Interfaces engineering in $NiSe_2/Ni_2Co/CoSe_2$ heterostructures encapsulated in hollow carbon shell for high-rate Li-Se batteries

Yuqing Cao[a], Feifei Lei[a], Yunliang Li[a], Yifang Fu[a], Jun Zhao[a], Shilun Qiu[a] and Zongtao Zhang[a]*

[a] *State Key Laboratory of Inorganic Synthesis and Preparative Chemistry, College of Chemistry, Jilin University, Changchun 130012, China.*

**Corresponding author. E-mail: zzhang@jlu.edu.cn (Z. Zhang)*

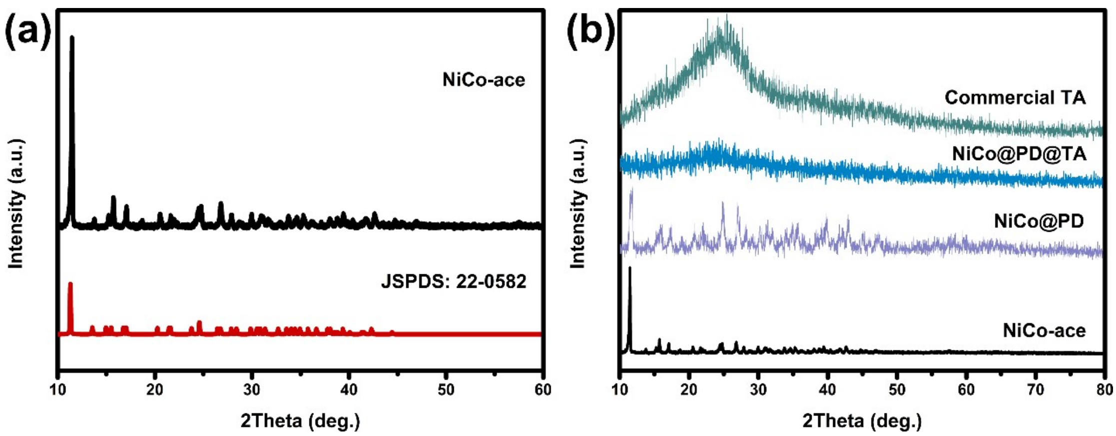

Fig. S1 XRD patterns of (a) precursor NiCo-ace and (b) intermediate products NiCo-ace@PD and NiCo@PD@TA.

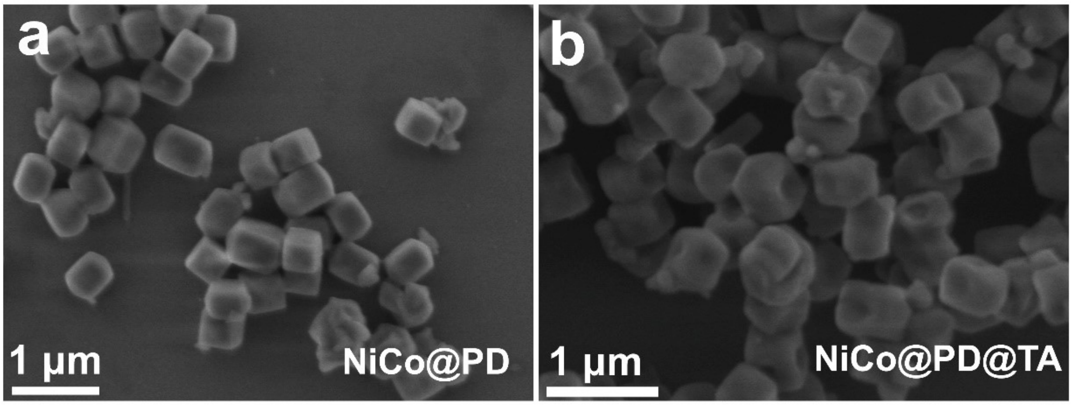

Fig. S2 SEM images of intermediates (a) NiCo@PD and NiCo@PD@TA.

