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Supplementary Information

Electrodeposited cobalt sulfide on vertical graphene nanocomposite for high-performance supercapacitors

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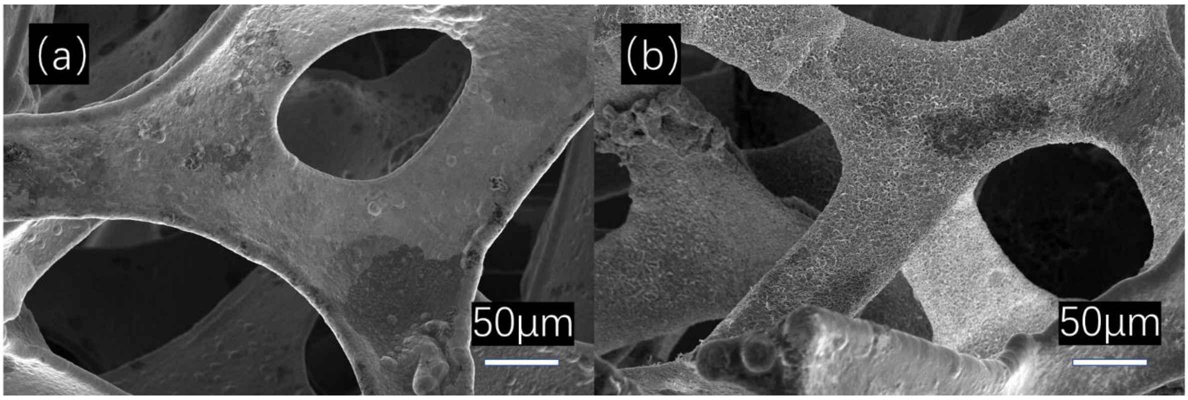

Figure S1 Low magnification SEM images (a) porous nickel foam; (b) CoS/VG deposited nickel foam.

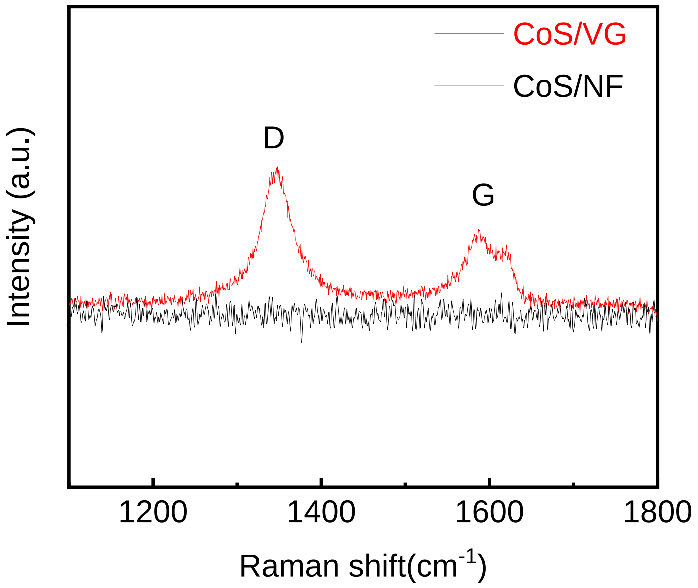

Figure S2 Raman spectra of CoS/VG and CoS/NF electrodes.

