Supporting Information

Carbon Capsule Confined Sb_2Se_3 for Fast Na^+ Extraction in Sodium-ion Batteries

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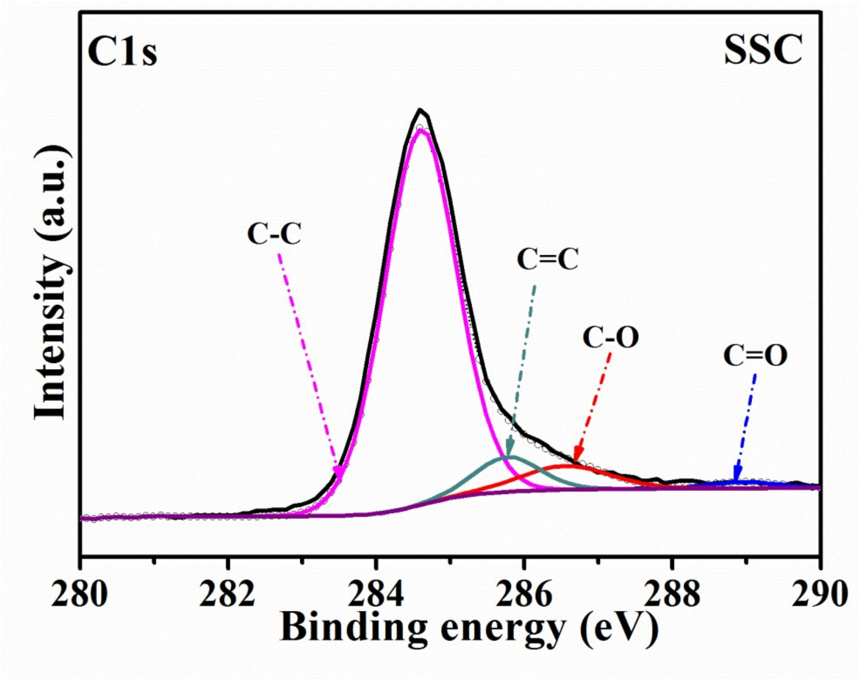


Fig. S1 XPS spectra of C1s core level of SSC.