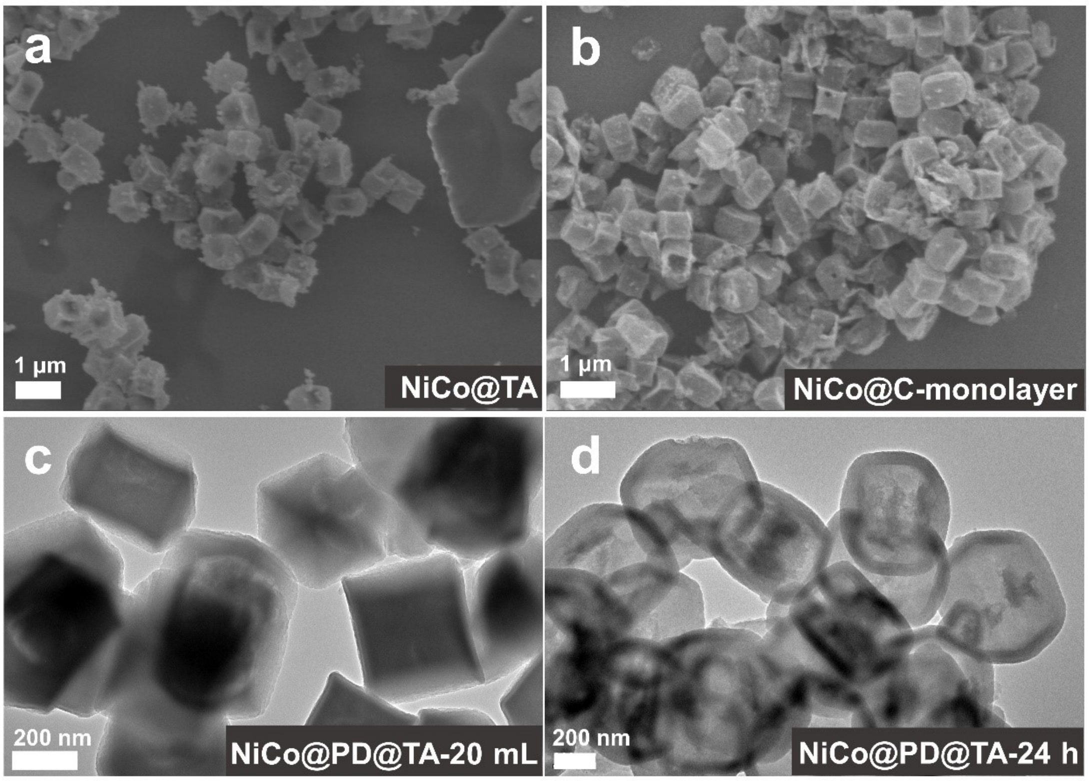

Fig. S3 SEM images of contrast samples (a) NiCo@TA without PD layer and (b) corresponding carbonized product NiCo@C-monolayer, (c) NiCo@PD@TA-20 mL, (d) NiCo@PD@TA-24 h.

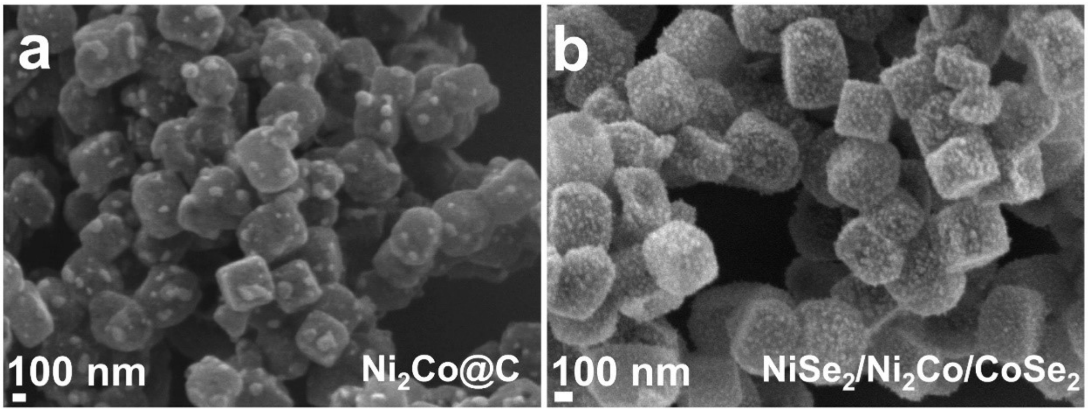

Fig. S4 SEM images of (a) Ni_2Co@C and (b) $NiSe_2/Ni_2Co/CoSe_2$.

