# A Multifunctional Coating on Sulfur-containing Carbon-based Anode for High-performance Sodium-ion Batteries

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**Table S1.** Summary of some different carbon-based materials for SIBs

| Number | Material | Reversible capacity (mAh $g^{-1}$, at A $g^{-1}$) | ICE (%) | Reference |
|---|---|---|---|---|
| 1 | G-NCs | 329 (0.05 A $g^{-1}$) | 32 | Ref. [51] |
| 2 | Natural graphite | 127 (0.1 A $g^{-1}$) | - | Ref.[52] |
| 3 | A-CG | 280 (0.04 A $g^{-1}$) | 38 | Ref. [53] |
| 4 | HPCCNFs-1 | 215 (0.1 A $g^{-1}$) | 25.3 | Ref.[15] |
| 5 | P-CNSs | 237.5 (0.05 A $g^{-1}$) | 42.65 | Ref.[37] |
| 6 | HCS-1900 | 295 (0.05 A $g^{-1}$) | 68.8 | Ref. [54] |
| 7 | SNMHCSs | 240 (0.05 A $g^{-1}$) | 29 | Ref. [55] |
| 8 | PC-800 | 263.2 (0.05 A $g^{-1}$) | 79.6 | Ref. [56] |

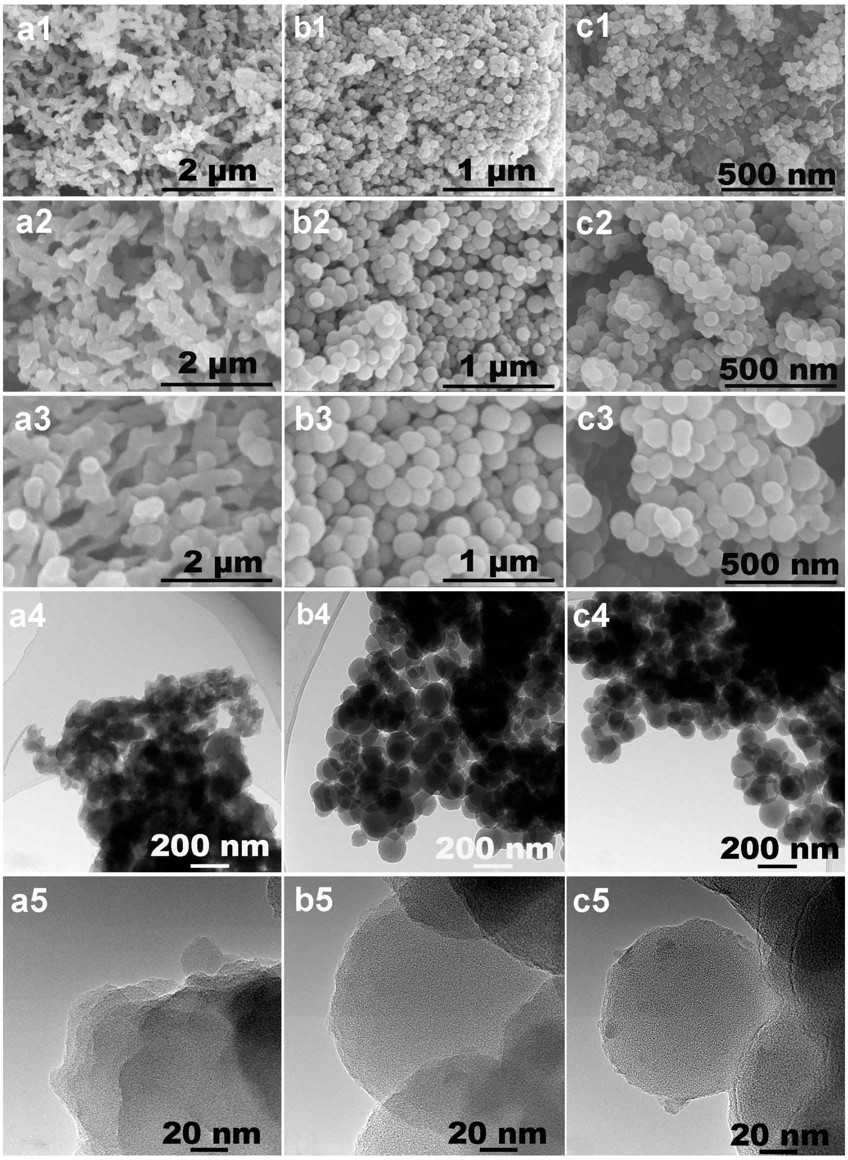


**Figure S1.** The SEM images of **a1, a2, a3**) NSC, **b1, b2, b3**) SGCS and **c1, c2, c3**) GCS at different magnifications. TEM and HRTEM images of **a4, a5**) NSC, **b4, b5**) SGCS and **c4, c5**) GCS.