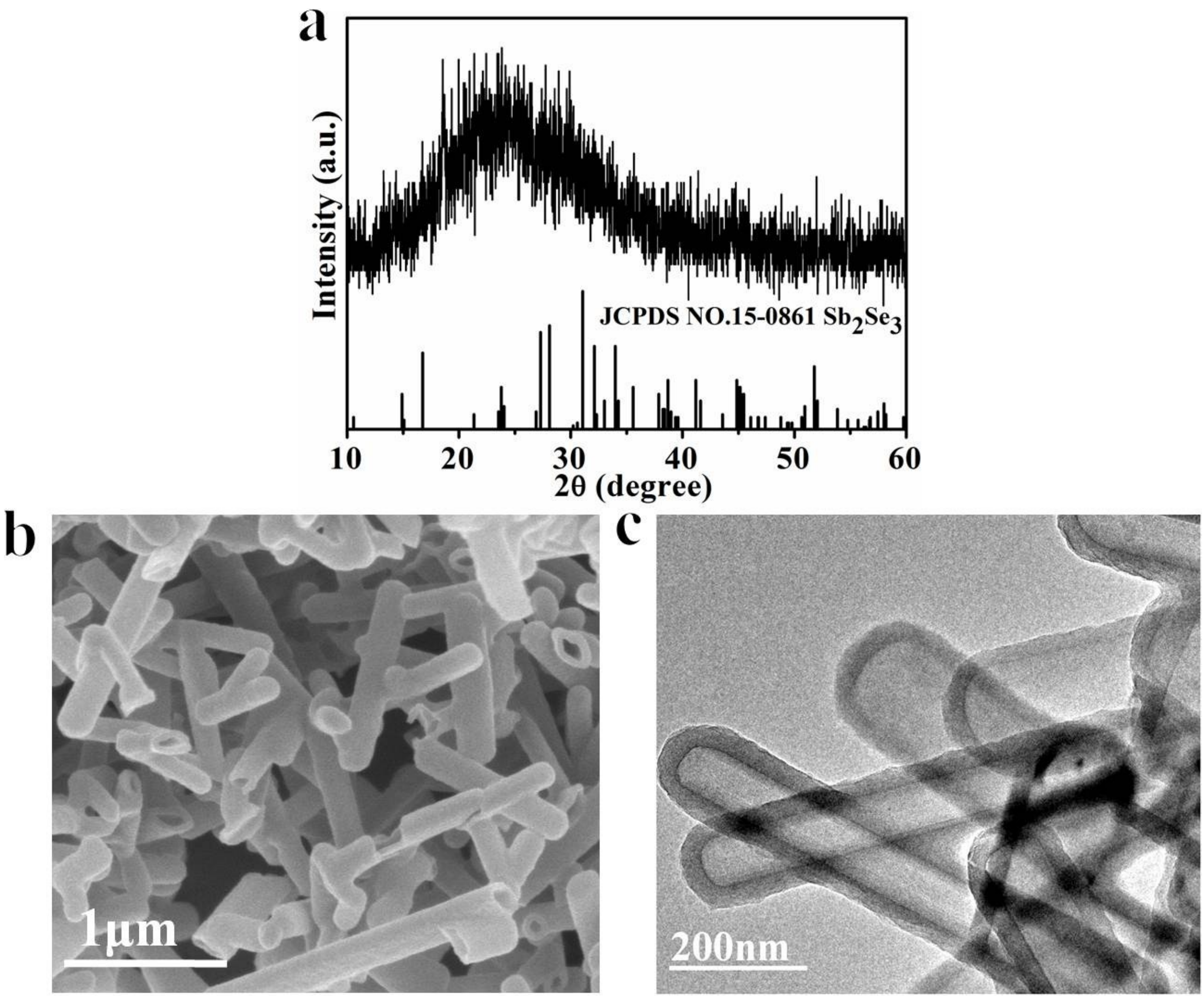


Fig. S2 The XRD pattern, SEM and TEM of C (carbon capsule).

The capsule-like carbon shell was obtained by treating SSC with a 3.0 M NaOH solution for 3 h to remove Sb_2Se_3. The XRD pattern of C was shown in Figure S2a, it is found that all the diffraction peaks of Sb_2Se_3 are disappeared except for a tiny peak at $2\theta \approx 26^{o}$ corresponding to carbon, indicating that pure carbon capsule have been successfully obtained. The morphology and microstructure of C was explored by SEM andTEM. As shown in Figure S2b, 2c, the C exhibits hollow structure with thickness about 20 nm, indicating that Sb_2Se_3 nanorods is confined in carbon capsule with thickness about 20 nm.

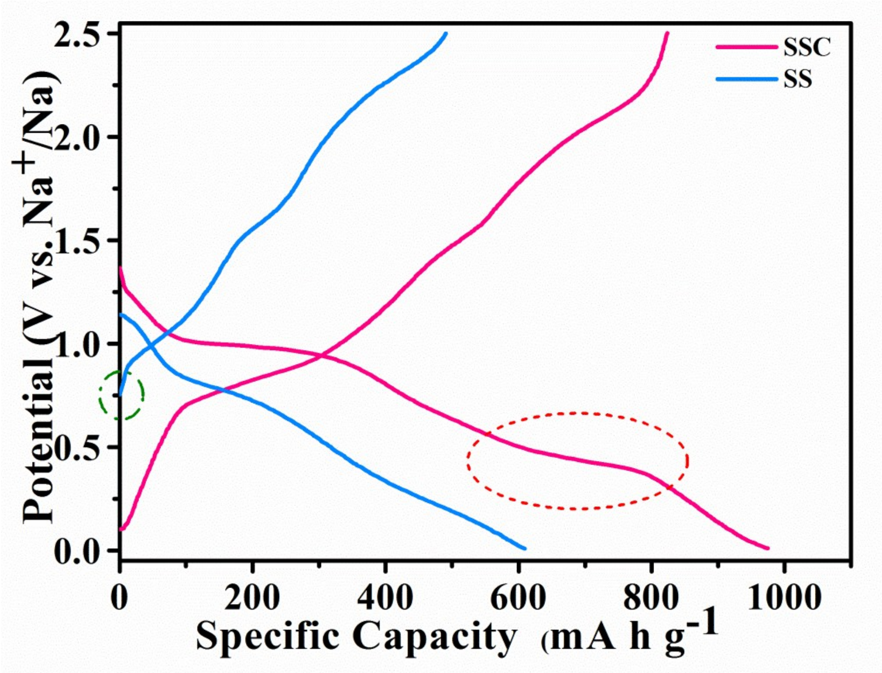


Fig. S3 The initial charge/discharge profiles of SS and SSC electrodes under 2 A g^{-1}.

