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


# Supplementary Information

# Remarkable Improvement in Supercapacitor Performance by Sulfur Introduction during a One-Step Synthesis of Nickel Hydroxide

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**Calculations**

The mass and area specific capacitances can be calculated from the CV curve using the following: [1,2]

$$C = \frac{\int I(v)dv}{2vmU} \quad (1)$$

$$C = \frac{\int I(v)dv}{2vAU} \quad (2)$$

where $I$ (A) and $U$ (V) are the current and potential in the CV, $v$ (V $s^{-1}$) is the scan rate, $A$ ($cm^2$) is the area of the current collector together with the active material, $U$ is the potential window of discharge (0.5 V here), $I$ is the constant discharge current and $t$ (s) is the discharge time.

The mass and area specific capacitances, power density and energy density are calculated based on the galvanic charging-discharging curves using the equation as follows:[3,4]

$$C = \frac{It}{mU} \quad (3)$$

$$C = \frac{It}{AU} \quad (4)$$

$$E = \frac{1}{2} \times C \times U^2 \quad (5)$$

$$P = \frac{E}{t} \quad (6)$$

where $C$ ( F $g^{-1}$) is specific capacitance, $A$ is the area of the current collector, $E$ (Wh $kg^{-1}$)

is energy density, $P$ (W kg$^{-1}$) is power density, $U$ is potential window (here 1.6 V), $I$ (A) is discharge current, $t$ (s) is discharge time, $m$ (g) is the sum of the masses of the positive electrode (NSO, here 8 mg) and negative electrode(reduced graphene oxide, here 20 mg), thus here m is 28 mg.

The areal energy density can be estimated by

$E_a=E_g\times m$ / (2 cm×2 cm) (The area of two pieces of carbon fiber paper)

$P_a=P_g\times m$ / (2 cm×2 cm)

The volumetric energy density can be estimated by

$E_v=E_g\times m$ / (2 cm×2 cm×0.049 cm) (The volume of carbon fiber paper)

$P_v=P_g\times m$/ (2 cm×2 cm×0.049 cm)

All the above parameters are based on the weight of active material, we also calculate and report all the parameters based on the weight of total electrode, i.e. active material and the weight of carbon fiber paper.

In the three electrode configuration, the weight of carbon fiber paper which is 16 mg is added.

In the two electrode configuration, the weight of two pieces of carbon fiber paper, which is 24 mg, is added**.**

