Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting information

Se vacancies-driven nickel cobalt selenides electrode for boosting supercapacitive performance

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Supplementary Figure

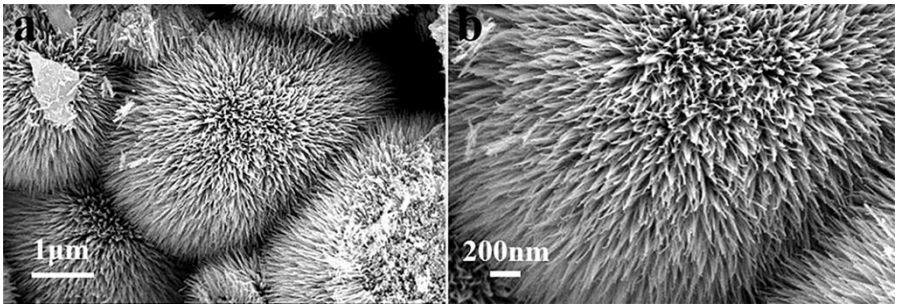

Fig. S1. SEM images of the (a-b) NiCo precursor.

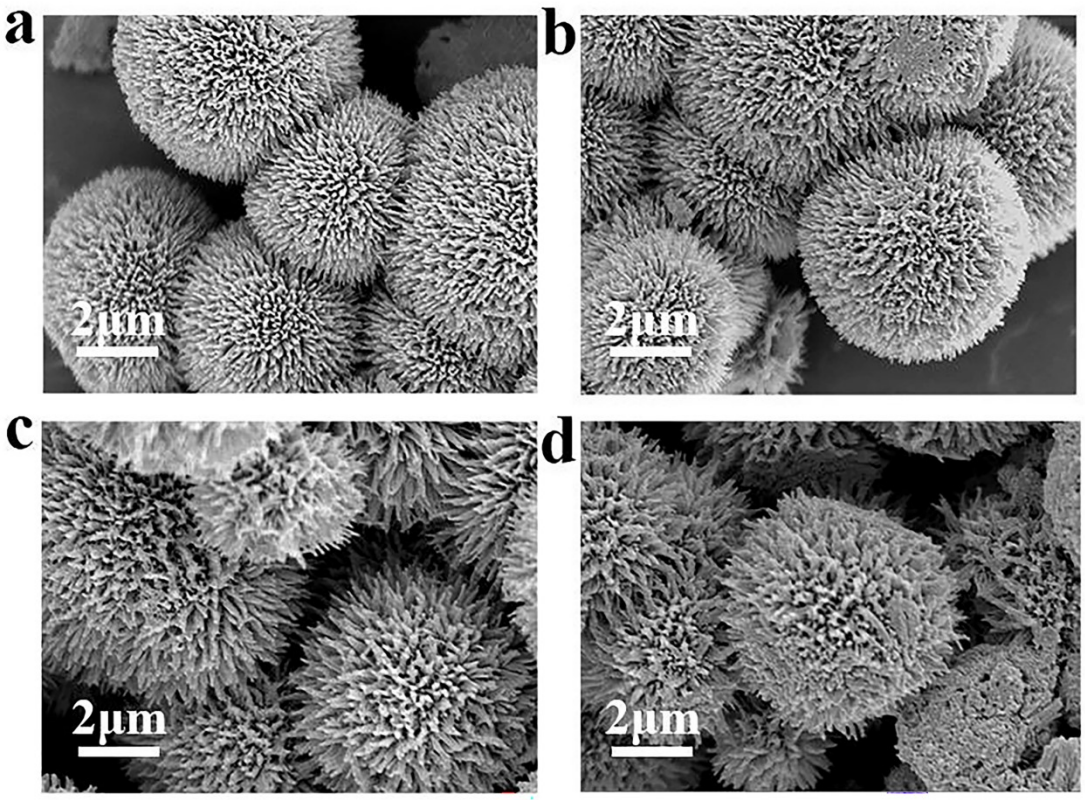

Fig. S2. SEM images of (a) $V_{0.5}$-$NiCo_2Se_x$, (b) V_1-$NiCo_2Se_x$, (c) $V_{1.5}$-$NiCo_2Se_x$, (d) $V_{2.5}$-$NiCo_2Se_x$.