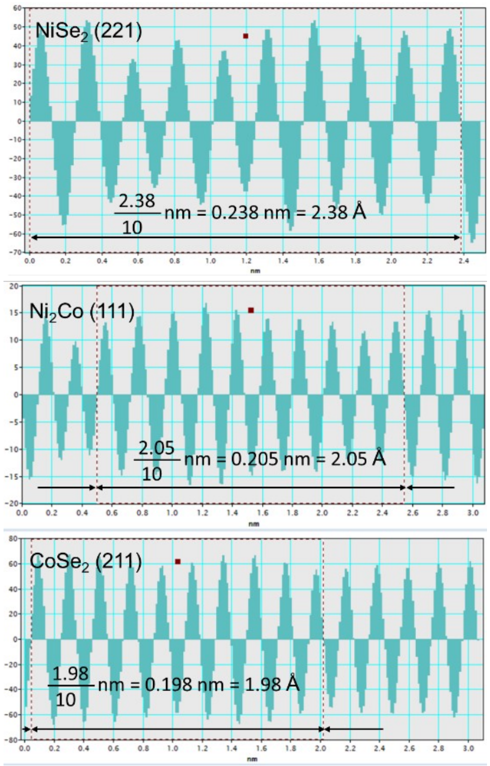

Fig. S5 The profiles of corresponding intensity variations to determine crystal plane spacing in Figure 2c.

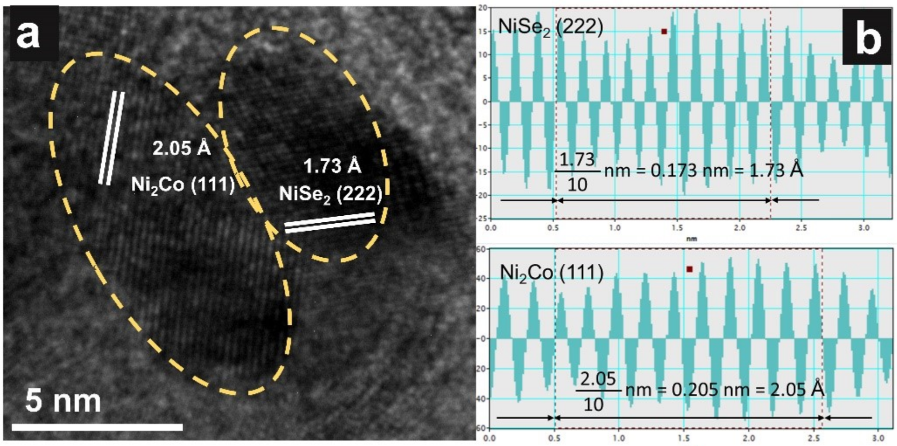

Fig. S6 (a) The heterointerface of Ni_2Co and $NiSe_2$ and (b) the profiles of corresponding intensity variations of crystal plane spacing.

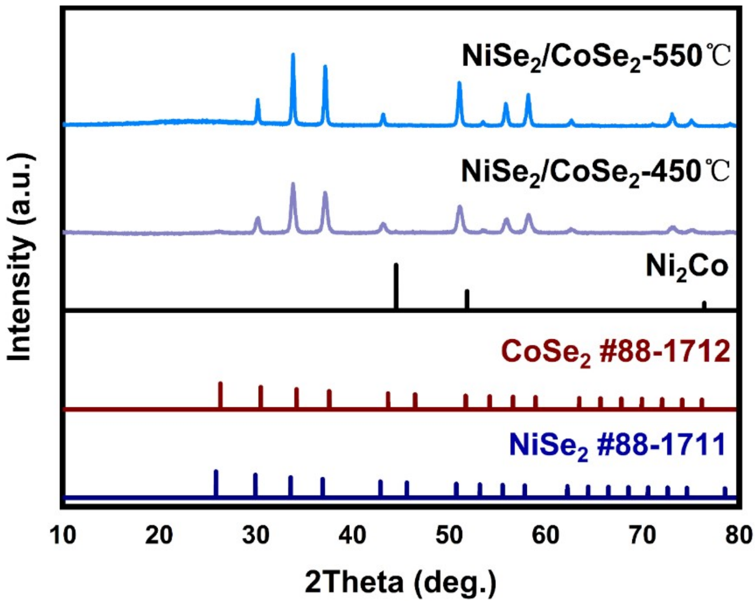

Fig. S7 XRD patterns of contrast samples heterogenous $NiSe_2/CoSe_2$.

