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Supplementary Information

Tetra germanium nonaselenide enwrapped with reduced graphene oxide and functionalized carbon nanotubes (Ge_4Se_9/RGO/FCNTs) hybrids for improved energy storage performances

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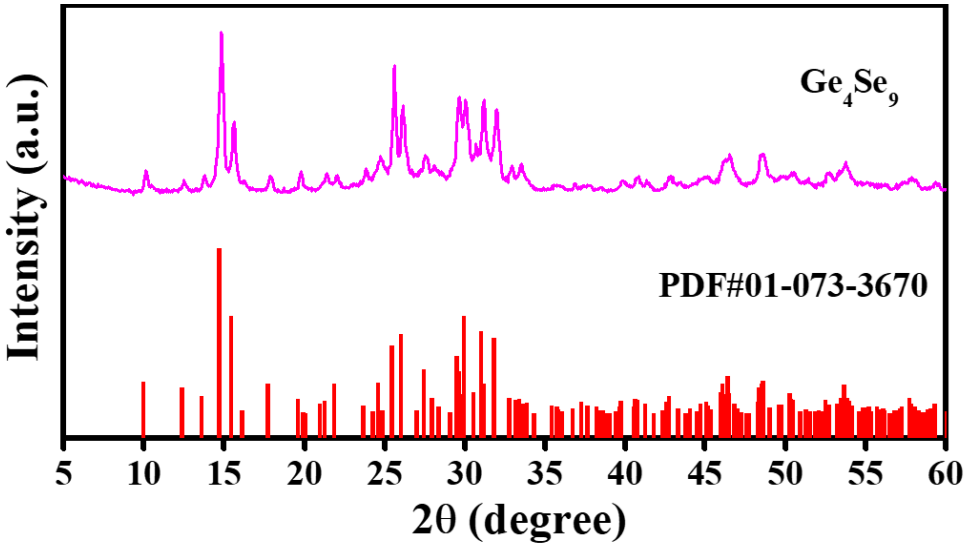

Fig. S1 Powder diffraction pattern for bare Ge_4Se_9 nanoplates.

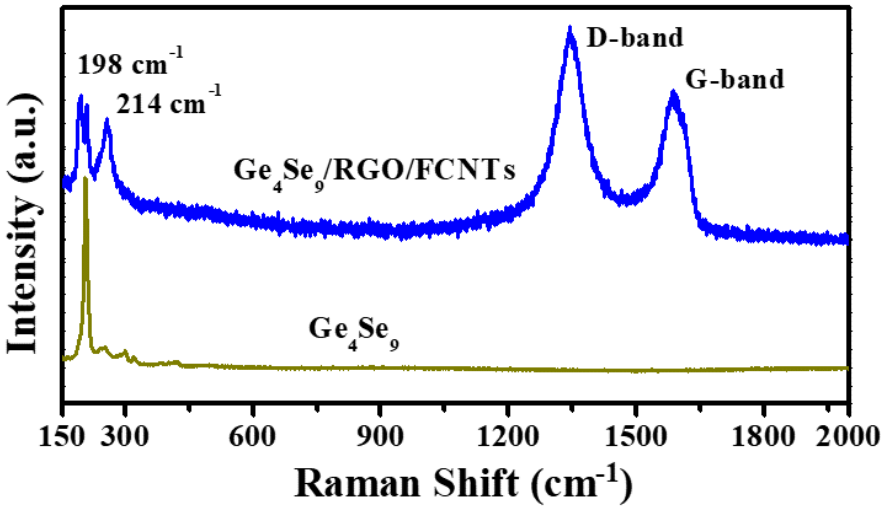

Fig. S2 Raman study for bare Ge_4Se_9 and Ge_4Se_9/RGO/FCNTs hybrids.