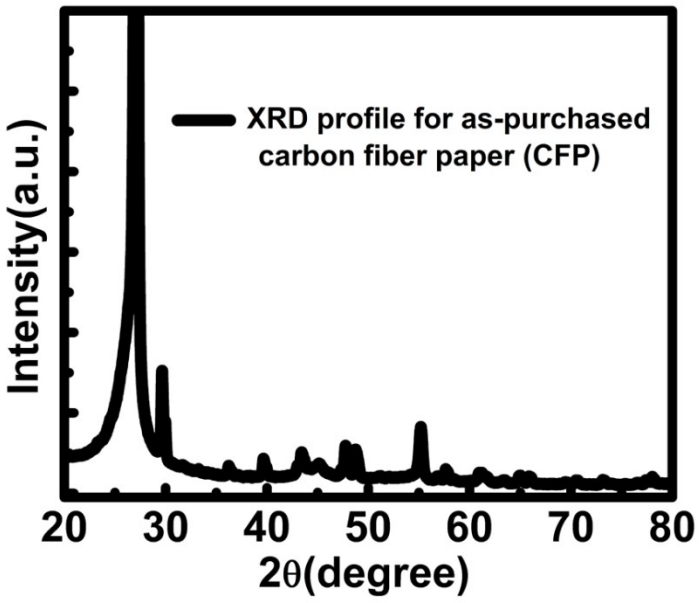
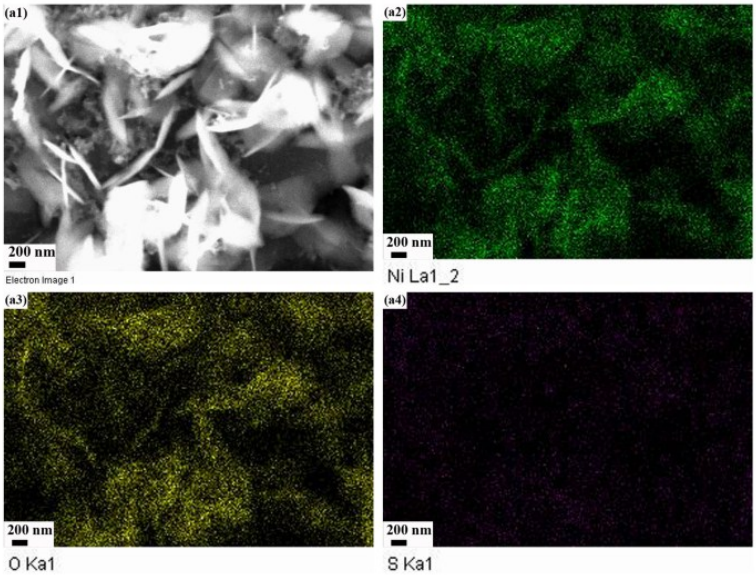
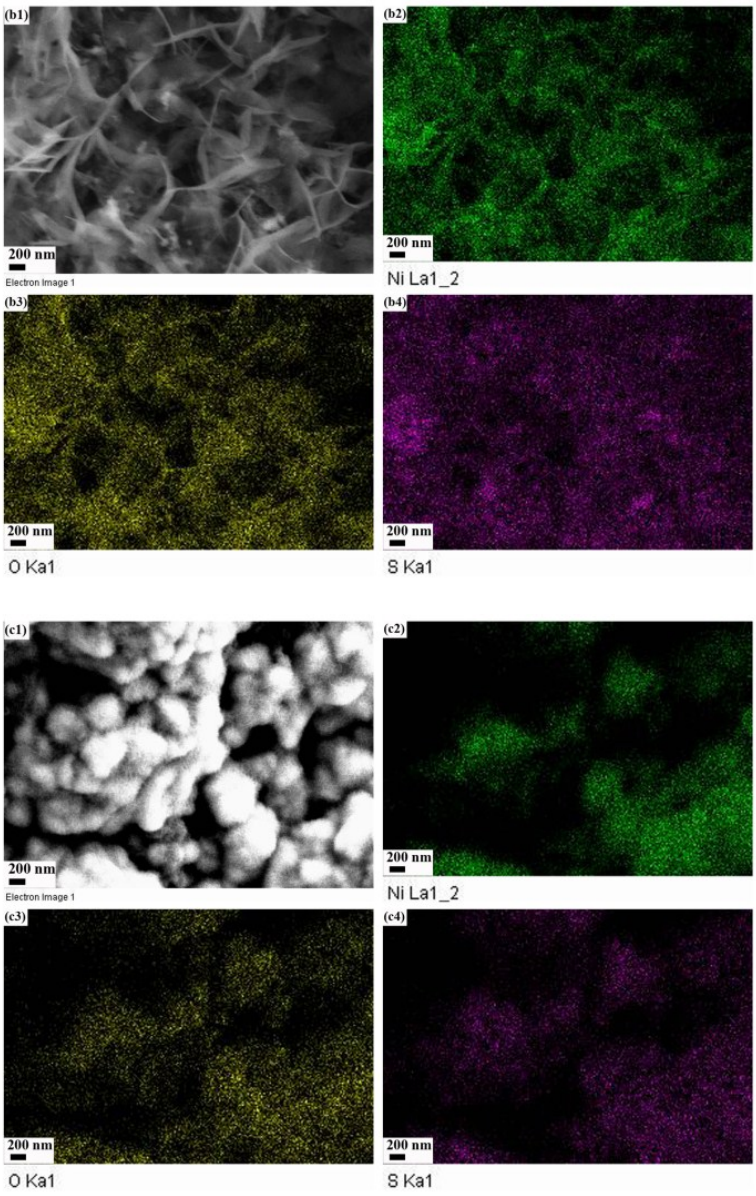



Figure S1 XRD profile of pure carbon fiber paper (CFP).