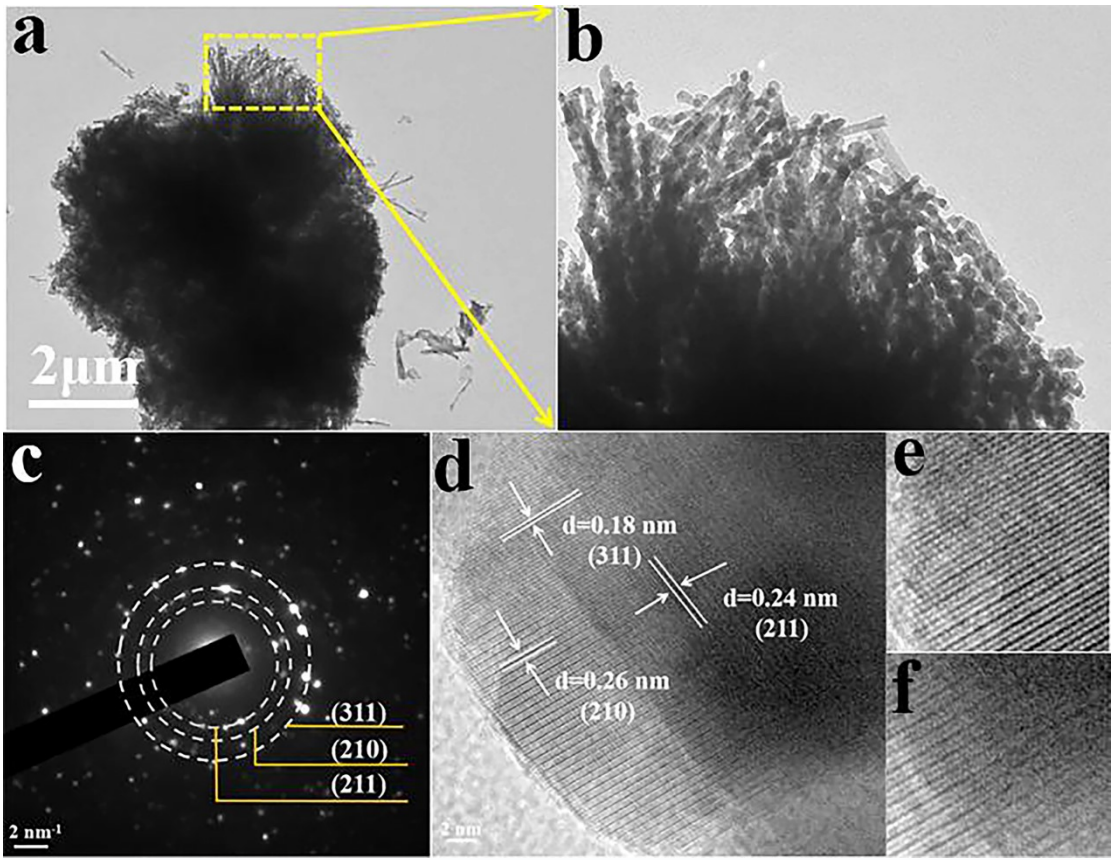

Fig. S3. (a-b) TEM images, (c) SAED images, (d-f) HRTEM images of the Pure-$NiCo_2Se_4$.

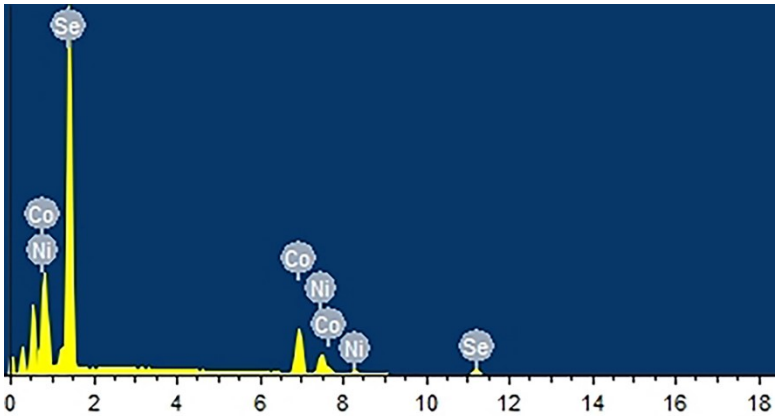

Fig. S4. Elemental analysis results from energy dispersive spectrometer in scanning electron microscopy (SEM-EDS) spectrum of V_2-$NiCo_2Se_x$.

