Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Hierarchical nano-MoS_2 flake/micro-MXene lamellar complex structure within carbon coating for rapid sodium-ion storage

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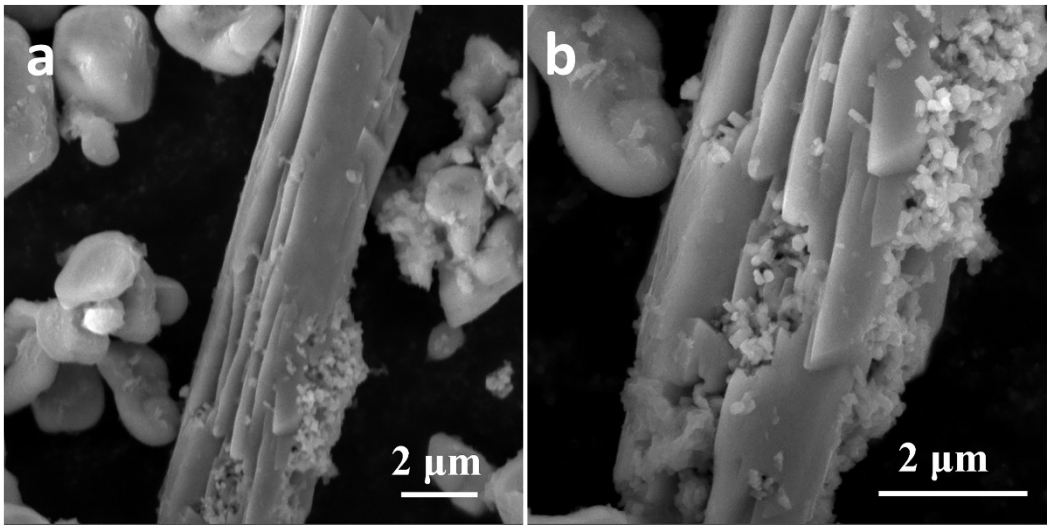

Figure S1. SEM images of $MoCl_x/V_2C$ at different magnifications.

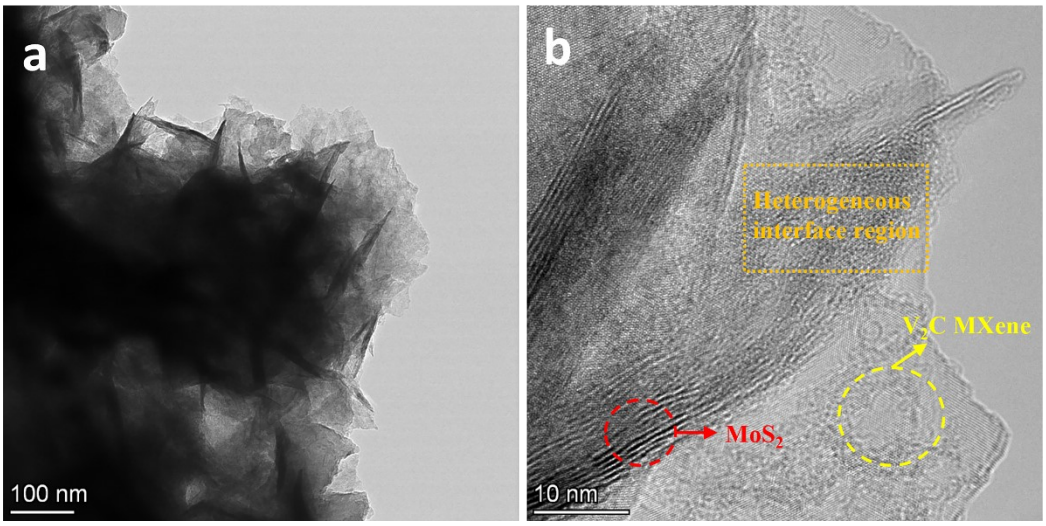

Figure S2. (a) TEM image, (b) HRTEM image of MSVC.

