

Supporting Information

Elevating the comprehensive performance of carbon-based hybrid electrode materials by incorporating nickel silicate for lithium-ion capacitors

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1. Material Characterization

The morphology and size of the samples were analyzed by scanning electron microscope (SEM, Hitachi, SU8010) and transmission electron microscope (TEM, JEM-2100). The content and distribution of elements were determined by energy dispersive X-ray spectrometer (EDS, TSL, AMETEK) and X-ray photoelectron spectrometer (XPS, Thermo Scientific K-Alpha, $h\nu=1486.6$ eV). Due to the fact that EDS results are obtained simultaneously with SEM observation, the data obtained contains signals from the Au coating used for SEM observation. The crystal structure of the samples was analyzed by Raman microscopy (Raman, HORIBA Scientific LabRAM HR Evolution) and X-ray diffraction spectroscopy (XRD, Brooke D2 PHASER).

2. Detailed evaluation process of Li^+ diffusion coefficient

For the galvanostatic intermittent titration technique (GITT) test, cells were charged and discharged at a current density of 100 mA g^{-1} for 10 min and left to stand for 30 min. The diffusion coefficient can be calculated based on $D_{\text{Li}^+} = (4/\pi\tau) \times (m_{\text{B}}V_{\text{M}}/(M_{\text{B}}S))^2 \times (\Delta E_{\text{s}}/\Delta E_{\text{t}})^2$, where D_{Li^+} is the Li^+ diffusion coefficient ($\text{cm}^2 \text{ s}^{-1}$), τ is the duration of current pulse (10 min), m_{B} (g) and M_{B} (g mol^{-1}) are the mass and molecular weight of the active materials in the electrode, respectively, V_{M} ($\text{cm}^3 \text{ mol}^{-1}$) and S (cm^2) are the molar volume and the total area of the electrode, respectively, and ΔE_{t} and ΔE_{s} are the changes in the cell voltage during the 10 min current pulse from τ_0 to τ_{0+t} and the relaxation period of 30 min, respectively. [1, 2]

3. Detailed evaluation process of Li^+ diffusion coefficient

According to previous literature [3], the relationship between peak current (i) and scan rate (v) of CV curves can be described by the following formula: $i = av^b$ (1), $\log(i) = \log(a) + b \log(v)$ (2), where a and b are adjustable parameters. The b -value is determined by the slope of $\log(v)$ vs $\log(i)$ plot, which is between 0.5 and 1. The b -value of 1 manifests that the charge storage is dominated by surface capacitance, the b -value of 0.5 represents a mass diffusion-controlled process, and the b -value between 0.5 and 1 means hybrid control [4]. Furthermore, the contribution ratio of the capacitive behavior (k_1v) and the diffusion-controlled process ($k_2v^{1/2}$) can be quantitatively calculated using CV data with reference to the following formula [4]: $i(V) = k_1v + k_2v^{1/2}$ (3), where, $i(V)$, k_1 , and k_2 correspond to the current value at a given voltage, the slope, and intercept of the fitted plot between $i(V)/v^{1/2}$ and $v^{1/2}$, respectively.

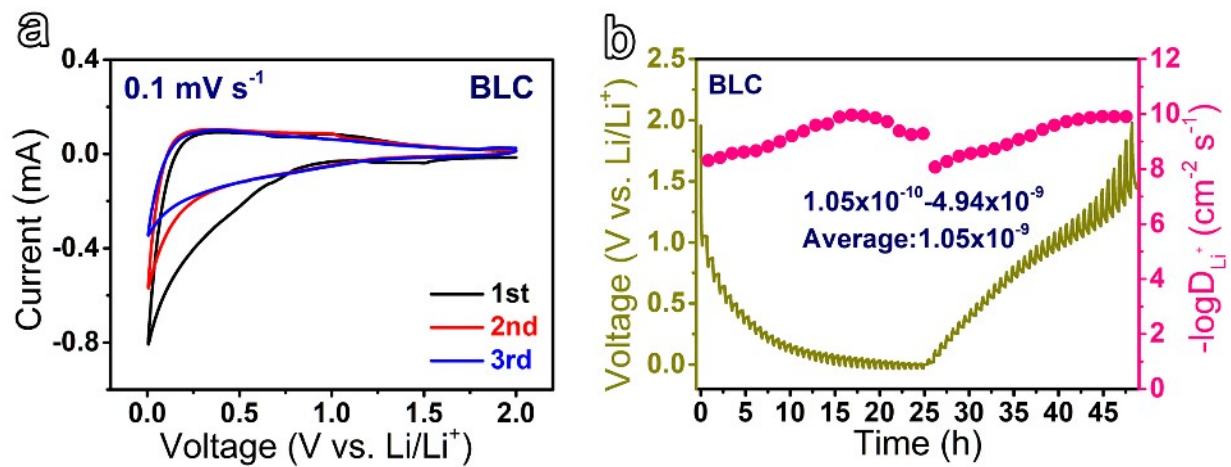


Figure S1. (a) CV curves at 0.1 mV s^{-1} and (b) GITT curves of BLC.