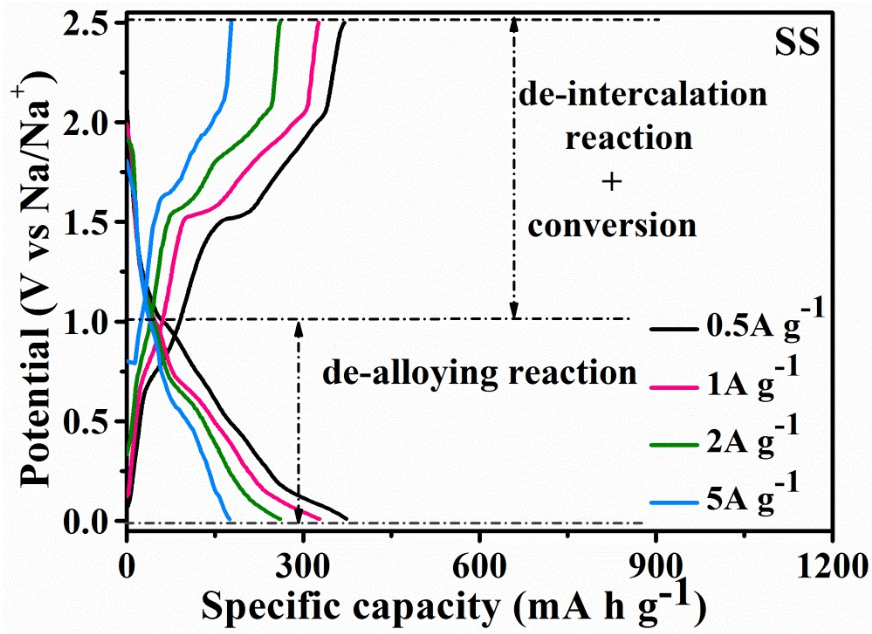


Fig. S4 The charge/discharge profiles of SS electrodes at different current rates.

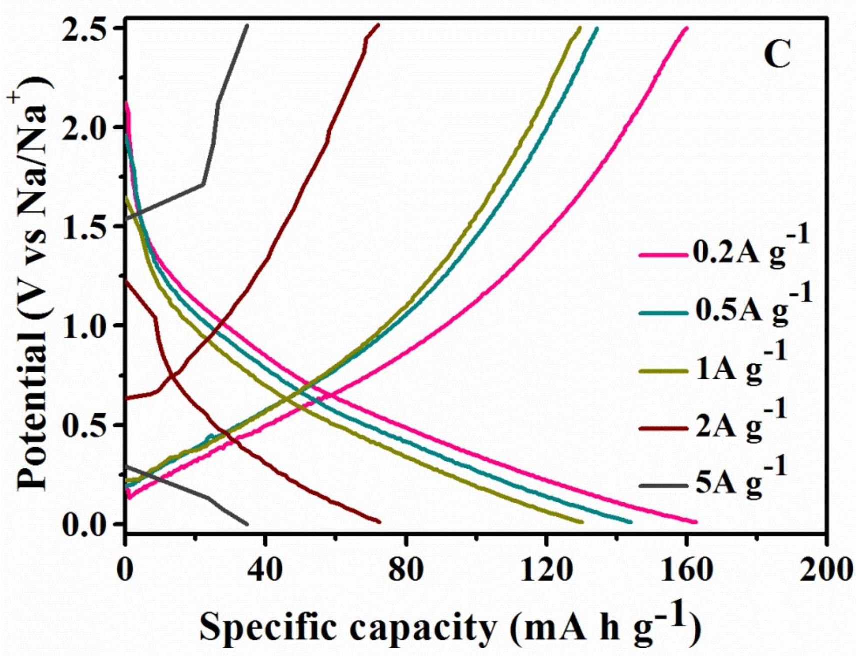


Fig. S5 The charge/discharge profiles of C (carbon capsule) electrode at different current rates.