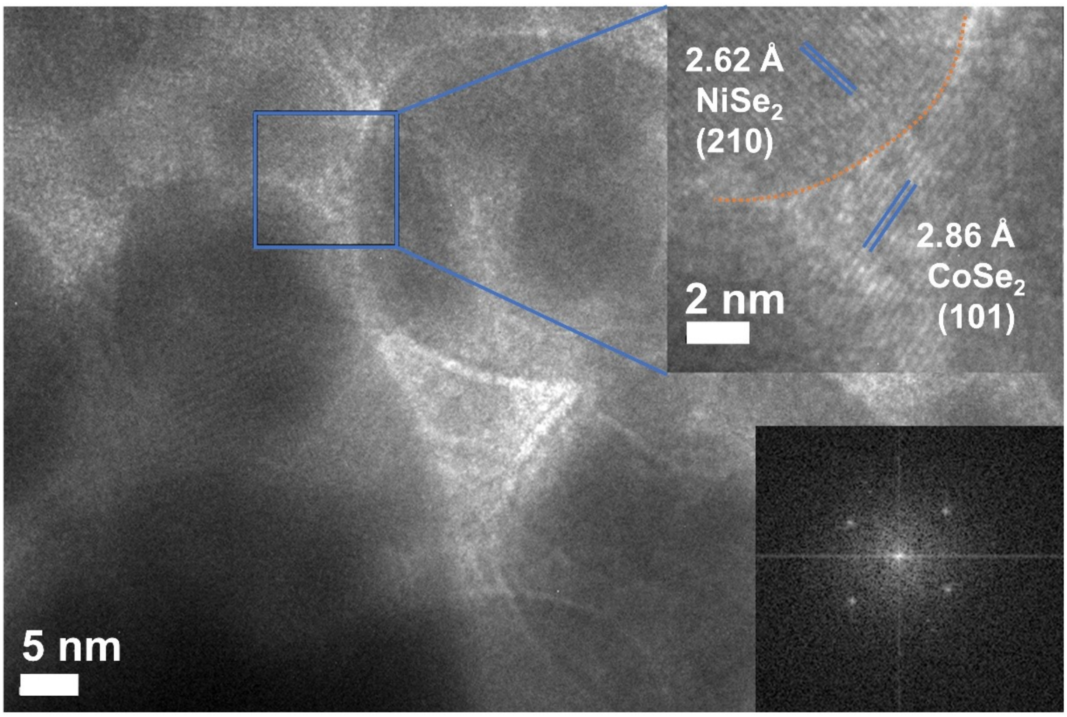

Fig. S8 The HRTEM image of contrast sample $NiSe_2/CoSe_2$ with single heterointerface.