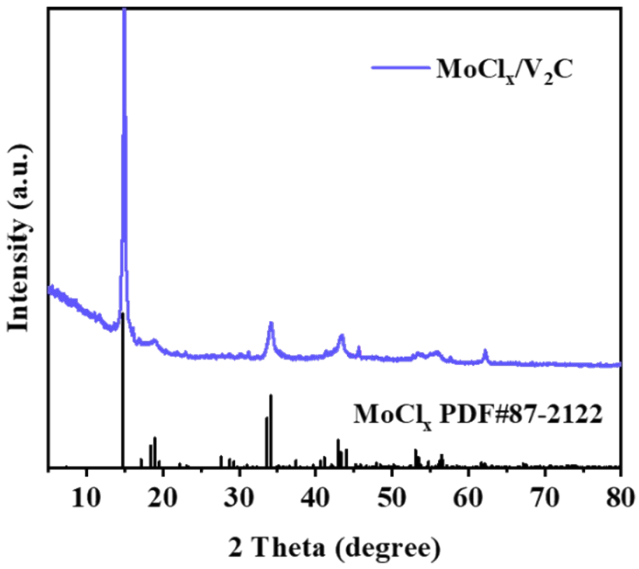

Figure S3. XRD pattern of $MoCl_x/V_2C$.

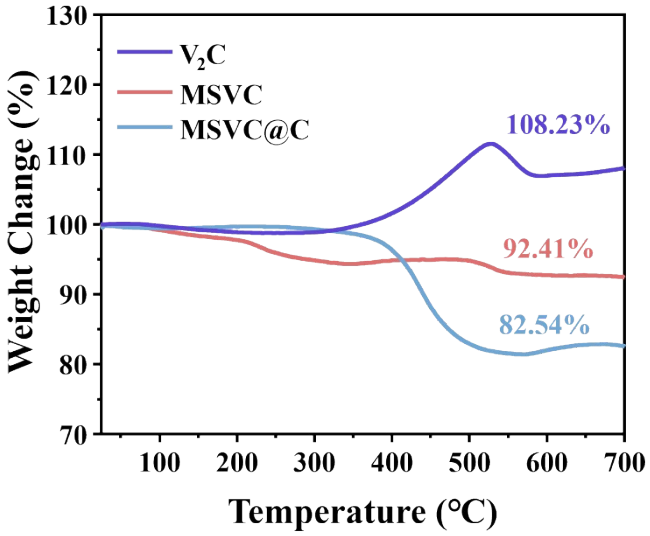

Figure S4. TGA curves of V_2C, MSVC, and MSVC@C.

The detailed calculation process of TGA was as follows：

The original masses of V_2C, MSVC and MSVC@C samples are denoted as m_{V2C}^{0}, m_{MSVC}^{0} and $m_{MSVC@C}^{0}$. The weight loss below 200 ℃ is due to the evaporation of water and residual HF. The masses of the samples at 200 ℃ are recorded as m_{V2C}^{1},

m_{MSVC}^{1} and $m_{MSVC@C}^{1}$, respectively. The subsequent change in weight to 700 ℃ can be attributed to the oxidation of V_2C MXene, MoS_2 and carbon coating. The final masses of three samples are named as m_{V2C}^{2}, m_{MSVC}^{2} and $m_{MSVC@C}^{2}$, respectively.

From the TGA curves:

$m_{V2C}^{1} = 0.9887 m_{V2C}^{0}$, $m_{MSVC}^{1} = 0.9771 m_{MSVC}^{0}$, $m_{MSVC@C}^{1} = 0.9966 m_{MSVC@C}^{0}$

f_x is represent the rate of mass change, and ω_x is represent the mass content of a certain component, then:

$$f_{V2C} = \frac{m_{V2C}^{2}}{m_{V2C}^{1}} = \frac{1.0823 m_{V2C}^{0}}{0.9887 m_{V2C}^{0}} = 1.0947$$

,

$$f_{MSVC} = \frac{m_{MSVC}^{2}}{m_{MSVC}^{1}} = \frac{0.9241 m_{MSVC}^{0}}{0.9771 m_{MSVC}^{0}} = f_{V2C} \times \omega_{V2C} + f_{MoS2} \times \omega_{MoS2}$$

,

Since MoS_2 is all oxidized to MoO_3 at high temperature, and $f_{MoS2} = \frac{M_{MoO3}}{M_{MoS2}} = \frac{143.958}{160.07}$ is obtained. For the MSVC composite, $\omega_{V2C} + \omega_{MoS2} = 1$, and the final calculation gives: $\omega_{MoS2} = 82.95\%$, $\omega_{V2C} = 17.05\%$.