(b1)
200 nm
Electron Image 1
(b2)
200 nm
Ni La1_2
(b3)
200 nm
O Ka1
(b4)
200 nm
S Ka1
(c1)
200 nm
Electron Image 1
(c2)
200 nm
Ni La1_2
(c3)
200 nm
O Ka1
(c4)
200 nm
S Ka1

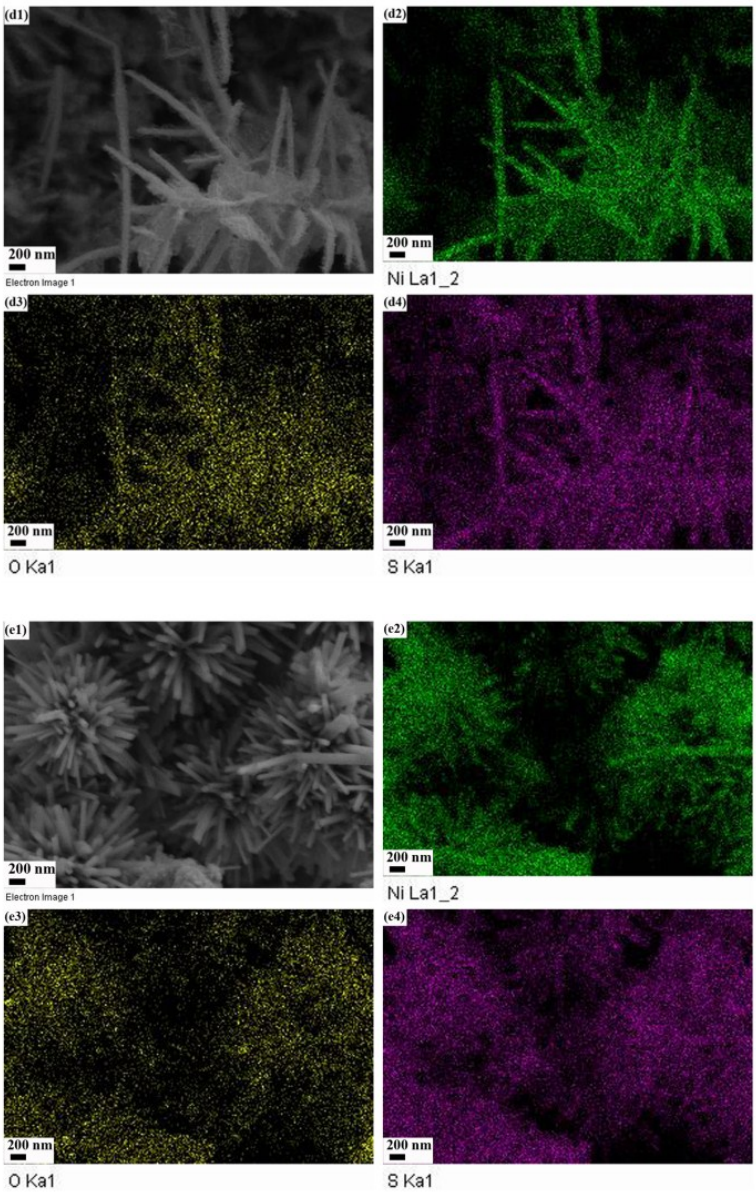



Figure S2 EDS mapping results of all the samples: (a) NSO04, (b) NSO21, (c) NSO53, (d) NSO61, (e) NSO79: (1) image (2) nickel (3) oxygen (4) sulfur.