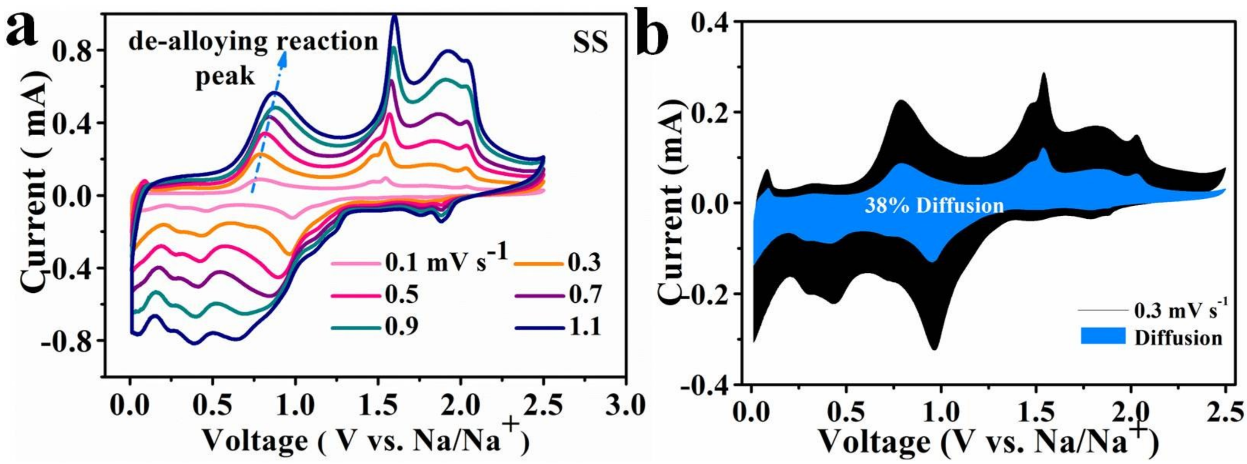


Fig. S6 The cyclic voltammograms of the SS electrodes at different scan rates (a); the diffusion contribution shown by the shaded region at 0.3 mV s^{-1} for SS (b).

Randles-Sevciik equation as follows:

$I_P = (2.69 \times 10^5) n^{3/2} A D^{1/2} C v^{1/2}$ Where n is for the number of transfer electrons, A represents the anode area (cm^2), D stands for Na^+ diffusion coefficient, C is the shuttle concentration (mol cm^{-3}), and v is for the scan rate (V s^{-1}).

$$D_{Na^+} = \left(\frac{I_P}{v^{1/2}} \times \frac{1}{(2.69 \times 10^5) n^{3/2} A C} \right)^2$$

For SS electrode: $\frac{I_P}{v^{1/2}}$=0.64

$$C = \frac{n}{A \times h} = \frac{n/M}{A \times h} = \frac{(0.7175 \times 70\% \times 10^{-3}) g/480.48 \text{ g moL}^{-1}}{0.785 \times 14 \times 10^{-4} \text{ cm}^3} = 9.509 \times 10^{-4}$$

Therefrore, the sodium-ion diffusion coefficient (D_{Na^+}) of SS is about 5.04×10^{-9} cm^2 s^{-1}.

For SSC electrode: $\frac{I_P}{v^{1/2}}$=0.72

$$C = \frac{n}{A \times h} = \frac{n/M}{A \times h} = \frac{(0.7175 \times 70\% \times 80\% \times 10^{-3}) g/480.48 \text{g moL}^{-1}}{0.785 \times 14 \times 10^{-4} \text{ cm}^3} = 7.60 \times 10^{-4}$$

Therefrore, the sodium-ion diffusion coefficient (D_{Na^+}) of SSC is about 1.29×10^{-8} cm^2 s^{-1}.

$$i(\mathrm{V}) = k_1 \upsilon + k_2 \upsilon^{1/2}$$

Based on the above equation, the total current response (i) at a fixed potential (V) can be divided into two parts including capacitive $k_1 \upsilon$ and diffusion-controlled $k_2 \upsilon^{1/2}$.