As for the MSVC@C sample, the carbon coating is completely oxidized and volatilized at a high temperature. Therefore:

$$f_{MSVC@C} = \frac{m_{MSVC@C}^{2}}{m_{MSVC@C}^{1}} = \frac{0.8254 m_{MSVC@C}^{0}}{0.9966 m_{MSVC@C}^{0}} = f_{MSVC} \times \omega_{MSVC}$$

,

$\omega_{MSVC} = 87.57\%$, and $\omega_{Carbon}^{*} = 1 - \omega_{MSVC} = 12.43\%$,

$\omega_{MoS2}^{*} = \omega_{MoS2} \times \omega_{MSVC} = 72.64\%$, and $\omega_{V2C}^{*} = \omega_{V2C} \times \omega_{MSVC} = 14.93\%$.

In summary, the content of each component in MSVC@C composite is:

$\omega_{MoS2}^{*} = 72.64\%$, $\omega_{V2C}^{*} = 14.93\%$, $\omega_{Carbon}^{*} = 12.43\%$, respectively

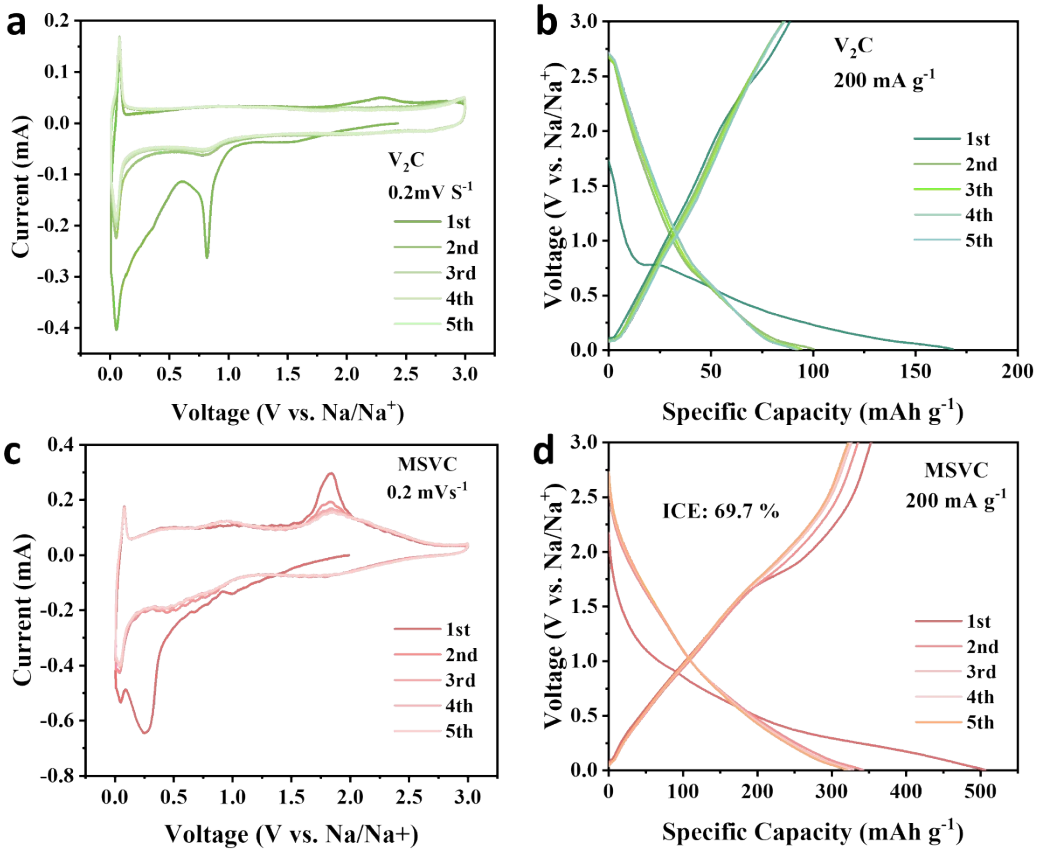

Figure S5. (a) CV curves and (b) GCD profiles for the initial five cycles of V_2C. (c) CV curves and (d) GCD profiles for the initial five cycles of MSVC.

Table S1. Kinetic parameters are calculated by fitting an equivalent circuit of two electrodes after cycling.