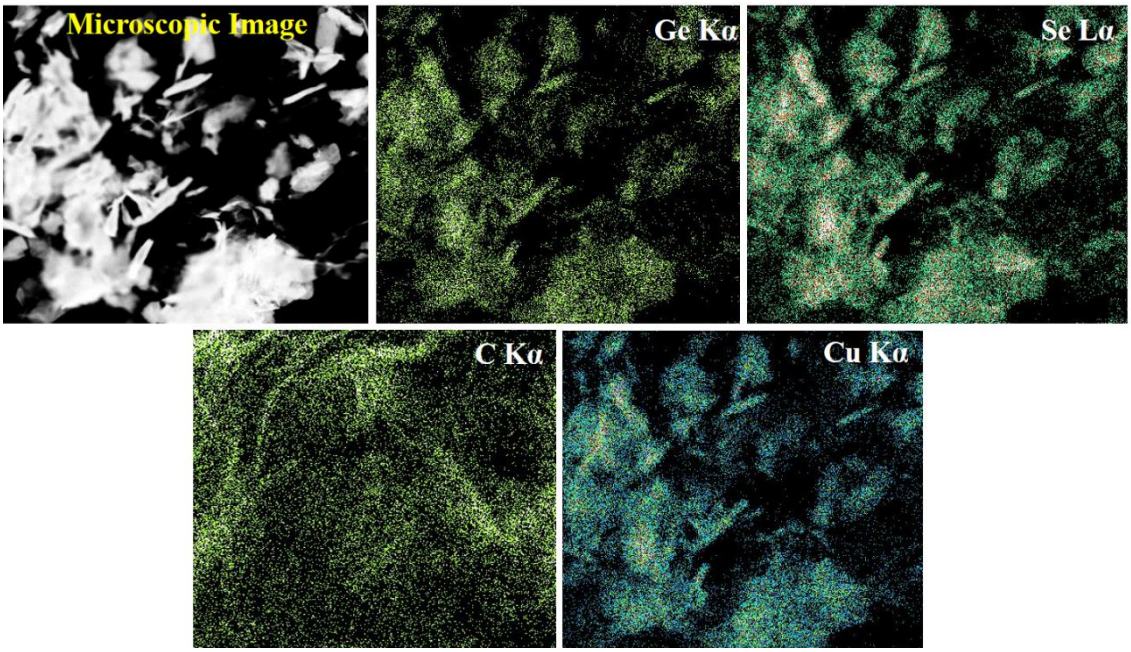

Fig. S3 Elemental mapping for Ge_4Se_9/RGO/FCNTs hybrids.

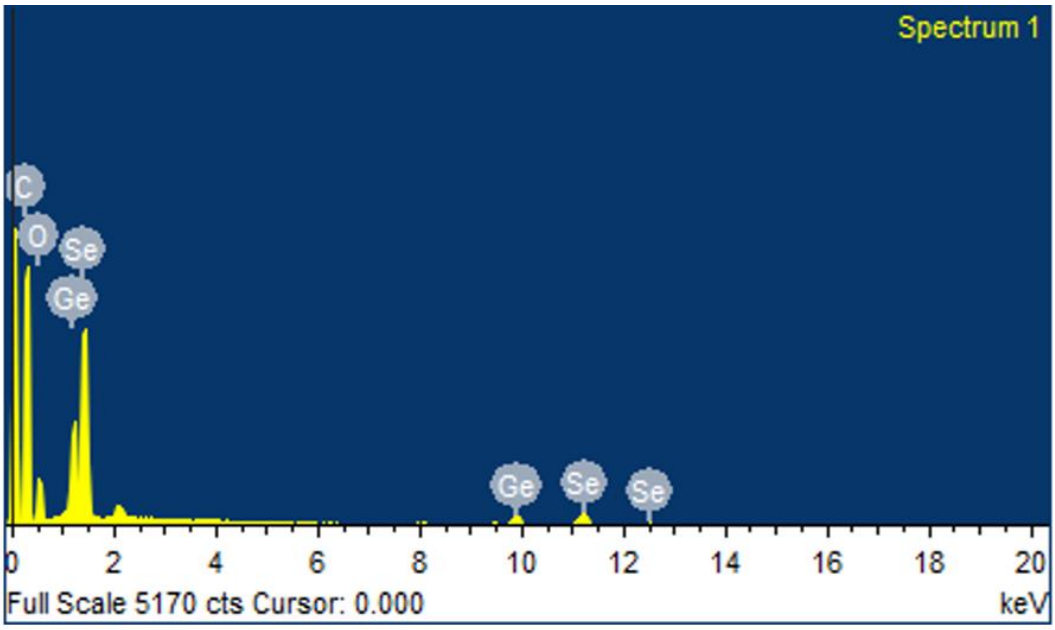

Fig. S4 Energy dispersive spectrum (EDAX) for Ge_4Se_9/RGO/FCNTs hybrids.