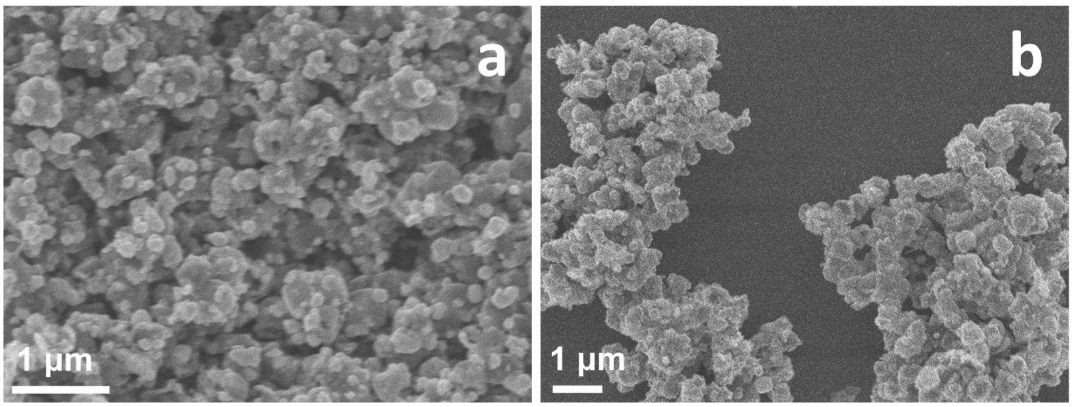

Fig. S9 SEM images of (a) $NiSe_2/CoSe_2$@Se and (b) $NiSe_2/Ni_2Co/CoSe_2$@Se.

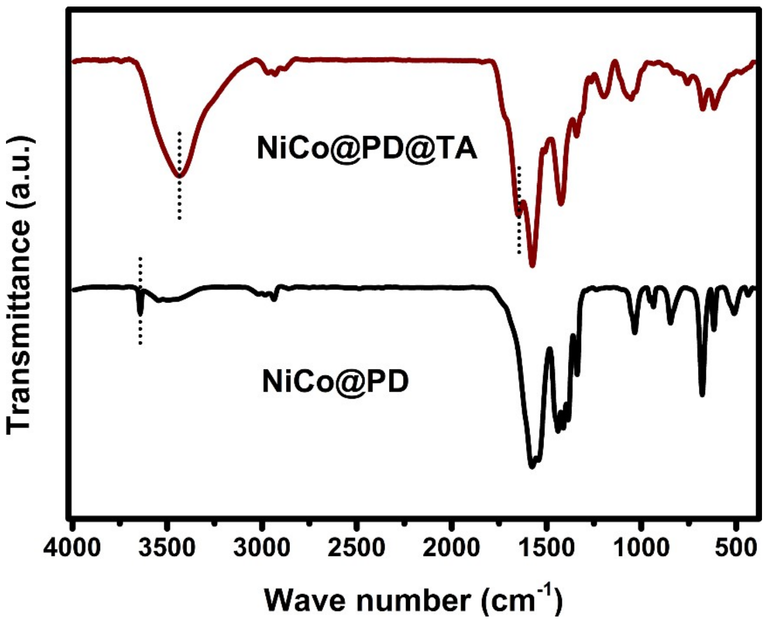

Fig. S10 The FTIR spectra of intermediate products NiCo@PD and NiCo@PD@TA.