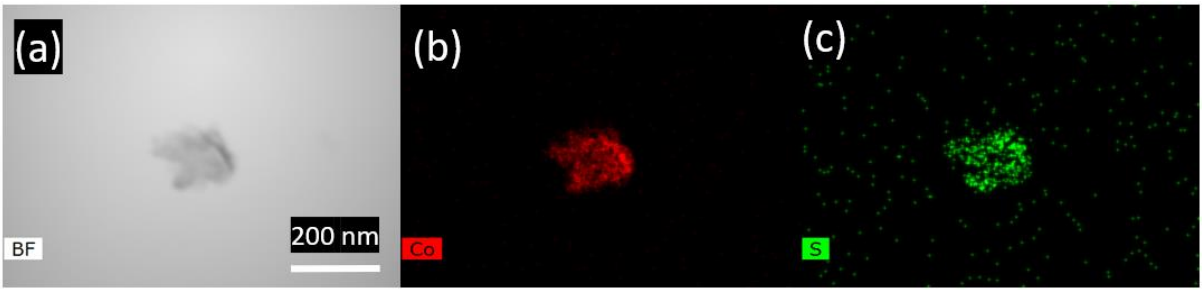

Figure S3 Energy-dispersive X-ray spectroscopy (EDS) elemental mapping (a) CoS/VG bright-field (BF) images and (b, c) element mapping of cobalt and sulfide.

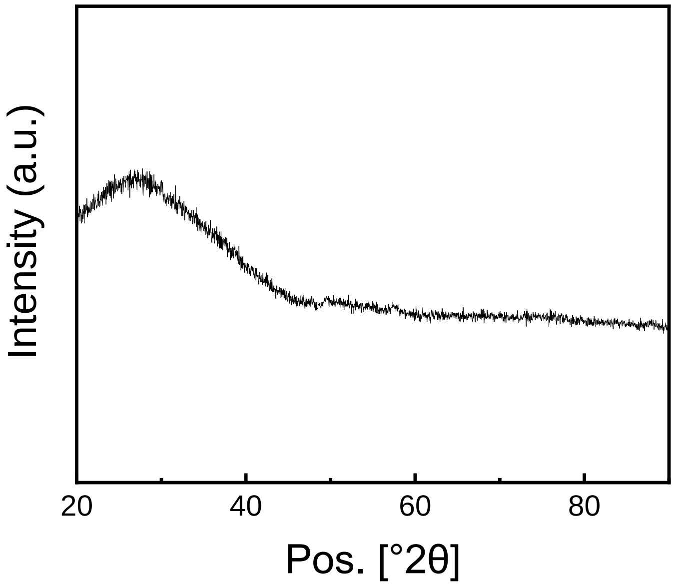

Figure S4 XRD patterns for CoS/VG scratched from NF on the glass.

Name	Area (Peaks)	Atomic %
C1s	9577.43	30.14
O1s	31965.18	35.96
S2p3	1931.34	4.83
N1s	8287.99	15.74
Co2p3	25636.77	7.29
Ni2p3	24368.92	6.02

Table S1 Atomic ratio from XPS survey of CoS/VG/NF

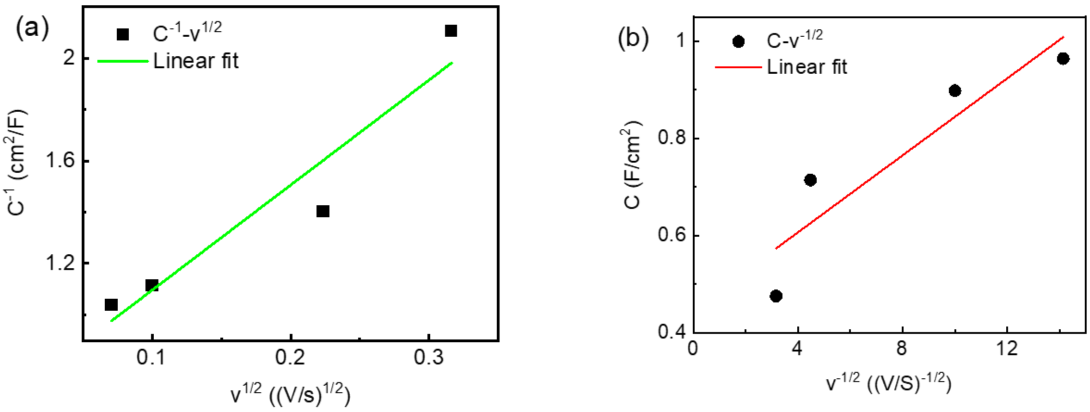

Figure S5 Linear fit of (a)the reciprocal of the areal capacitance and the square root of scan rate; (b) the areal capacitance and the reciprocal of square root of scan rate.

