Supporting Information

Synergistic effect of carbon nanotubes and graphitic carbon nitride on the enhanced supercapacitor performance of cobalt diselenide-based composites

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Electrochemical measurements

The electrochemical properties of the composites were conducted on a CS350H electrochemical workstation (Corrtest instrument, Wuhan, China). In a three-electrode system, Ag/AgCl electrode and Pt foil were used as the reference electrode and the counter electrode, respectively. The working electrode was prepared by mixing the active material, conductive agent (Super-P) and polyvinylidene fluoride (PVDF) with mass ratio of 8:1:1 in 1-methyl-2-pyrrolidone. The loading mass of active material was 2.0 mg. The performance of the electrode was tested in 3 M KOH electrolyte at room temperature. The specific capacitance (C, F g^{-1}) and specific capacity (Q, mAh g^{-1}) of the electrode can be calculated by the GCD curves according to the following formula.

$$C=(I\times\Delta t)/(m\times\Delta V) \qquad (1)$$

$$Q=(I\times\Delta t)/(m\times3.6) \qquad (2)$$

where I, Δt, ΔV and m represent discharge current, discharge time, potential window and the mass of active materials, respectively. The CV curves were conducted at various scan rates within the potential window of -0.2–0.5 V. The GCD curves were conducted at various current densities in the potential range from -0.1–0.35 V.

The asymmetric supercapacitor ($CoSe_2$/CNTs@g-C_3N_4//AC) device was assembled and tested in a coin cell, where the $CoSe_2$/CNTs@g-C_3N_4-3 composite and the active carbon were used as the positive electrode and the negative electrode, respectively. The mass ratio of active materials on the two electrodes was determined according to the following formula:

$$m^{+}/m^{-}=(C^{-}\times\Delta V^{-})/(C^{+}\times\Delta V^{+}) \quad (3)$$

Where C is the specific capacitance, ΔV is the voltage window and m is the loading mass of positive (+) and negative (–) electrodes, respectively. Herein, the mass of $CoSe_2$/CNTs@g-C_3N_4-3 is 1.0 mg and the active carbon is 6.5 mg. The energy density (E, Wh kg^{-1}) and power density (P, W kg^{-1}) of the device were calculated according to the following formulas.

$$E=(C\times V^{2})/(2\times3.6) \quad (4)$$

$$P=(3600\times E)/\Delta t \quad (5)$$

Where C is the specific capacitance, V is the discharge voltage, and Δt is the discharge time.

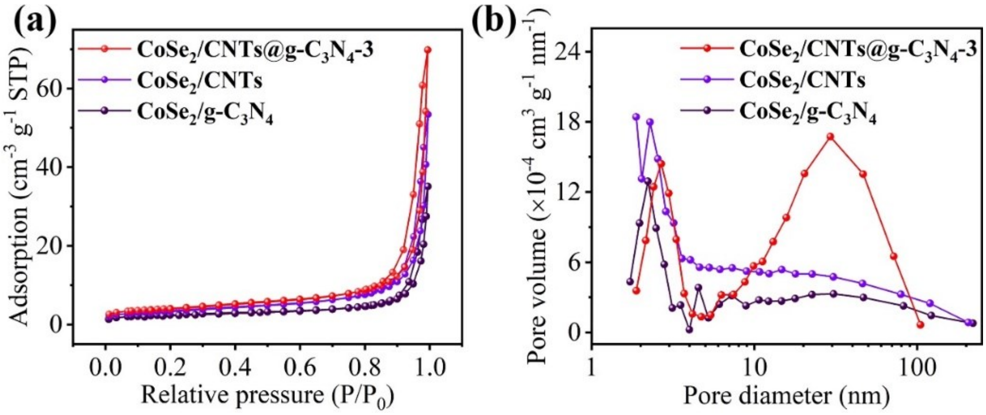

Fig. S1 the nitrogen adsorption/desorption isotherms and pore size distributions of the samples.

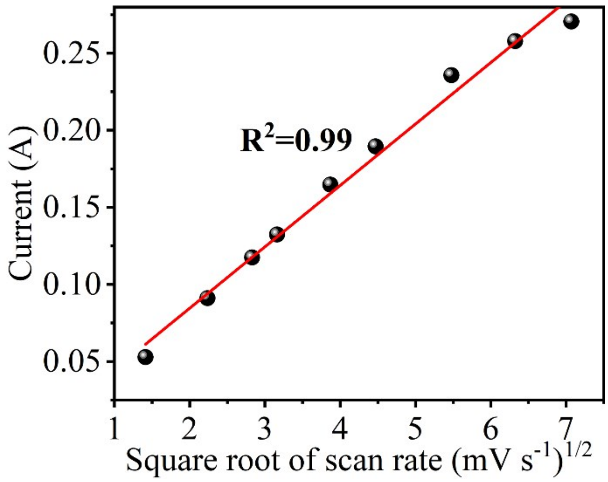

Fig. S2 the linear relation between the positive peak current and square root of scan rate for $CoSe_2$/CNTs@g-C_3N_4-3 electrode at different scan rates.