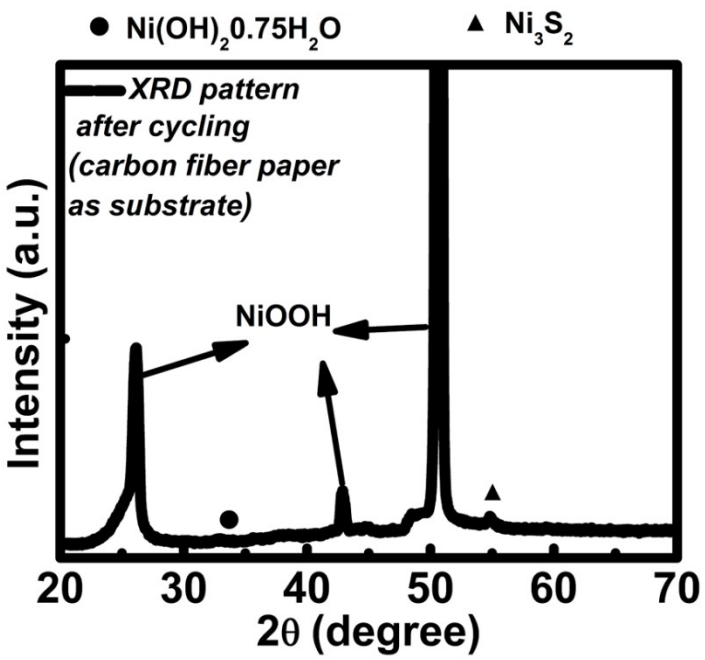



Figure S3 XRD of NSO53 after cycling.

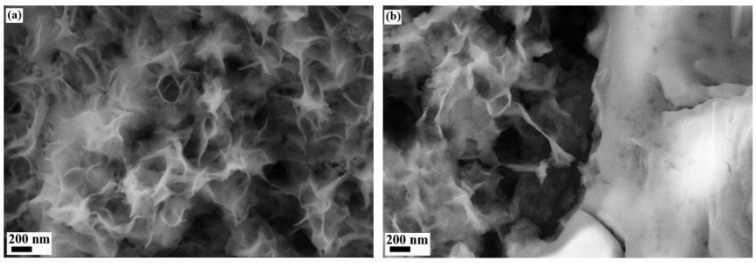



Figure S4 SEM images of NSO53 after cycling.

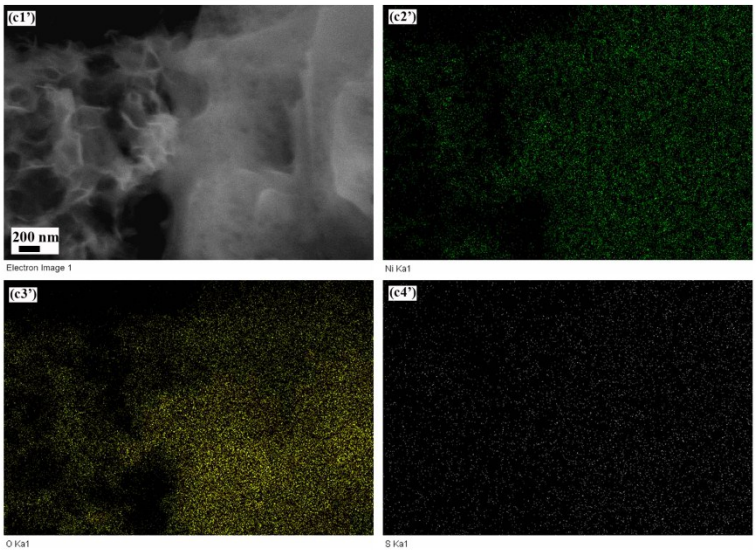



Figure S5 EDS mapping results of NSO53 after cycling :( c1') image (c2') nickel (c3') oxygen (c4') sulfur.

**REFERENCES**

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(3) Stoller, M. D.; Ruoff, R. S. Best Practice Methods for Determining an Electrode Material's Performance for Ultracapacitors. *Energy Environ. Sci*. **2010**, *3*, 1294-1301.

(4) Hulicova-Jurcakova, D.; Puziy, A. M.; Poddubnaya, O. I.; Suarez-Garcıa, F.; Tascon, J. M. D.; Lu, G. Q. Highly Stable Performance of Supercapacitors from Phosphorus-Enriched Carbons. *J. Am. Chem. Soc.* **2009**, *131*, 5026-5027.