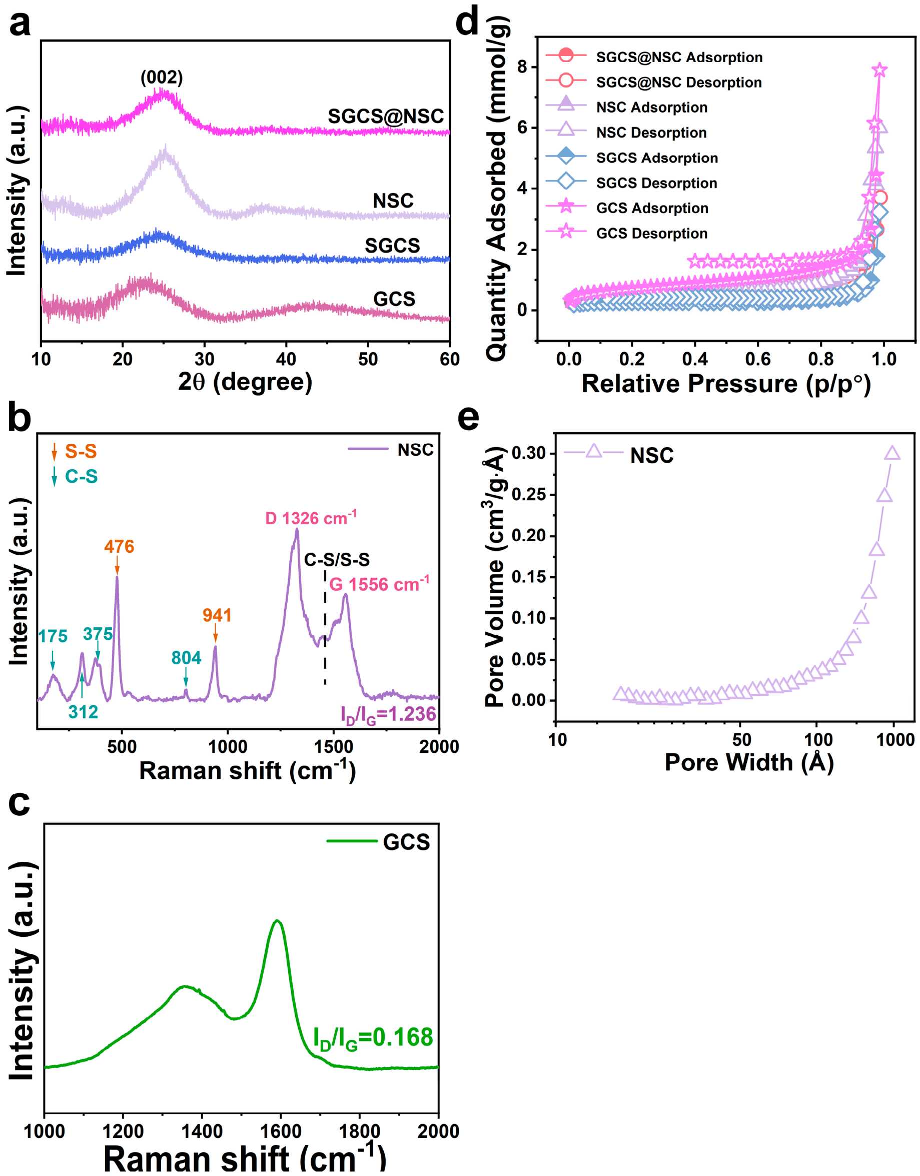


**Figure S2.** (**a**) X-ray diffraction patterns of SGCS@NSC, NSC, SGCS, and GCS. (**b, c**) Raman scattering spectra of NSC and GCS. (**d**) N2 adsorption-desorption isotherms of SGCS@NSC, NSC, SGCS, and GCS. (**e**) Pore distribution curves of NSC.

**Table S2.** Analysis of sulfur bonding area ratio of SGCS@NSC and SGCS.

| Sulfur bonding | SGCS@NSC | SGCS |
|---|---|---|
| **$HS_xC$-** | 8.1 | |
| **C-S** | 70.3 | 54.5 |
| **S-S** | 11.3 | 29.1 |
| **Sulfate** | 10.3 | 16.3 |

**Table S3.** Analysis of carbon bonding area ratio of SGCS@NSC and SGCS.

| Carbon bonding | SGCS@NSC | SGCS |
|---|---|---|
| **C-C** | 35.9 | 36.3 |
| **C-N/C-S** | 18.0 | 12.5 |
| **C=O/C=N** | 46.0 | 51.2 |

**Table S4.** Specific surface areas and pore volume analysis of SGCS@NSC, SGCS, GCS, and NSC.

| Samples | $S_{BET}$(m²/g) | $V_{pore}$(cm³/g) | $R_{pore}$(nm） |
|---|---|---|---|
| **SGCS@NSC** | 34.956 | 0.128 | 3.683 |
| **SGCS** | 18.670 | 0.113 | 6.052 |
| **GCS** | 56.147 | 0.274 | 4.880 |
| **NSC** | 31.168 | 0.208 | 8.984 |