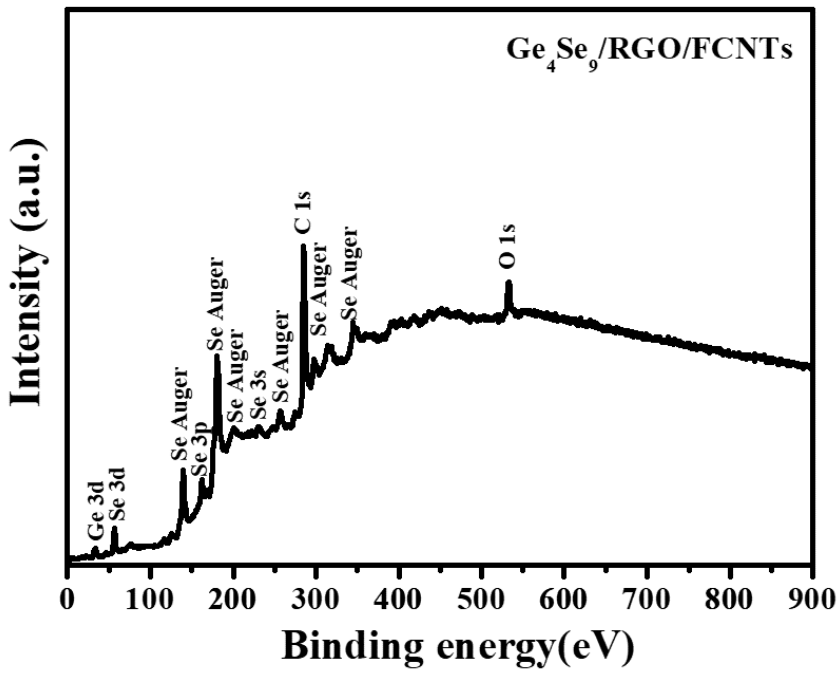

Fig. S5 Full scan XPS survey spectrum of Ge_4Se_9/RGO/FCNTs.