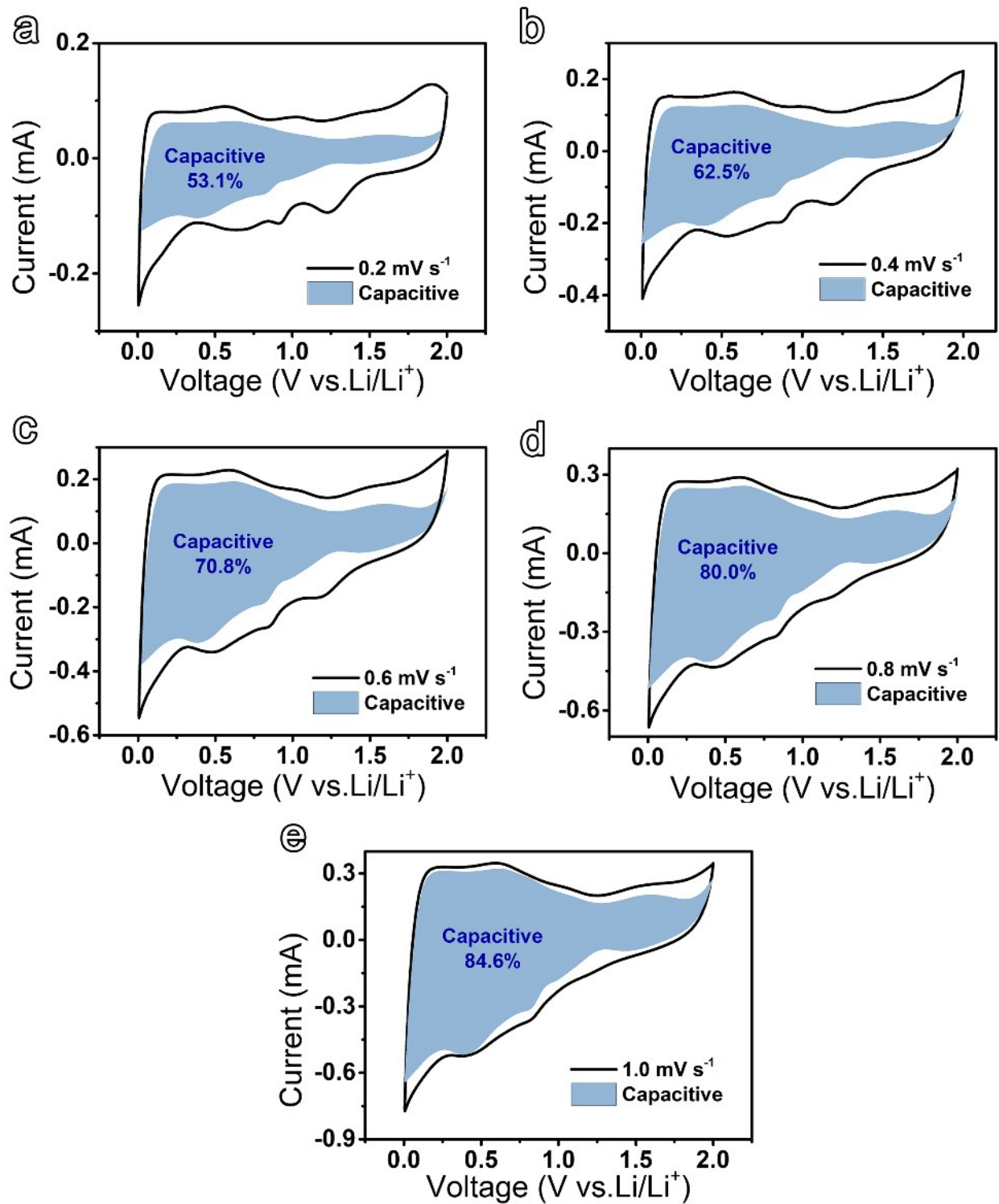


Figure S2. Capacitance contribution in CV curves at different scan rates of NiSiC electrode.