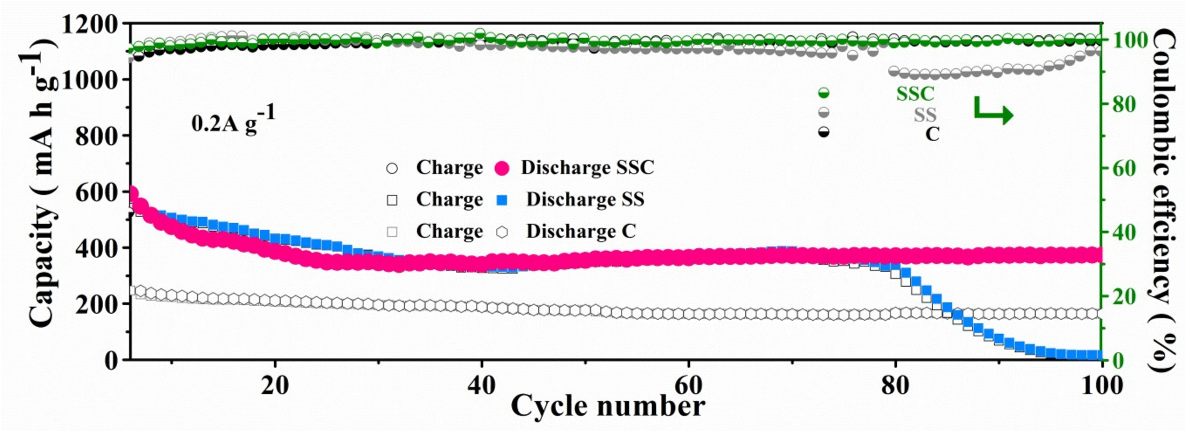
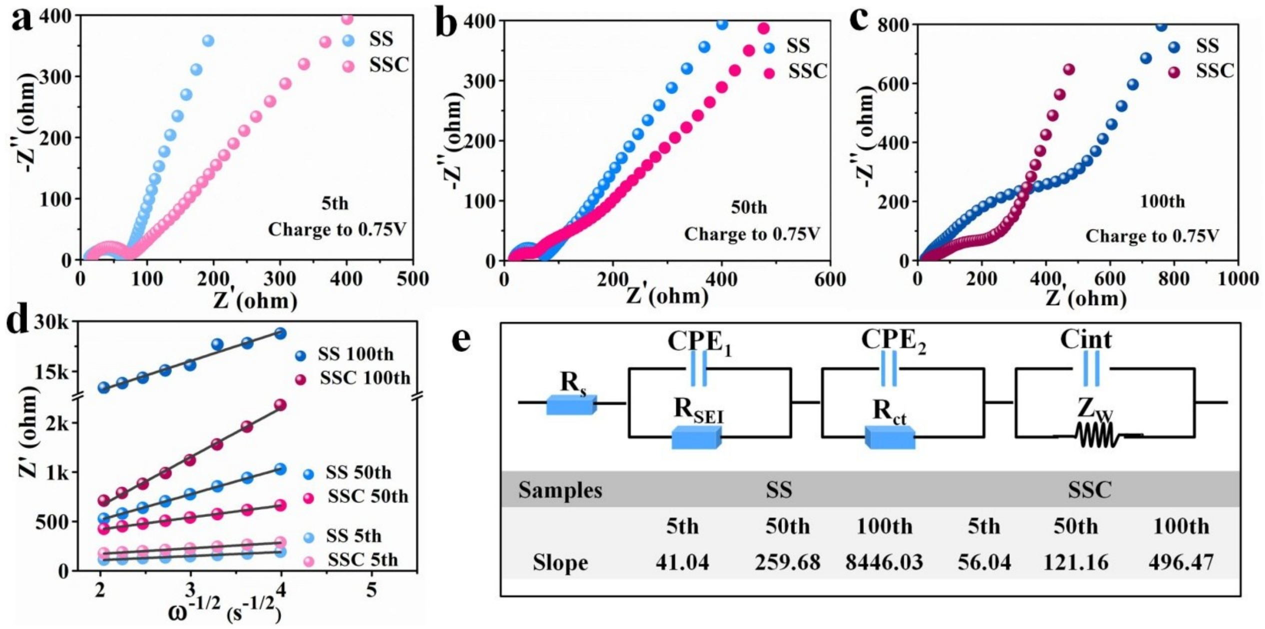


Fig. S7 The cycling performance of SS, SSC and C at a current density of 0.2 A g^{-1}.



Samples	SS			SSC		
	5th	50th	100th	5th	50th	100th
Slope	41.04	259.68	8446.03	56.04	121.16	496.47

Fig S8. The electrochemical impedance spectroscopy (EIS) of SS and SSC electrodes charge to 0.75 V at 5th (a), 50th (b) and 100th (c), (d) the Z′ versus $\omega^{-1/2}$ in the low frequency regions of and fitting liner of SS and SSC, (e) the corresponding equivalent circuit model for the impedance in (a, b, c) and the σ value of fitting liners in (d).