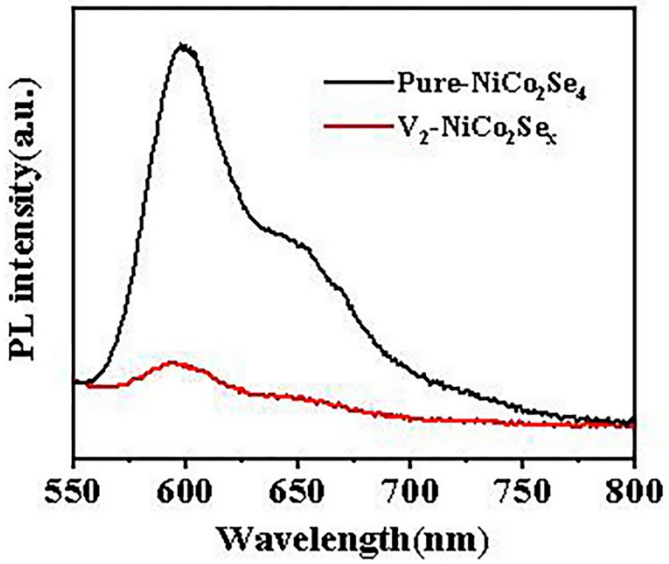

Fig. S5. PL spectras of Pure-$NiCo_2Se_4$ and V_2-$NiCo_2Se_x$.

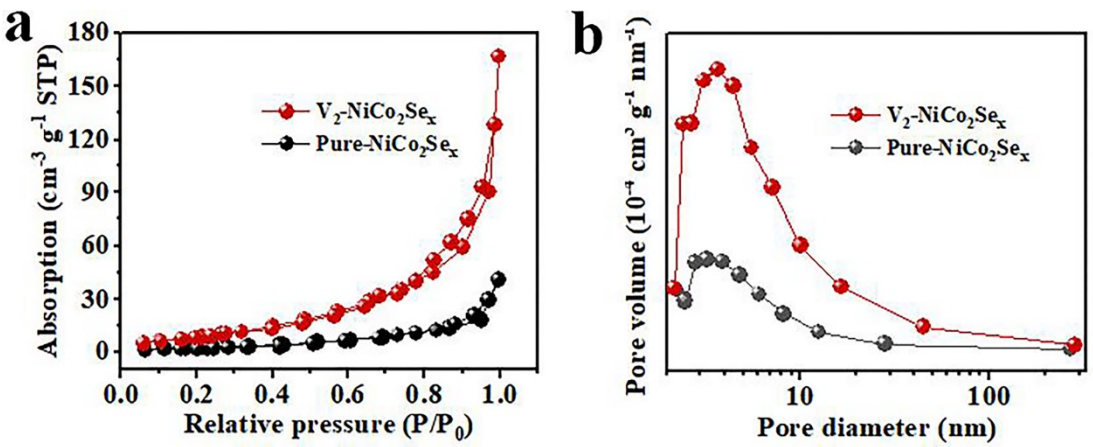

Fig. S6. (a) N_2 adsorption/desorption isotherm, (b) pore size distribution of Pure-$NiCo_2Se_4$ and V_2-$NiCo_2Se_x$.