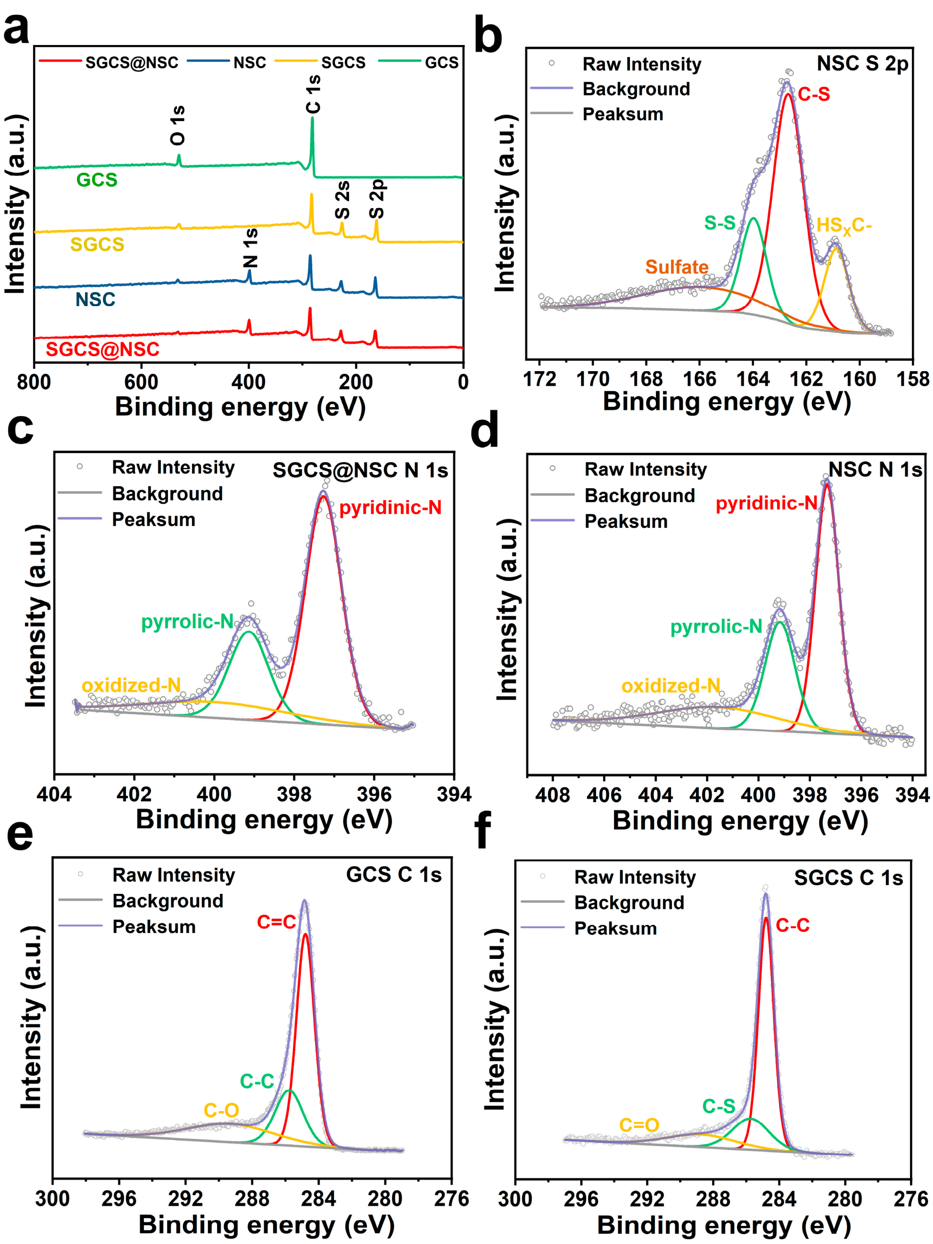


**Figure S3**. (**a**) Typical XPS survey spectra. (**b, d, f**) The high-resolution XPS of S 2p, N 1s, and C 1s for NSC, respectively. (**c**) The high-resolution XPS of N 1s for SGCS@NSC. (**e**) The high-resolution XPS of C 1s for GCS

**Table S5.** Element composition and ratio of the surface of four groups of samples calculated from XPS data (wt.%).

| **Samples** | **C（at%）** | **N（at%）** | **S（at%）** | **O（at%）** |
|---|---|---|---|---|
| **SGCS@NSC** | 63.019 | 12.637 | 19.075 | 2.471 |
| **NSC** | 61.019 | 16.542 | 19.860 | 1.813 |
| **SGCS** | 71.471 | | 22.083 | 5.446 |
| **GCS** | 92.808 | | | 7.192 |