Sample	R_s	R_{ct}
MSVC@C	4.46	**6.09**
MSVC	9.60	**25.26**

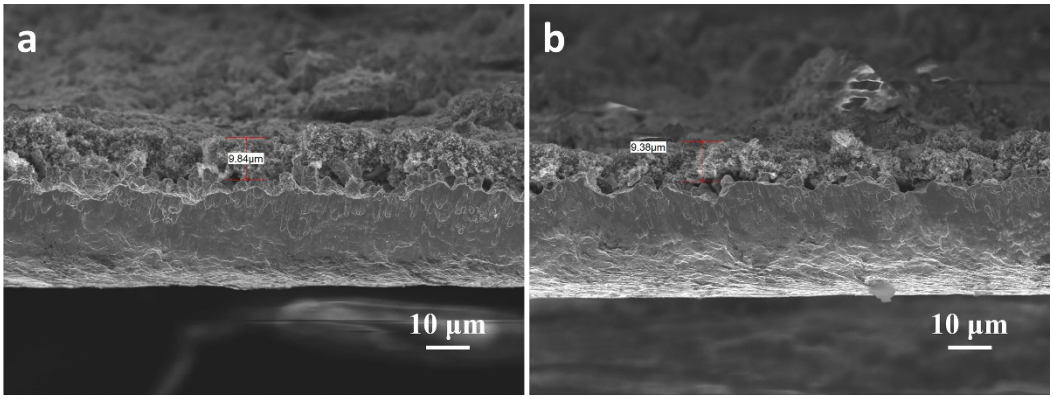

Figure S6. SEM images of (a) the MSVC@C electrode film and (b) the MSVC@C electrode film.

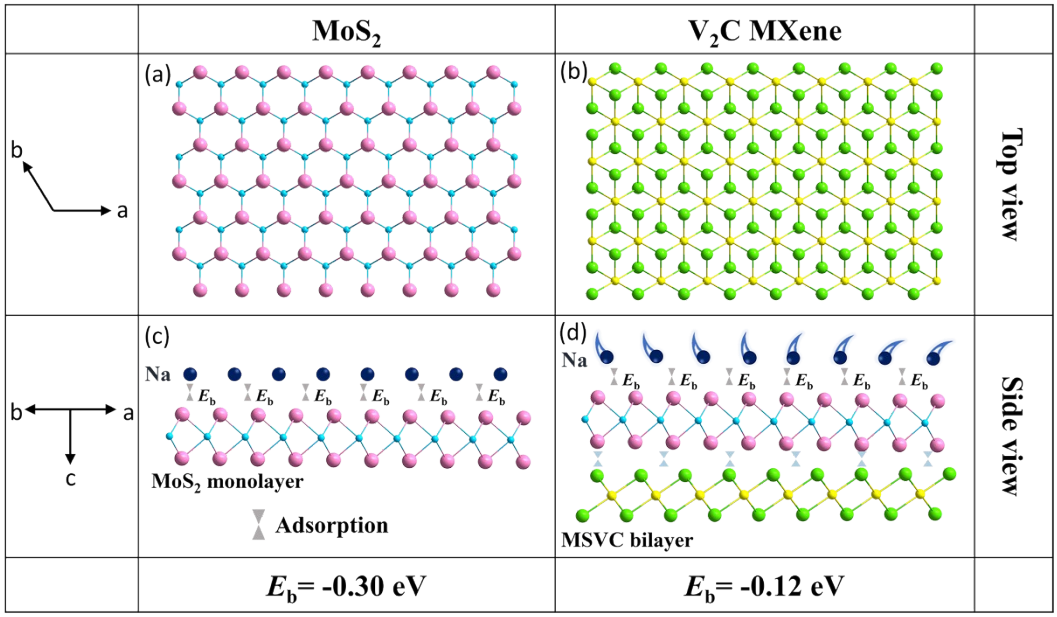

Figure S7. Structural models of (a) MoS_2 and (b) V_2C MXene. Simulated adsorption energies between Na atoms and (c) MoS_2 monolayer, and (d) MSVC bilayer.

