min, respectively.

Figure S2. EDS of NMSAS on flexible PET substrates with MnO_2 plating time (a) 10 min, (b) 15 min, (c) 20 min, and (d) 30 min. Corresponding Mn to O atomic ratios are (a) 1:2.02, (b) 1:1.89, (c) 1:1.91, and (d) 1:2.15.

Figure S3. High resolution XPS of Mn 2p, O 1s, and Au 4f electrons of NMSAS (MnO_2 plating time, 15 min). Blue dots and black lines represent the experimental and the fitted data, respectively.

Figure S4. CV data of the nanostructures on flexible PET substrates at various scan rates using a three-electrode system in $Na_2SO_{4(aq)}$ (1 M). (a) Au NWs, (b) – (e) NMSAS with MnO_2 plating time 10 min, 15 min, 20 min, and 30 min, respectively. (f) Specific capacitances of Au NWs and NMSAS, derived from the data in (a) – (e).

Figure S5. CV data of NMSAS (MnO_2 plating time 15 min) at various scan rates in $Na_2SO_{4(aq)}$ (1 M) using (a) three-electrode and (b) two- electrode systems. (c) Plots of specific capacitances using three-electrode (C_{3E}: ■) and two-electrode (C_{2E}: ★) systems, and ratios of C_{3E} and C_{2E} (△) at various scan rates.

Figure S6. Top: schematic diagram of solid-state NMSAS supercapacitor device, with PVA/H_3PO_4 polymer as the electrolyte and separator. Bottom: definition of bending angle °.

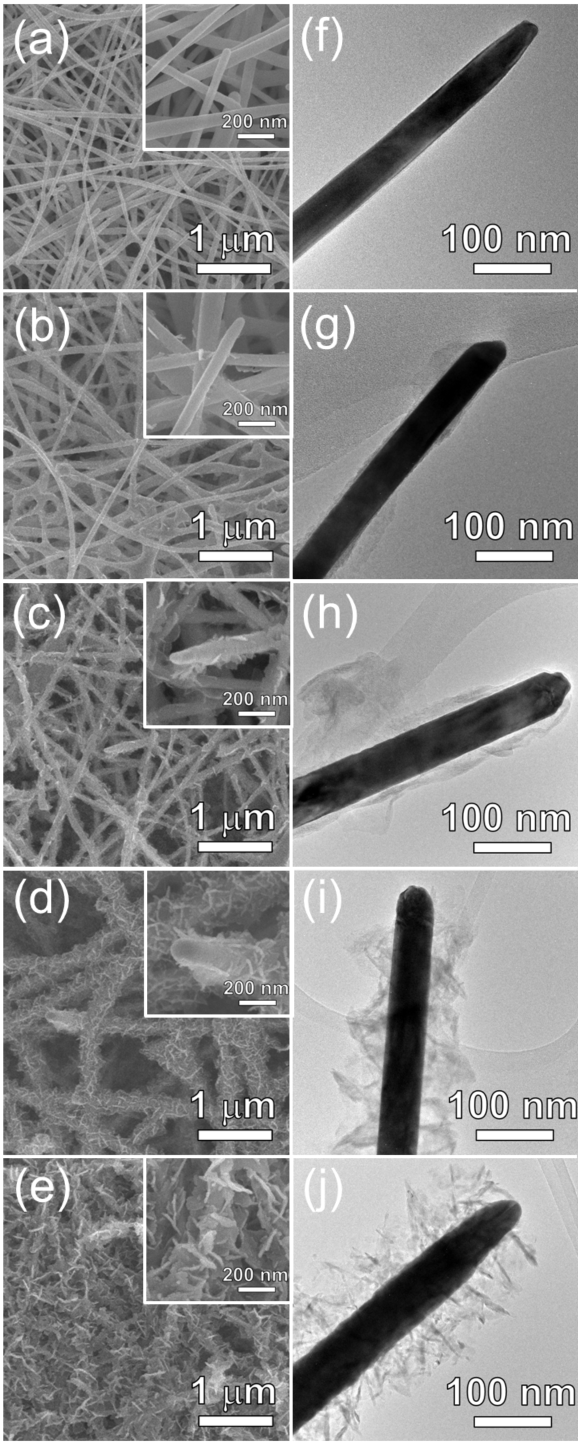
Figure S7. Nyquist plot of a solid-state NMSAS supercapacitor device.