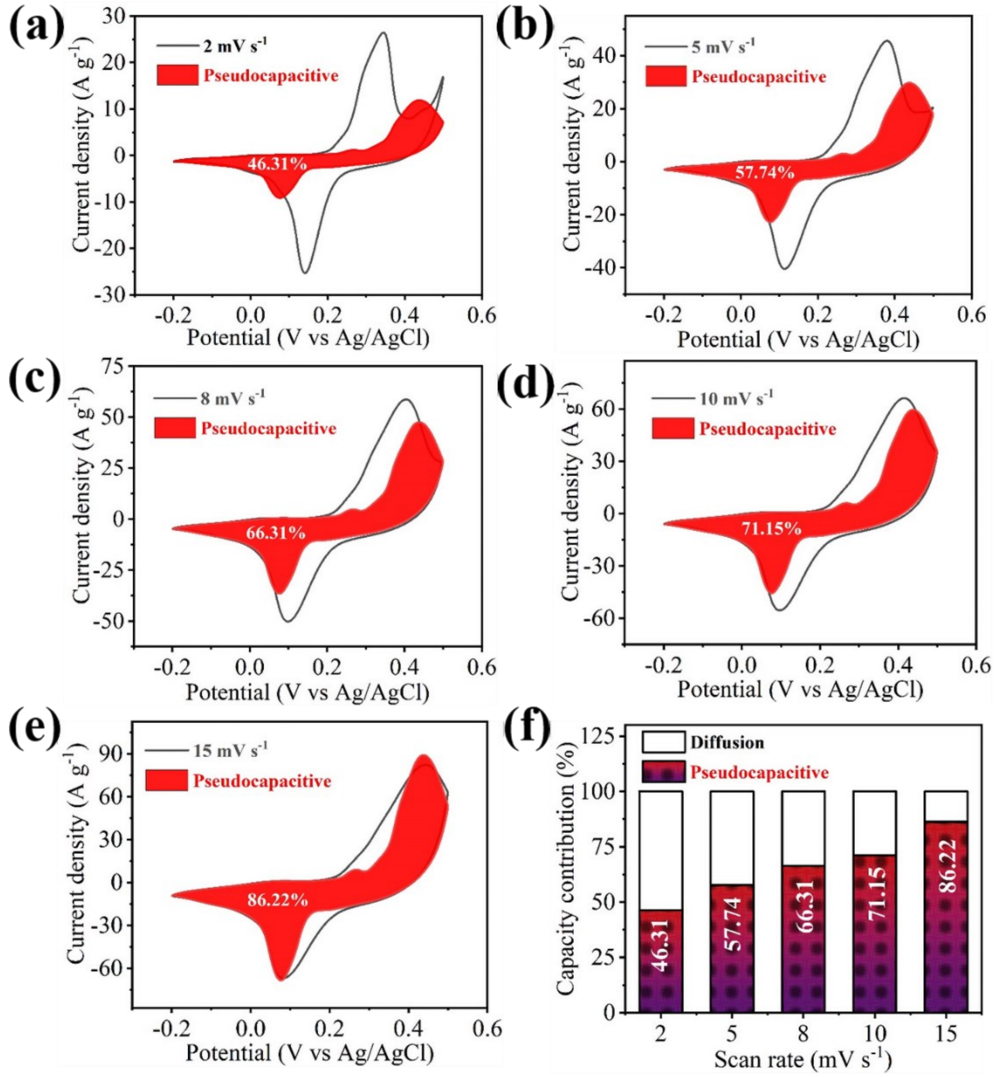

Fig. S3 (a-e) CV partition analysis showing pseudocapacitive contribution to total current at the selected scan rates, (f) contribution ratio of pseudocapacitance at different scan rates for $CoSe_2$/CNTs@g-C_3N_4-3 composite.

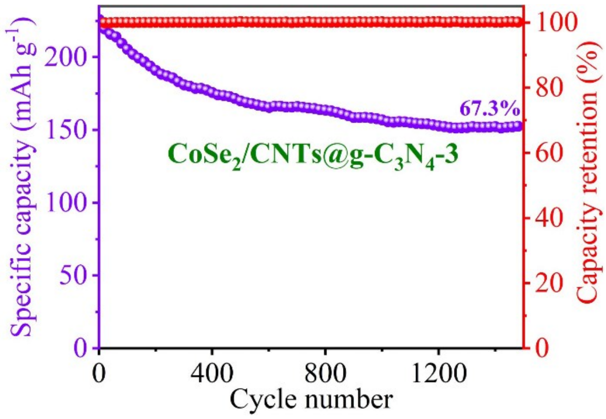

Fig. S4 the cycling performance of the $CoSe_2$/CNTs@g-C_3N_4-3 composite at 10 A g^{-1}.

Table S1. The energy density and power density of our device and some previously reported supercapacitors based on transition metal selenides

Symmetric/asymmetric supercapacitors	Energy density (Wh kg^{-1})	Power density (kW kg^{-1})
$CoSe_2$/CNTs@g-C_3N_4//AC [This work]	77.1	850.0
	36.3	295.1
$CoSe_2$//$CoSe_2$ [38]	60.5	800
MoS_2-$CoSe_2$//MoS_2-$CoSe_2$ [39]	40.9	980.0
$CoSe_2$/NC-NF//AC [40]	40.5	538.0
E-$CoSe_2$/$Ni_{0.85}Se$//AC [41]	21.1	500
1D-$CoSe_2$//1D-$CoSe_2$ [42]	18.9	387.0
$CoSe_2$//AC [43]	34.8	399.9
N_2C_4Se//HPC [44]	20.2	144.1
bamboo-like $CoSe_2$//AC [45]	32.2	1914.7

$CoSe_2$//N-doped carbon nanowall [46]