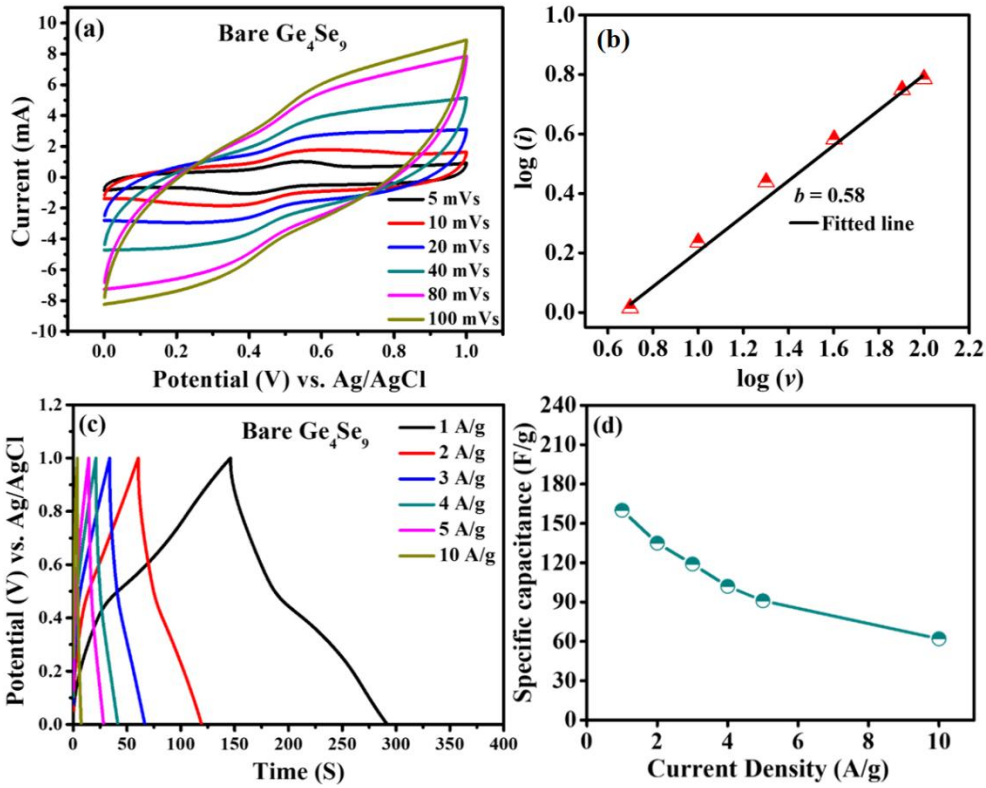

Fig. S6 Cyclic voltammograms of bare Ge_4Se_9 from the scan rates 5-100 mV/s (a), the charge storage mechanism, (b) galvanostatic charge-discharge plot (c), and the C_{sp} vs current density for bare material (d).

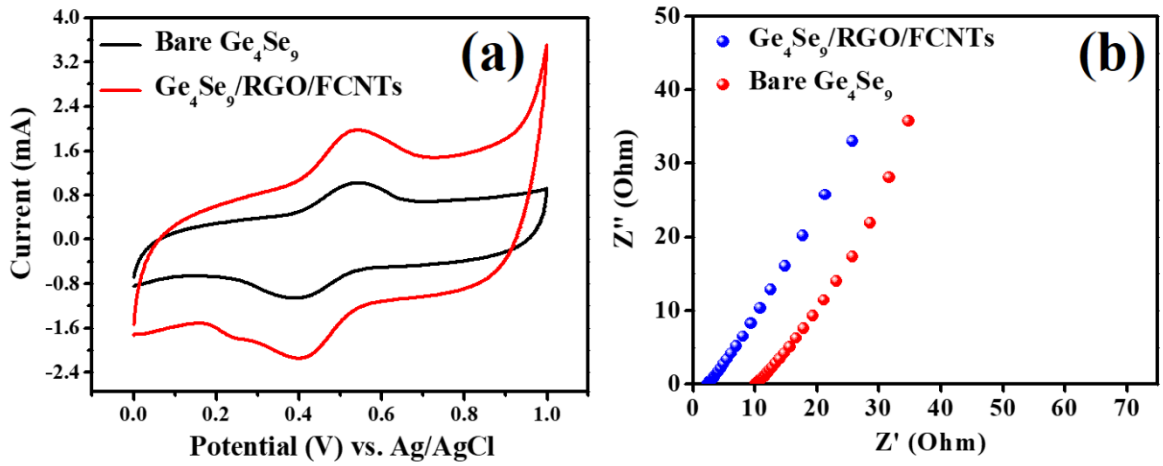

Fig. S7 Comparison plots of CVs (a) and Nyquist diagram of bare Ge_4Se_9 and Ge_4Se_9/RGO/FCNTs hybrids (b).

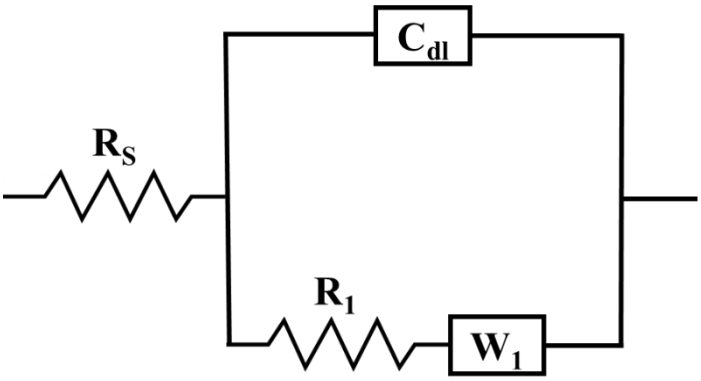

Fig. S8 Corresponding equivalent circuit models for all the relevant cases of impedance analyses.