Calculations of electrochemical capacitance performances.

Table S1. Charges applied and MnO_2 masses loaded on Au NWs at different plating time.

MnO_2 Plating Time (min)	Charge (mC)[a]	MnO_2 Mass (μg)[b]
10	27.4	12.4
15	45.6	20.6
20	63.8	28.7
30	92.1	41.5

[a] Charges are obtained by integrating the applied deposition currents against the plating time.
[b] Masses are converted from the charges by using Faraday's Law.



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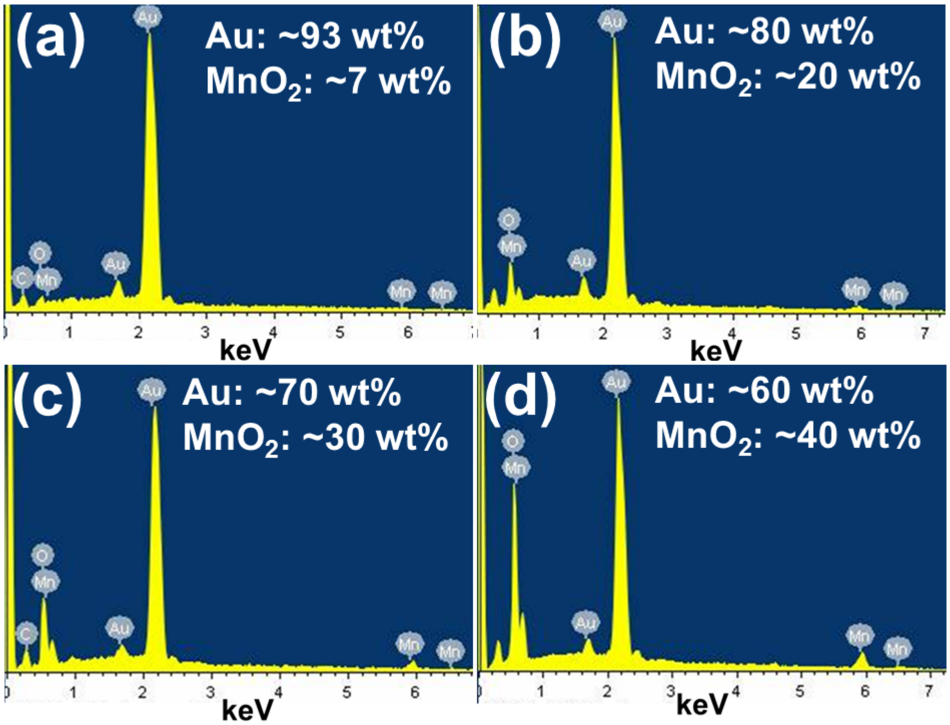

