Supplementary Information

Mesoporous LaNiO3/NiO Nanostructured Thin Films for High-performance Supercapacitors

Kun Liang[1, 2], Ni Wang[1], Mei Zhou[1], Zeyuan Cao[2], Taoli Gu[2], Qing Zhang[2], Xianzhong Tang[1], Wencheng Hu[1*], Bingqing Wei[2*]

[1-] State Key Laboratory of Electronic Thin Films and Integrated Devices,
University of Electronic Science & Technology of China, Chengdu, 610054, P. R. China
[2-]partment of Mechanical Engineering, University of Delaware, Newark, DE 19716, USA

The specific capacitance with three-electrode system is derived from CVs can be calculated, using Equation S1:

$$C = \frac{1}{2 \cdot \Delta V \cdot A} \int_{V_{initial}}^{V_{final}} \frac{|I|}{(dV/dt)} dV \qquad \text{(S1)}$$

where C is the specific capacitance, ΔV is the potential window (1 V), A is the areal area of the porous electrode materials, $V_{initial/final}$ is the starting/end potential in one cycle, $|I|$ is the instantaneous current at a given potential, and dV/dt is the potential scan rate.

The specific capacitance with two-electrode configuration based on CVs can be obtained from the following Equation S2:

$$C = \frac{1}{\Delta V \cdot A} \int_{V_{initial}}^{V_{final}} \frac{|I|}{(dV/dt)} dV \qquad \text{(S2)}$$

where C is the specific capacitance, ΔV is the potential window (2 V), A is the areal area of the porous electrode materials, $V_{initial/final}$ is the starting/end potential in one cycle, $|I|$ is the instantaneous current at a given potential, and dV/dt is the potential scan rate.

The specific capacitance determined by GCD curves can be calculation based on Equation S3:

$$C = \frac{I \cdot \Delta t}{A \cdot \Delta V} \qquad \text{(S3)}$$

where C is the specific capacitance, I is the discharge current, Δt is the discharge time in the potential window, A is the areal area of the porous electrode materials, ΔV is the potential window, I/A is the discharge current density.

Using the galvanostatic charge/discharge curves, the energy density and power density can be calculated following the Equations S4 and S5 as shown:

$$D_e = \frac{1}{2} C(\Delta V)^2 \tag{S4}$$

$$D_p = \frac{D_e}{\Delta t} \tag{S5}$$

where D_e is the energy density, C is the specific capacitance values, ΔV is the potential window of discharge, D_p is the power density, Δt is the discharge time in potential window.

The average discharge current can be obtained based on the Equation S6:

$$I_d = \frac{\int_0^1 I dV}{2\Delta V} \tag{S6}$$

where I_d is the average discharge current, I is the current at certain potential, ΔV is the potential window of discharge.

The mean areal cell capacitance is calculated by the slope of the straight line in Figure 4 (d) and Figure S6 (b, c), using the following Equation S7:

$$C_m = \frac{\Delta I}{A \cdot \Delta v} \tag{S7}$$

where C_m is the mean areal cell capacitance, ΔI and Δv are the difference of discharge currents and scan rates on the straight line, A is the areal area of the as-prepared electrode.

Supplementary Figures

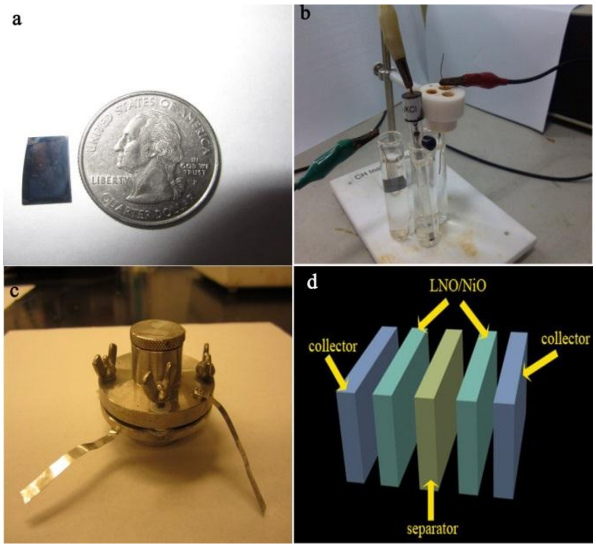

Figure S1. (a) A digital photograph of an as-prepared LNO/NiO thin film. (b, c) The three-electrode and two-electrode electrochemical configurations were used in the experiment test, respectively. (d) Schematic of the assembled structure used in the two-electrode system with organic electrolyte.