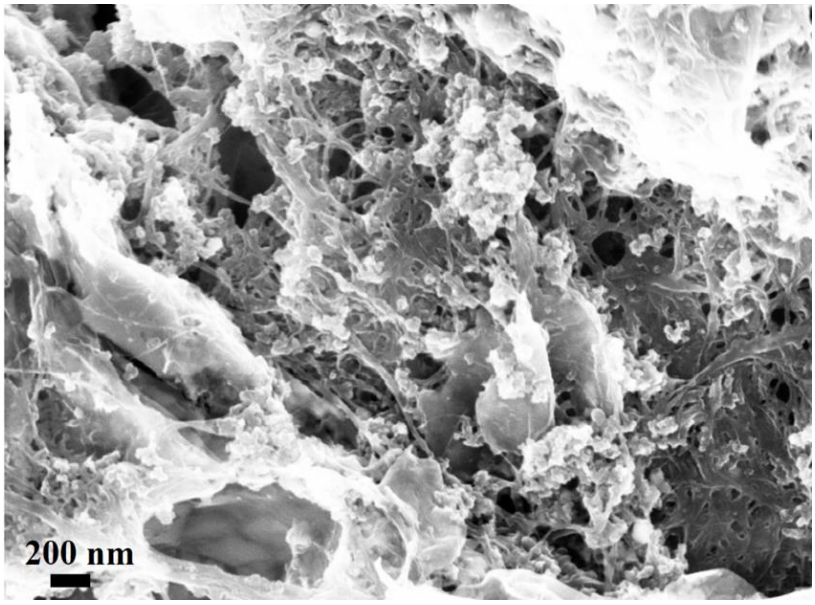

Fig. S9 Post-stability SEM images of the Ge_4Se_9/RGO/FCNTs after the cyclic test of the ASC device.

Table S1 The values of the individual elements (R_s, R1, C_{dl}, W1) in the equivalent circuit model of the impedance data.

Sample name	R_s (Equivalent series resistance)	R_1 (Charge-transfer resistance)	C_{dl} (Double-layer capacitance)	W_1 (Warburg Impedance)
Bare Ge_4Se_9	10.16	0.24	55×10^{-6}	19.16
Ge_4Se_9/RGO/FCNTs	2.41	0.04	0.36×10^{-3}	9.65

Table S2. Electrochemical energy storage comparison of Ge_4Se_9/RGO/FCNTs hybrid with the previously reported literature.

Electrode material	**Specific capacitance [F g^{-1}] (Three electrodes)**	**Specific capacitance of ASC [F g^{-1}]**	**Energy density [Wh/kg]**	**Power density [W/kg]**	**Repeated Cyclic number for stability**	**References**
3D-$GeSe_2$	300				2000	1
SnSe NSs	228				1000	2
2H MoS_2/MWCNT// VSe_2/MWCNT	274.63 (symmetric device)	118.23	32.18	1121.72	5000	3
WSe_2/GR	389		34.5	400	3000	4
2D–2D $MoSe_2$/ graphene nanohybrid		75	26.6	800	3000	5
Ni_3S_2/d-Ti_3C_2/ NF//AC HSC		66.5	23.6	4004.4	5000	6
VSe_2/MXene//MoS_2/ MWCNT	140 (symmetric device)		42	2316	5000	7
NiCoS/d-Ti_3C_2//AC	758.9 C/g		22.6	4000	10000	8
Ge_4Se_9/RGO/FCNTs //MXene	**440 (Three electrodes)**	**102**	**32 (device)**	**1071 (device)**	**5000 at 2.5 A/g**	**This work**

Table S3 Comparison of all the parameters related to specific energy and power calculations.

Active material	Active mass loading (mg)	Current Density (A/g)	Specific capacitance (C_{sp}, F/g)	Energy Density (Wh/kg)	Power Density (W/kg)
Pristine Ge_4Se_9 **(Three electrode)**	1	1	160	22.22	552
Ge_4Se_9/RGO/FCNTs **(Three electrode)**	1	1	440	61.2	588
Ge_4Se_9/RGO/FCNTs// MXene **(ASC Device)**	1.5	1	102	32	1071

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