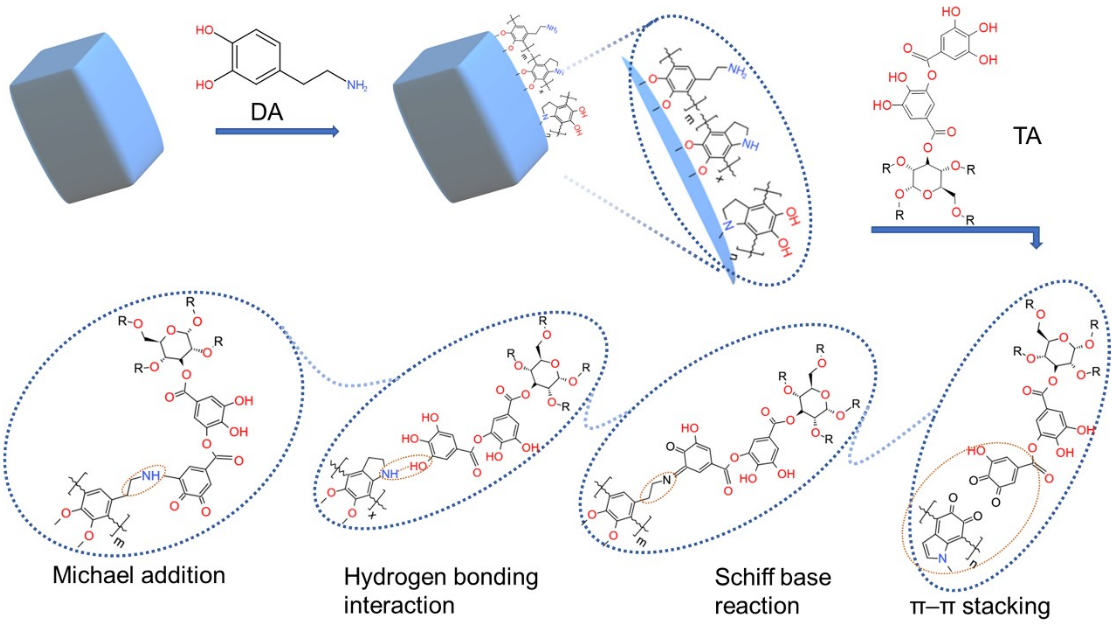

Fig. S11 The schematic illustration of the linking process between PD layer and TA layer with four possible functional group reactions.

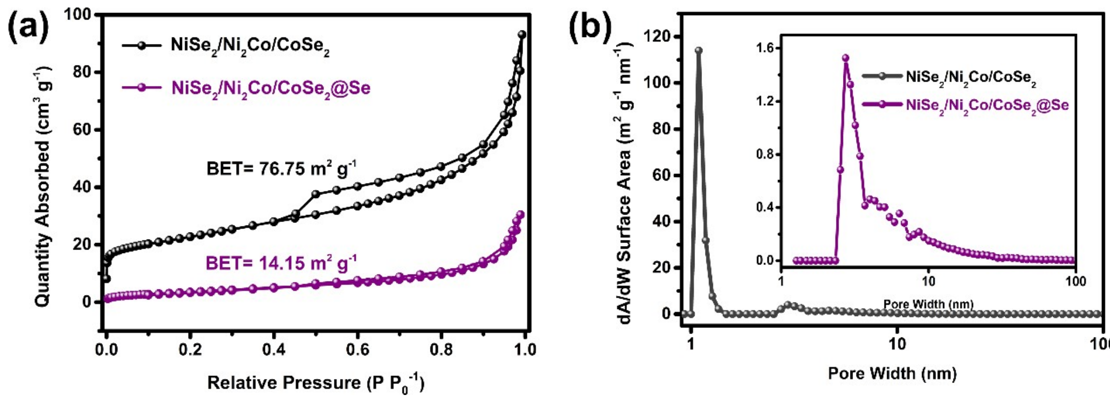

Fig. S12 (a) The nitrogen adsorption–desorption isotherms and (b) the pore size distribution of $NiSe_2/Ni_2Co/CoSe_2$ and $NiSe_2/Ni_2Co/CoSe_2@Se$.

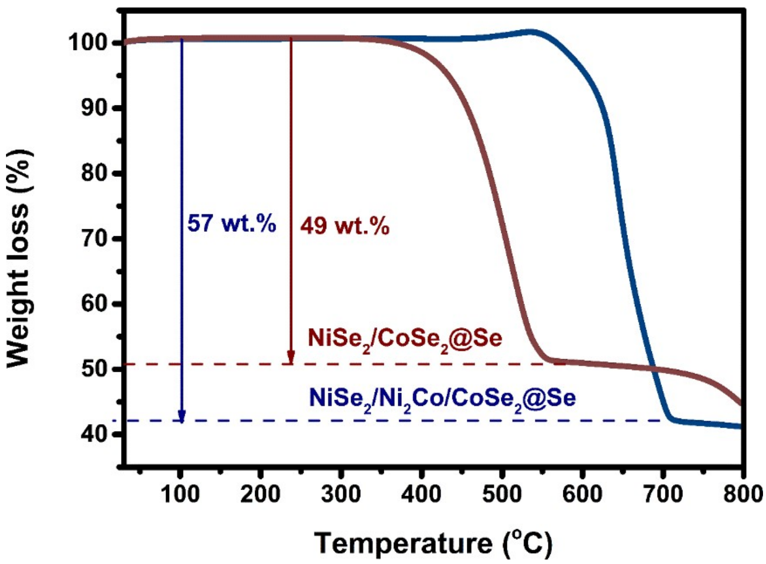

Fig. S13 The TG curves of $NiSe_2/Ni_2Co/CoSe_2@Se$ and $NiSe_2/CoSe_2@Se$ in N_2 atmosphere.