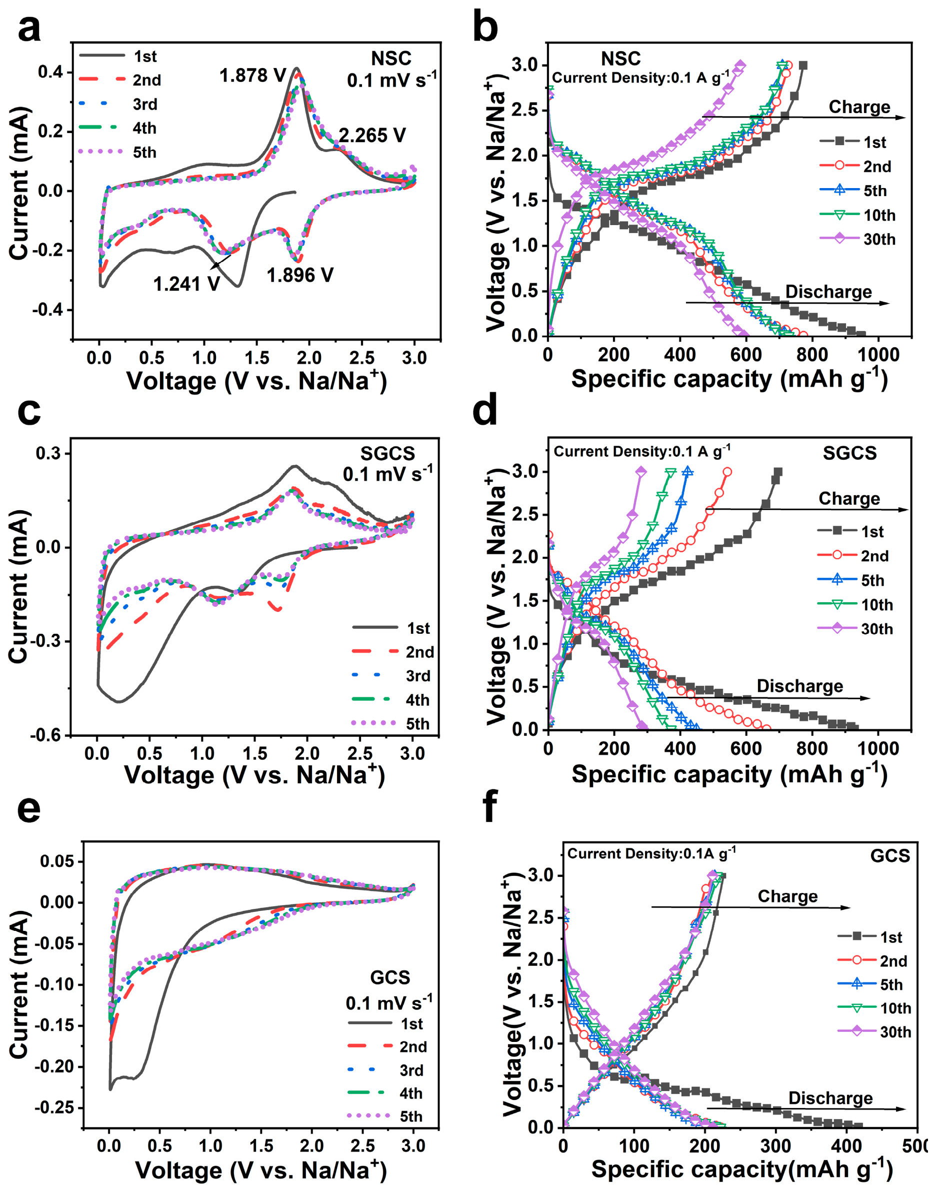


**Figure S4.** The first five successive CV curves of **a**) NSC, **c**) SGCS, and **e**) GCS at the scan rate of 0.1 mV $s^{-1}$. Galvanostatic discharge-charge profiles (100 mA $g^{-1}$) at the 1st, 2nd, 5th, 10th, and 30th cycles of **b**) NSC, **d**) SGCS, and **f**) GCS.