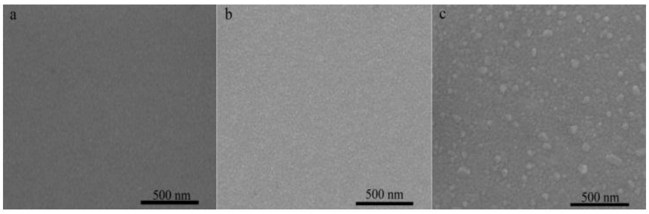

Figure S2. (a-c) FESEM images for the surface morphologies of the as-prepared LNO/NiO films annealed at 550℃, 600℃, and 650℃, respectively.

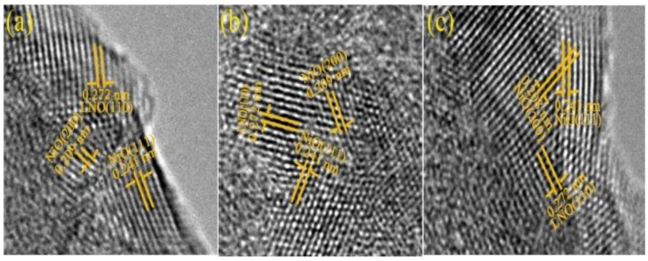

Figure S3. (a-c) Crystalline structures of the samples annealed at 550℃, 600℃, and 650℃, respectively.

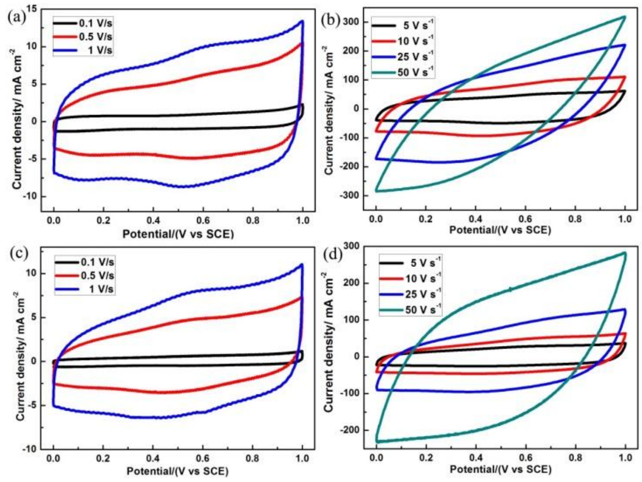

Figure S4. (a, b) CVs of the samples annealed at 550℃ with different scan rates from 0.1 to 50 Vs^{-1}; (c, d) CVs of the samples annealed at 600℃ with different scan rates from 0.1 to 50 Vs^{-1}.

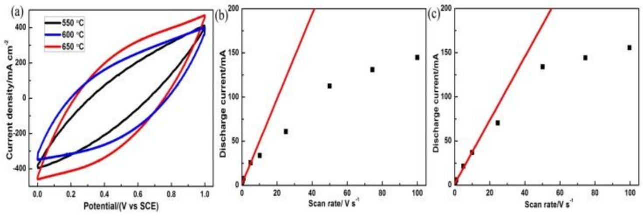

Figure S5. (a) CVs of the three samples with the scan rate of 100 Vs^{-1}; (b, c) Discharge currents of the samples annealed at 550℃ and 600℃, respectively, with the scan rate from 0.1 up to 100 V s^{-1}.

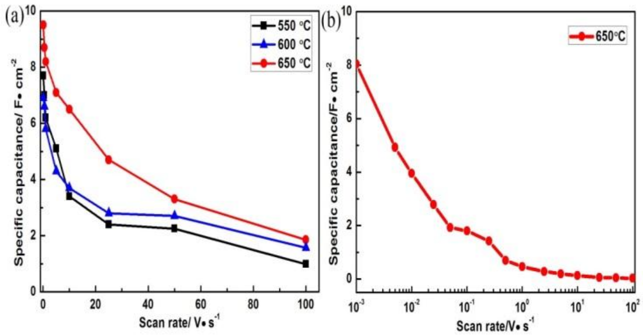

Figure S6. (a) Specific capacitance derived from CVs in the aqueous electrolyte as function of scan rate for the three as-prepared electrodes. (b) Specific capacitance vs. scan rate from 0.001 Vs^{-1} to 100 Vs^{-1}in the organic electrolyte for the sample annealed at 650℃.

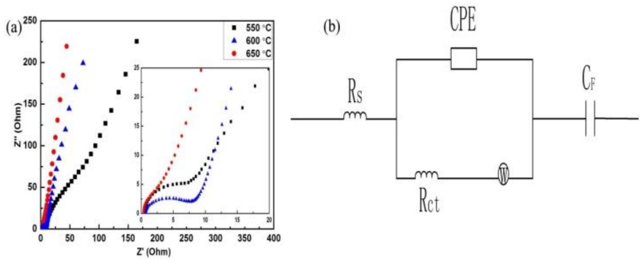

Figure S7. (a) Nyquist plots for the three as-prepared films, the inset presents the expanded plots at high frequency region; (b) Equivalent circuit derived from Nyquist plots.