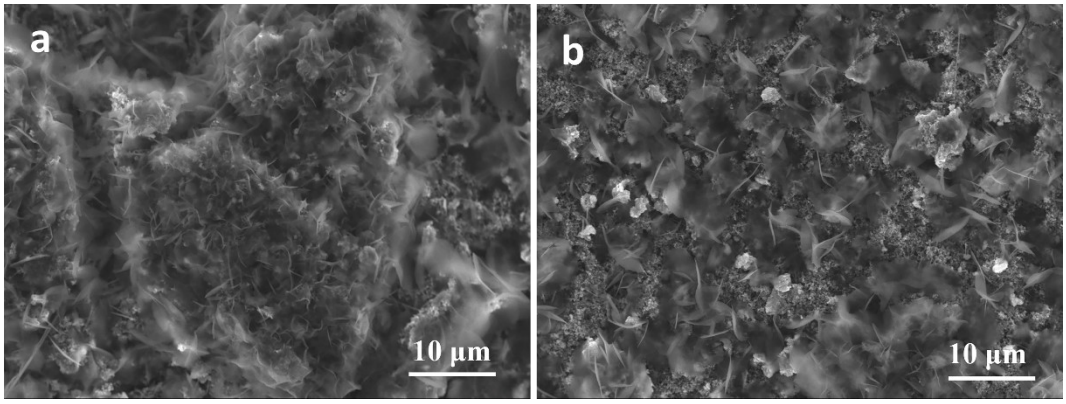

Figure S8. SEM images of MSVC electrode after 100 cycles at 0.5 A g^{-1}.

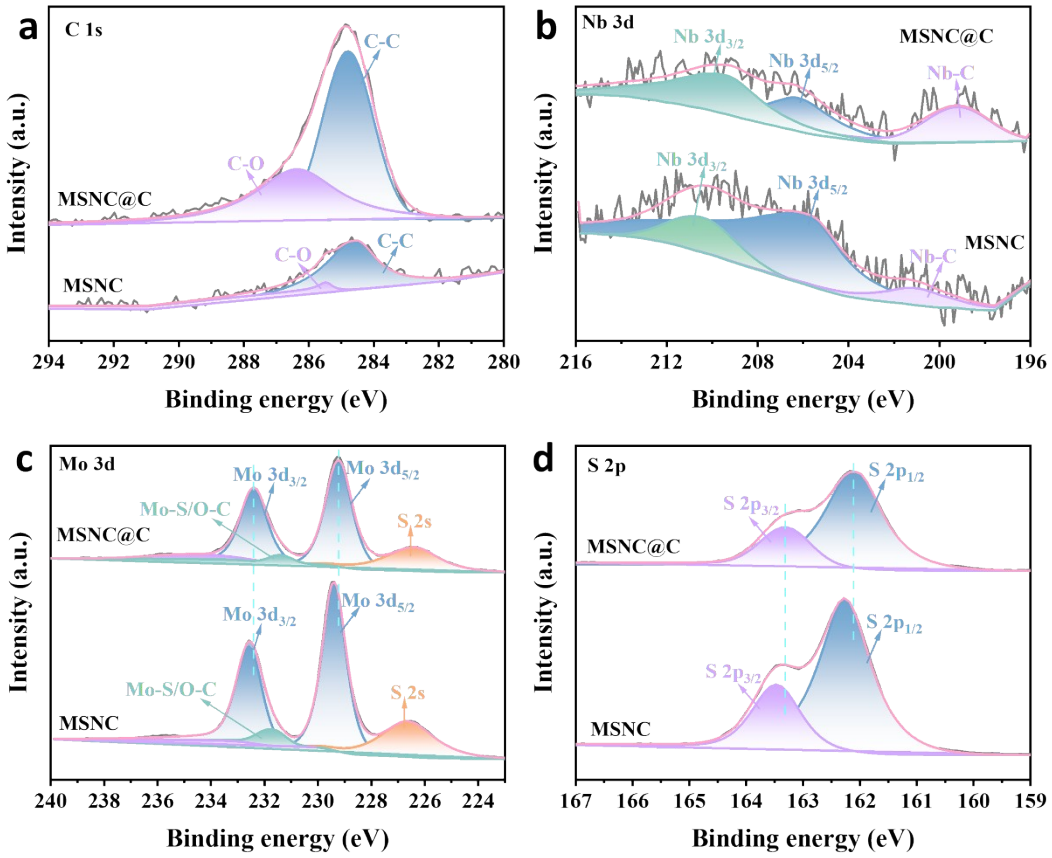

Figure S9. XPS high-resolution spectra of (a) C 1s, (v) Nb 3d, (c) Mo 3d, and (d) S 2p of MSVC@C and MSNC.