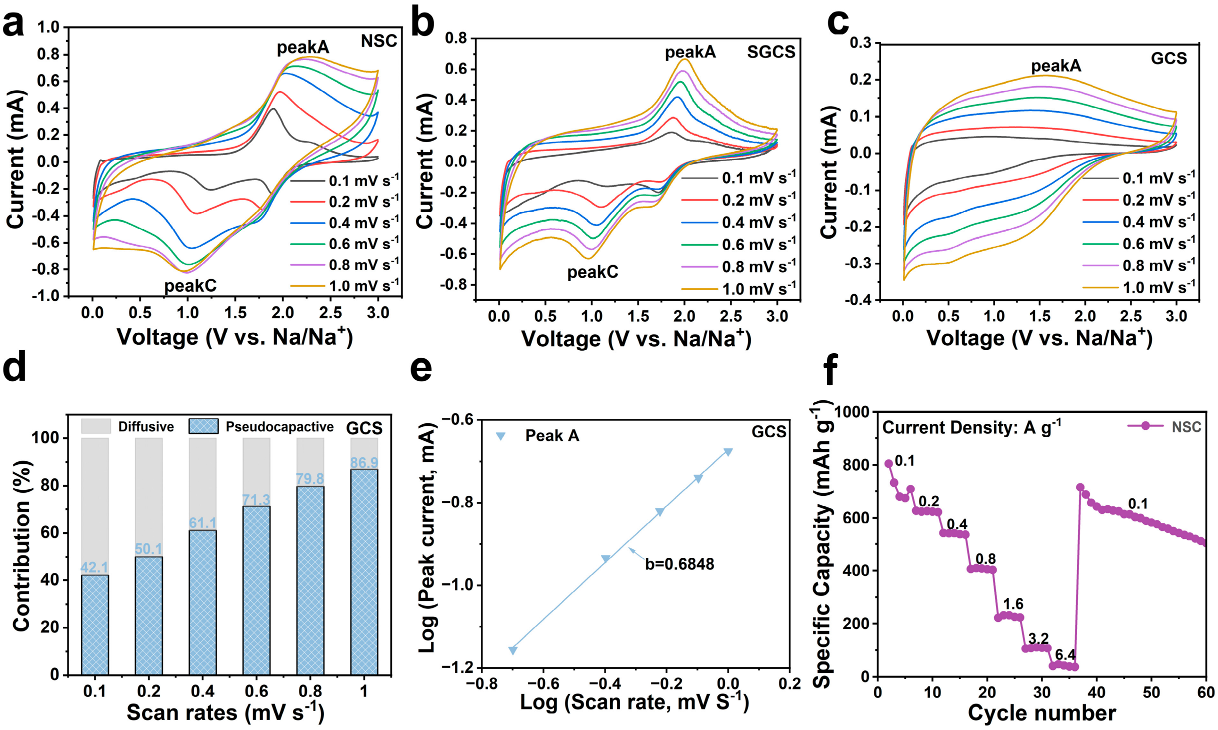


**Figure S5.** CV curves at different scan rates of **a**) NSC, **b**) SGCS, and **c**) GCS from 0.1 to 1.0 mV $s^{-1}$. (**d**) Normalized pseudocapacitive contribution rations of GCS at scan rates from 0.1 to 1.0 mV $s^{-1}$. (**e**) Log ($i$) versus log ($v$) plots of GCS at selected peak currents. (**f**) Rate capability of NSC electrodes at increasing current densities from 0.1 to 6.4 A $g^{-1}$.

The galvanostatic intermittent titration technique is used to calculate the $Na^+$ diffusion coefficient according to the following formula (S1):

$$D = \left(\frac{\Delta E_s}{\Delta E_t}\right)\frac{4L^2}{\pi\tau} \qquad \text{(S1)}$$

In the formula, $\Delta E_s$represents the change in steady-state potential of a current pulse (V), $\Delta E_t$is the elimination of constant current pulse potential (V) changes after iR drops, t is the duration of the current pulse, $\tau$ is the relaxation time, and L is the diffusion length of $Na^+$[42,57].

**Table S6.** The EIS fitting parameters of SGCS@NSC, NSC, SGCS, and GCS.

| Samples | $R_s(\Omega)$ | $R_{ct}(\Omega)$ |
|---|---|---|
| **SGCS@NSC** | 4.9 | 637.2 |
| **NSC** | 7.832 | 975.1 |
| **SGCS** | 11 | 1875 |
| **GCS** | 13.1 | 981 |