During the cyclic voltammetry experiments, the interface between CoS/VG electrode and liquid electrolyte appeared double-layer capacitance. To demonstrate the contribution of double layer capacitance and faraday capacitance, the capacitance can be evaluated by Trisatti method as followed.[1]

The data is collected from different scan rate and the corresponding areal capacitance is evaluated based on: $C = \frac{S}{2 \cdot \Delta U \cdot v}$, where C is the areal capacitance, S is the enclosed area corresponding cyclic voltammograms (in $A \cdot V/cm^2$),

ΔU is the potential window (in V), and v is the scan rate (in V/s). If the ion diffusion follows a semi-infinite diffusion pattern, the reciprocal of the calculated areal capacitance (C^{-1}) is linearly correlated with the square root of scan rates ($v^{1/2}$), as shown in the following equation:

$$C^{-1} = Constant \cdot v^{1/2} + C_\tau^{-1}$$

Where C, v and C_t are calculated areal capacitance, scan rate and maximum areal capacitance, respectively. The "maximum areal capacitance (C_τ)" is the sum of double layer capacitance and faraday capacitance. C_τ equals to the reciprocal of the y-intercept of the C^{-1}-$v^{1/2}$ (figure S5 (a)), which is 0.6867 F/cm^2.

The double layer capacitance (C_d) can be calculated by Trisatti method. The calculated areal capacitance (C) is linearly correlated with the reciprocal of square root of scan rate ($v^{-1/2}$), as shown in the following equation:

$$C = Constant \cdot v^{-1/2} + C_d$$

After Linear fitted the areal capacitance and the reciprocal of square root of scan rate (figure S5 (b)), the double layer capacitance can be read as 0.0396 F/cm^2. Subtraction of double layer capacitance from specific capacitance yields the faraday capacitance (C_f). The capacitance contribution is evaluated based on the following equations:

$$C_d\% = \frac{C_d}{C_\tau} \times 100\%$$

$$C_f\% = \frac{C_f}{C_\tau} \times 100\%$$

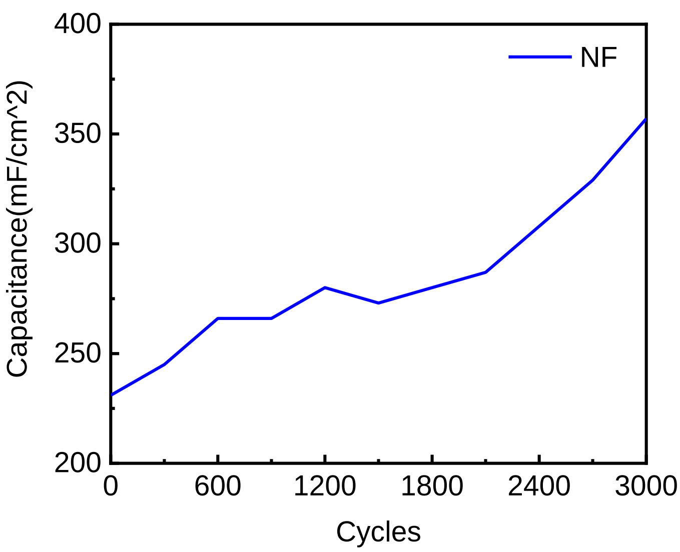

Figure S6 Cycling performance of the single substrate NF under the same charge/discharge current of 0.068 A (10 A/g for the CoS/VG electrode).

References

1. Z. H. Huang, T. Y. Liu, Y. Song, Y. Li and X. X. Liu, Nanoscale, 2017, 9, 13119-13127.