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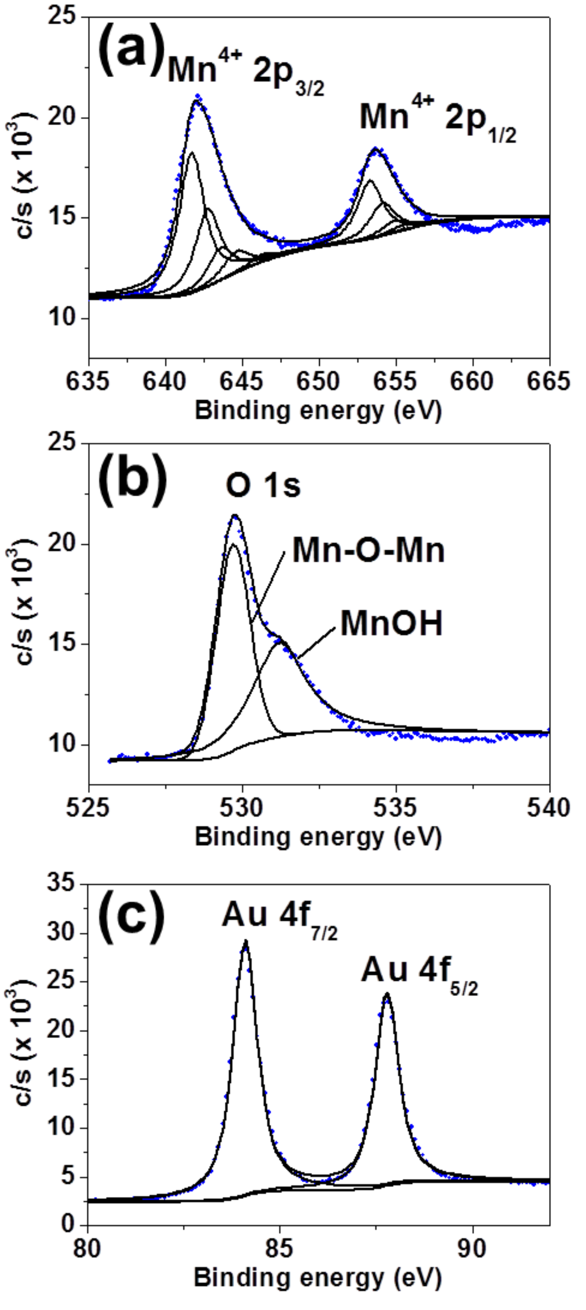

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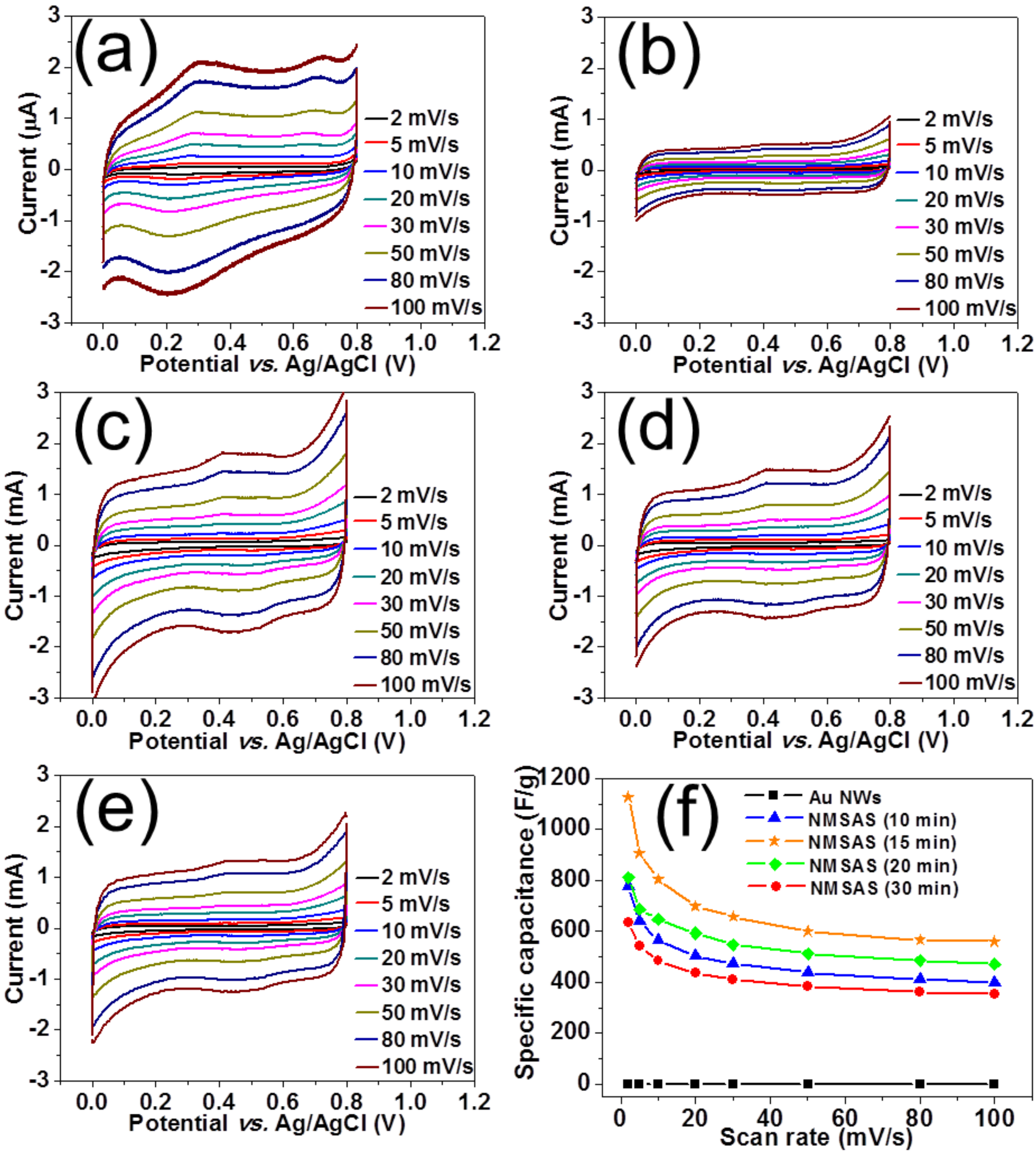