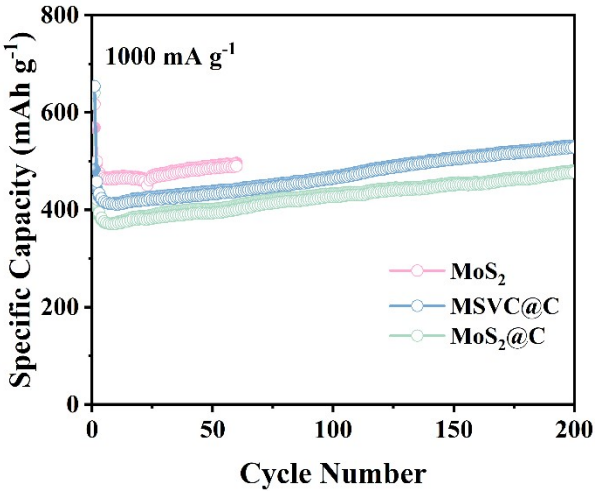

Figure S10. The cycling performance of MSVC@C, MSNC@C, MoS_2, and MoS_2@C at 1000 mA g^{-1}.

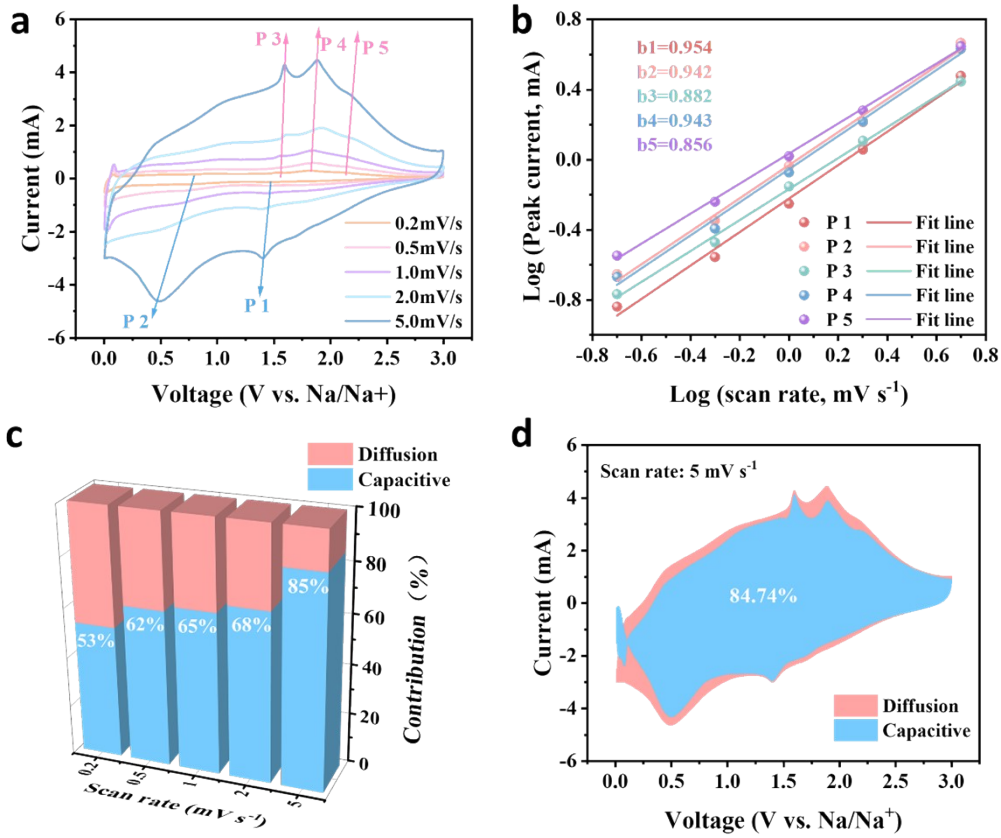

Figure S11. (a) CV curves at different scan rates, (b) relationships between the logarithm peak current and logarithm scan rate, (c) percentages of capacitive contribution at different scan rates, and (d) capacitive contribution at 5 mV s^{-1} of MSNC@C