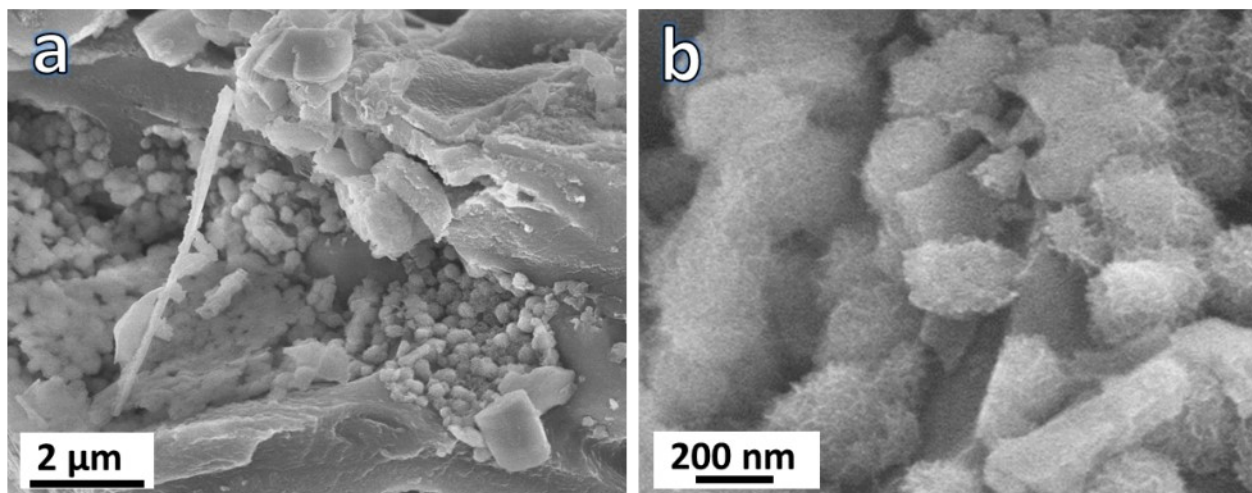


Figure S3. SEM images of NiC at different magnifications.

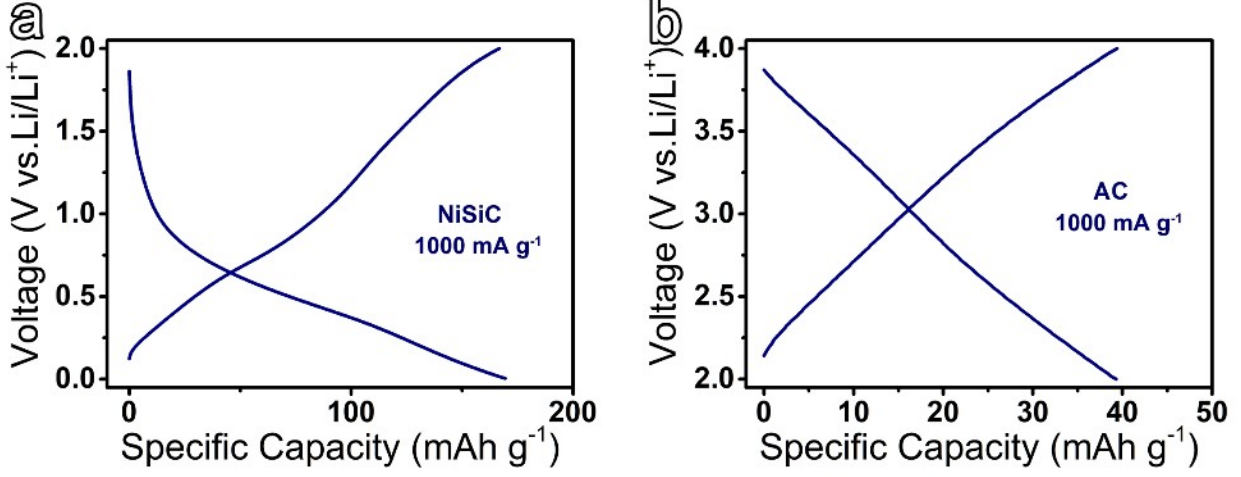


Figure S4. CD curves of (a) NiSiC and (b) AC electrodes in the half-cells at 1000 mA g⁻¹.

REFERENCES for Supporting Information

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