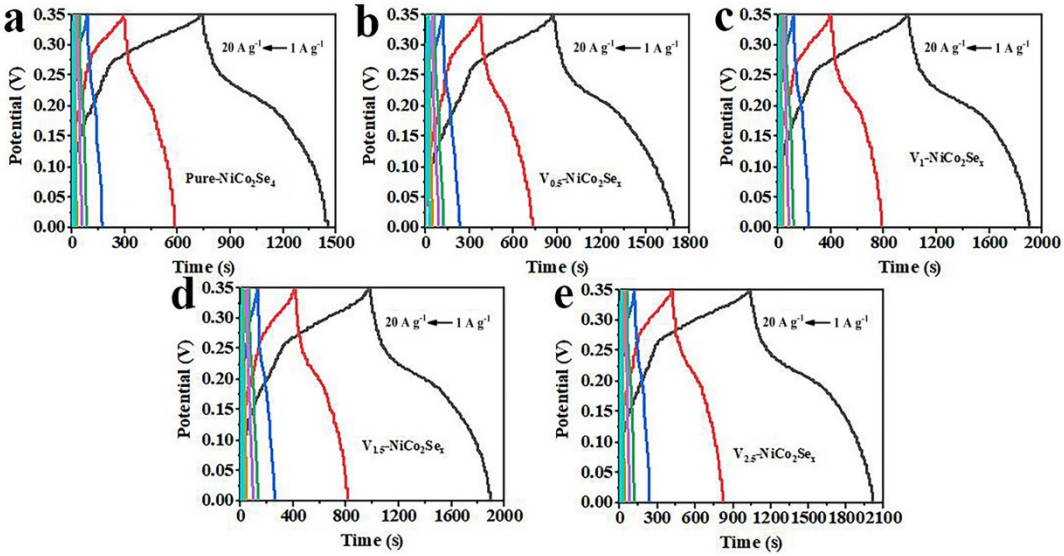

Fig. S7. GCD curves of (a) Pure-$NiCo_2Se_4$, (b) $V_{0.5}$-$NiCo_2Se_x$, (c) V_1-$NiCo_2Se_x$, (d) $V_{1.5}$-$NiCo_2Se_x$ and (e) $V_{2.5}$-$NiCo_2Se_x$ under different current densities

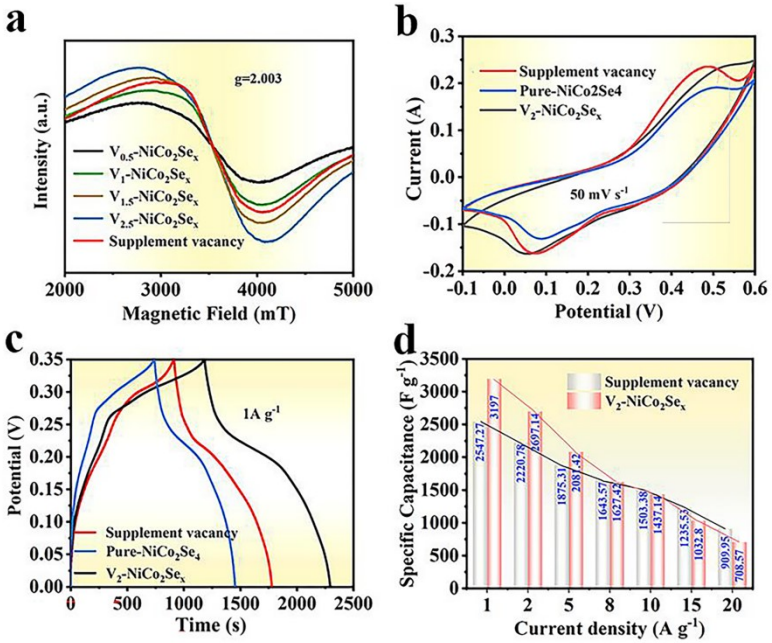

Fig. S8. (a) EPR spectra of vacancy supplement material and $V_{0.5}$-$NiCo_2Se_x$, V_1-$NiCo_2Se_x$, $V_{1.5}$-$NiCo_2Se_x$ and $V_{2.5}$-$NiCo_2Se_x$, (b) CV curves of vacancy supplement material and Pure-$NiCo_2Se_4$ and V_2-$NiCo_2Se_x$. (c) GCD curve comparison of vacancy supplement material and Pure-$NiCo_2Se_4$ and V_2-$NiCo_2Se_x$, (d) specific capacity of vacancy supplement material and V_2-$NiCo_2Se_x$ as a function of current density.