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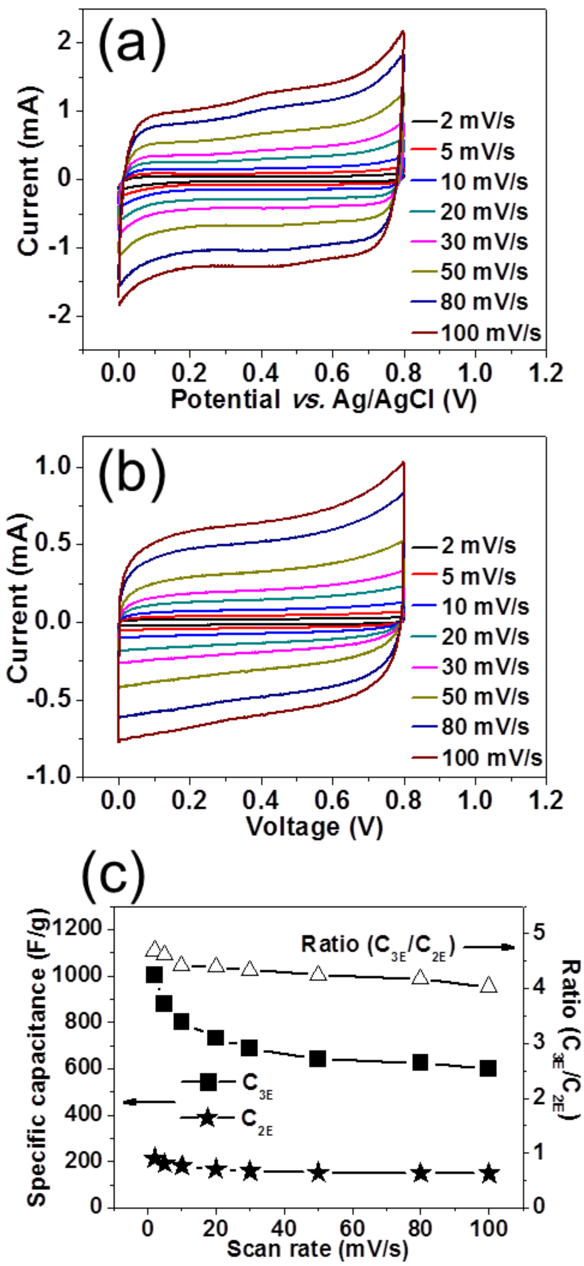