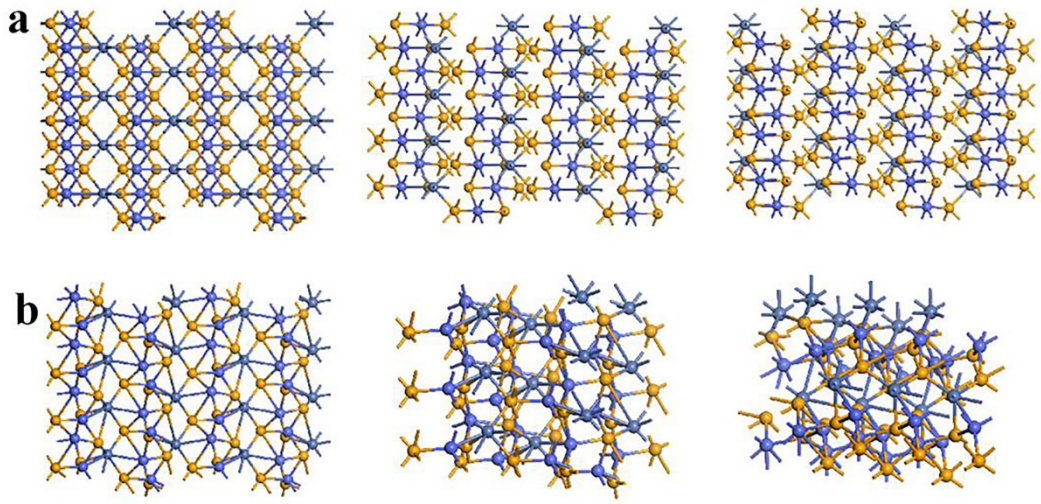

Fig. S9. Crystal structure optimization of (a) Pure-$NiCo_2Se_4$ and (b) V_2-$NiCo_2Se_x$.

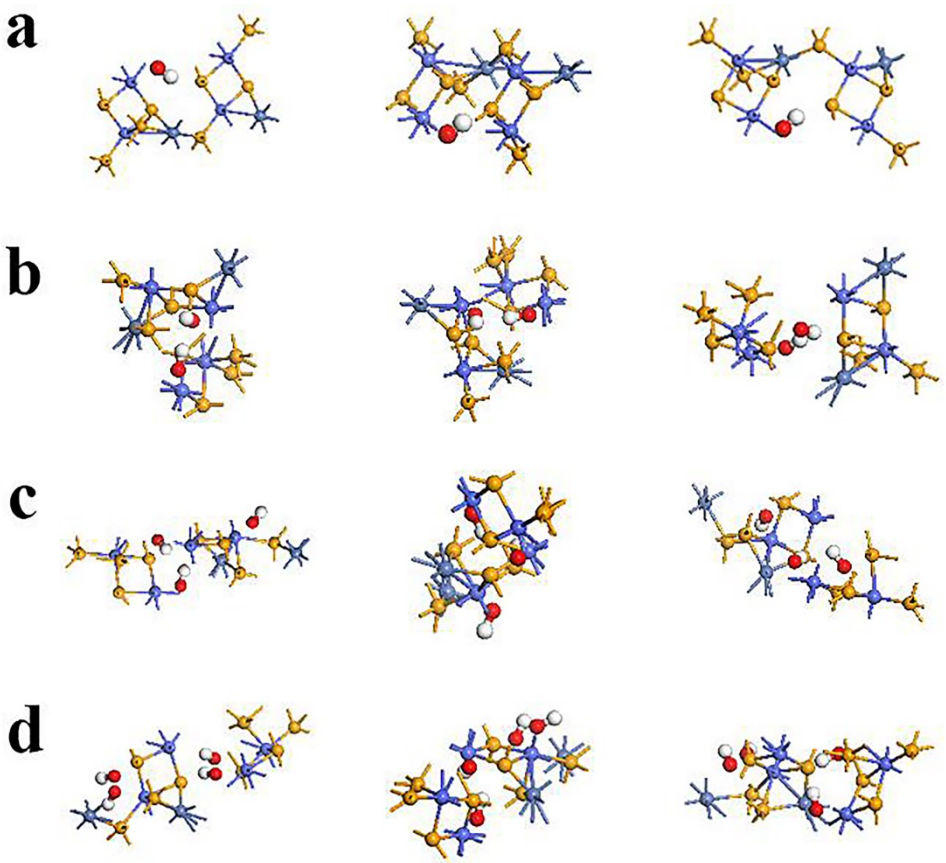

Fig. S10. Pure-$NiCo_2Se_4$ adsorption (a) one OH^-, (b) two OH^-, (b) three OH^-, (b) four OH^- structure diagram.

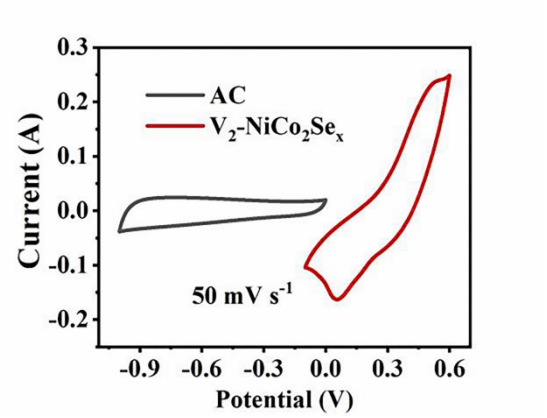

Fig. S11. Comparison of CV curves of AC electrode and V_2-$NiCo_2Se_x$ electrode at 50 mV s^{-1} scanning rate.