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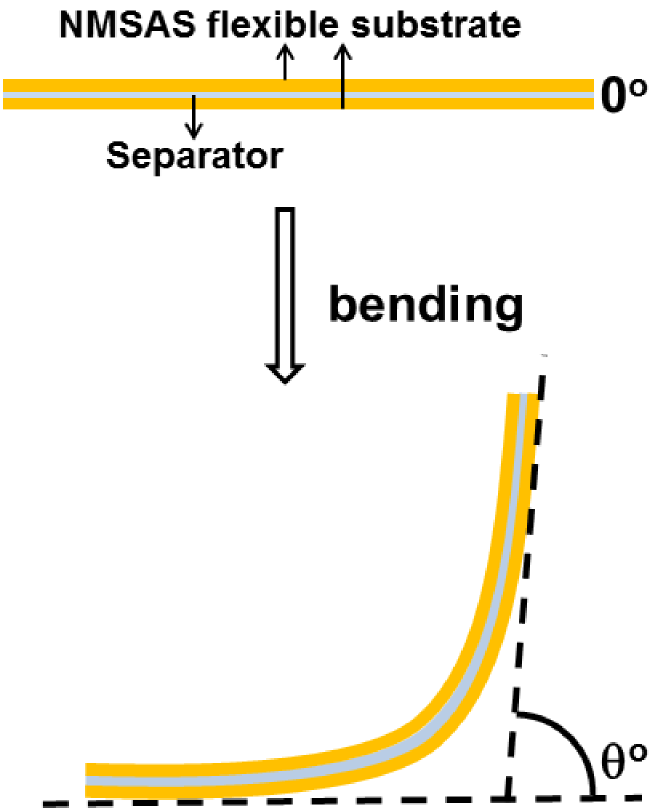

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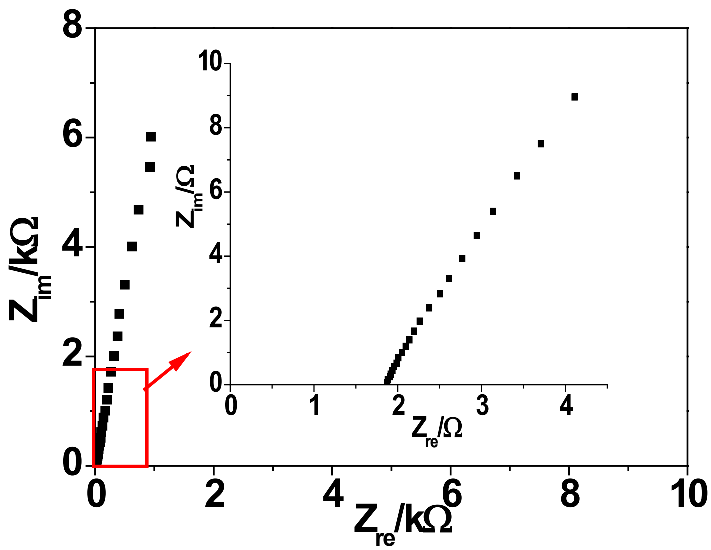

Figure S7. Nyquist plot of a solid-state NMSAS supercapacitor device.

Calculations of electrochemical capacitance performances

Specific capacitances derived from CV tests usig two- and three-electrode systems can be calculated from the equation:[1]

$$C = \frac{1}{m\nu(V_c - V_a)} \int_{V_a}^{V_c} I(V)dV$$

where C (F/g), m (g), ν (V/s), V_c and V_a, and I (A) are the specific capacitance, the mass of MnO_2 on the electrode, the potential scan rate, the high and low potential limits of the CV test, and the instant current of the CV curve, respectively.

Specific capacitances derived from galvanostatic (GV) tests using a two-electrode system can be calculated from the equation:[1, 2]

$$C = \frac{I\Delta t}{m\Delta V}$$

where C (F/g), I (A), Δt (s), m (g) and ΔV are the specific capacitance, the discharge current, the discharge time, the mass of MnO_2 on the electrode, and the potential window, respectively.

Specific energy (E) and specific power (P) are derived from GV tests using a two-electrode system. They can be calculated from the following equations:[2,3]

$$E = (C\times\Delta V^2) / (2\times3.6)$$

$$P = E / \Delta t$$

where E (Wh/kg), P (W/kg), C (F/g), ΔV (V), and Δt (h) are the specific energy, the specific power, the specific capacitance, the potential window, and the discharge time, respectively.

Reference

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