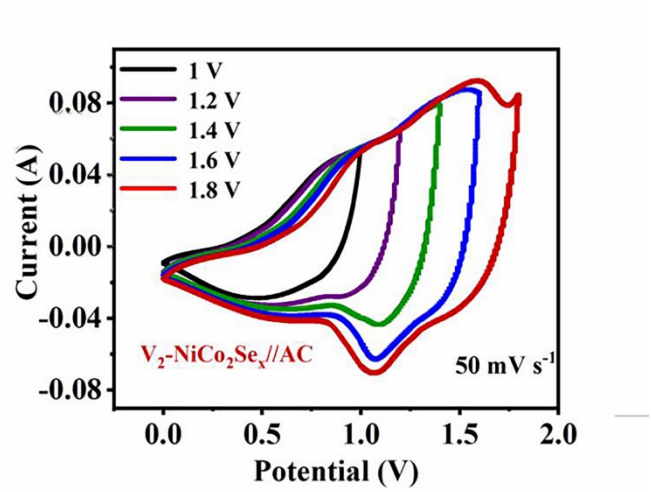

Fig. S12. CV curves for different voltage windows at a scan rate of 50 mV s^{-1}.

Supplementary Table

Table S1. EDS element contents of Pure-$NiCo_2Se_4$ and V_a-$NiCo_2Se_x$.

Electrode material	Ni (Atomic)	Co (Atomic)	Se (Atomic)
Pure-$NiCo_2Se_4$	**14.05%**	**26.02%**	**59.93%**
$V_{0.5}$-$NiCo_2Se_x$	**15.31%**	**27.17%**	**57.52%**
V_1-$NiCo_2Se_x$	**16.11%**	**30.36%**	**53.53%**
$V_{1.5}$-$NiCo_2Se_x$	**16.89%**	**31.12%**	**51.99%**
V_2-$NiCo_2Se_x$	**16.95%**	**32.68%**	**50.37%**
$V_{2.5}$-$NiCo_2Se_x$	**17.11%**	**33.19%**	**49.70%**

Table S2. Percentage contents of Ni^{2+}/Ni^{3+}, Co^{2+}/Co^{3+} and Se $3d_{3/2}$/Se $3d_{5/2}$ by Pure-$NiCo_2Se_x$ and V_a-$NiCo_2Se_x$.

Material	Co^{2+}/Co^{3+}	Ni^{2+}/Ni^{3+}	Se $3d_{3/2}$/Se $3d_{5/2}$
Pure-$NiCo_2Se_x$	**0.4605**	**0.6677**	**1.2970**
$V_{0.5}$-$NiCo_2Se_x$	**2.2784**	**0.2661**	**1.4429**
V_1-$NiCo_2Se_x$	**2.4176**	**0.1926**	**2.1350**
$V_{1.5}$-$NiCo_2Se_x$	**4.2671**	**0.1407**	**2.4004**
V_2-$NiCo_2Se_x$	**6.3225**	**0.1276**	**3.2127**
$V_{2.5}$-$NiCo_2Se_x$	**9.6260**	**0.04**	**5.0889**

Table S3. Power density and energy density comparison of V_2-$NiCo_2Se_x$ with recently reported Ni/Co-based electrode materials.

Supercapacitor device	Energy density (Wh kg^{-1})	Power density (W kg^{-1})	Reference
Ni_2Co_4Se//HPC	34.8	399.9	1
$CoSe_2$/$NiSe_2$//AC	27.8	750.0	2
$(Ni_{0.33}Co_{0.67})Se_2$ CHSs//AC	29.1	800	3
NiCoSe//AC	16	750	4
$Ni_{0.67}Co_{0.33}Se$//RGO	36.7	750	5
$NiCo_2Se_4$/MXene//AC	22.4	800	6
Ni-Co-Se//AC	38.5	802.1	7
$(Ni_{0.5}Co_{0.5})_{0.85}Se$//carbon	70.58	320.02	8
$NiCoSe_2$//AC	44.4	776.7	9
V_2-$NiCo_2Se_x$//AC	76.45	800.06	This work
	39.48	16030.14	

References

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