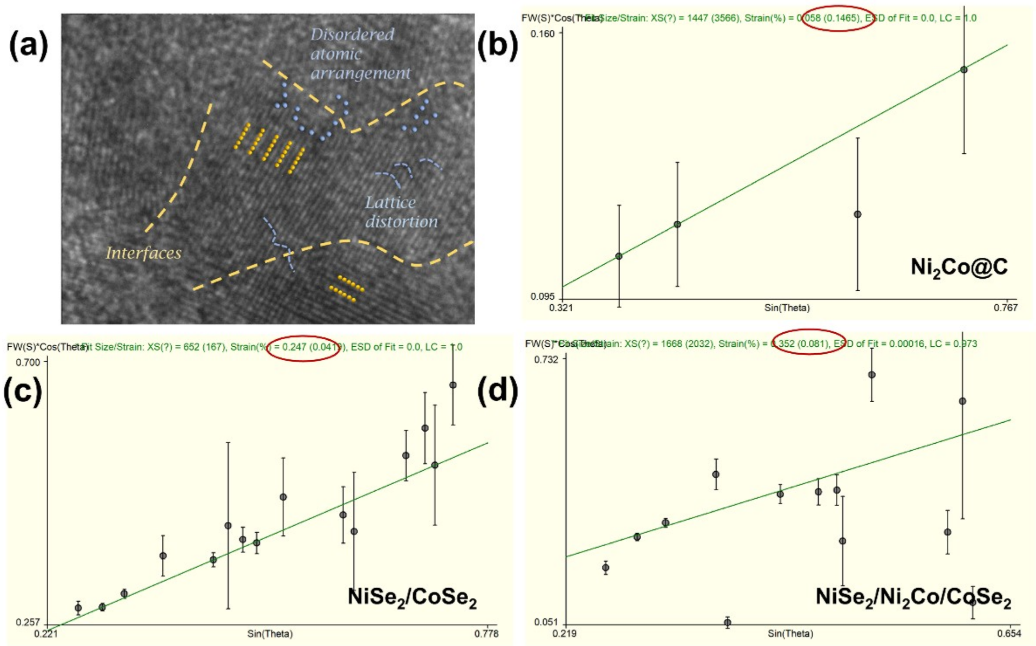

Fig. S14 (a) The scheme of subtle distortion at heterointerfaces. (b-c) Size and strain plots of Ni_2Co@C, $NiSe_2/CoSe_2$ and $NiSe_2/Ni_2Co/CoSe_2$ calculated by XRD Patterns in software MDI Jade 6.

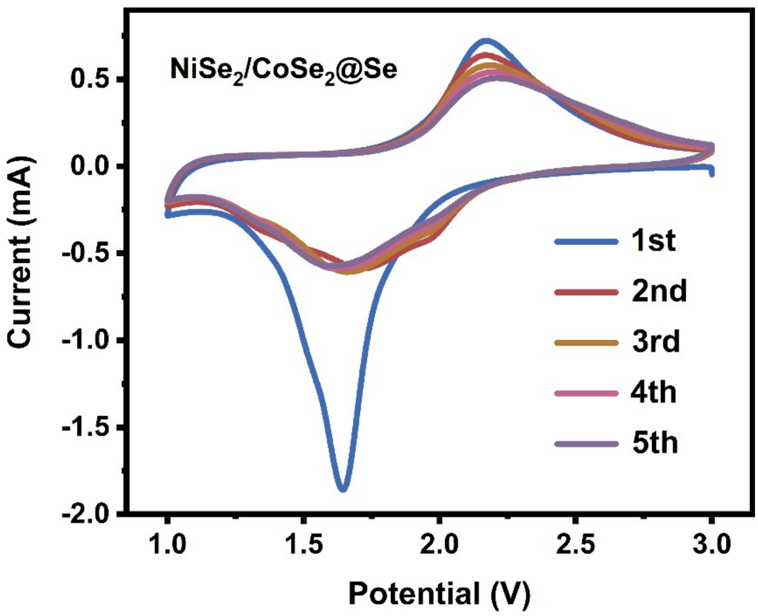

Fig. S15 CV curves of $NiSe_2/CoSe_2$@Se cathode at 0.2 mV s^{-1} in Li-Se batteries.

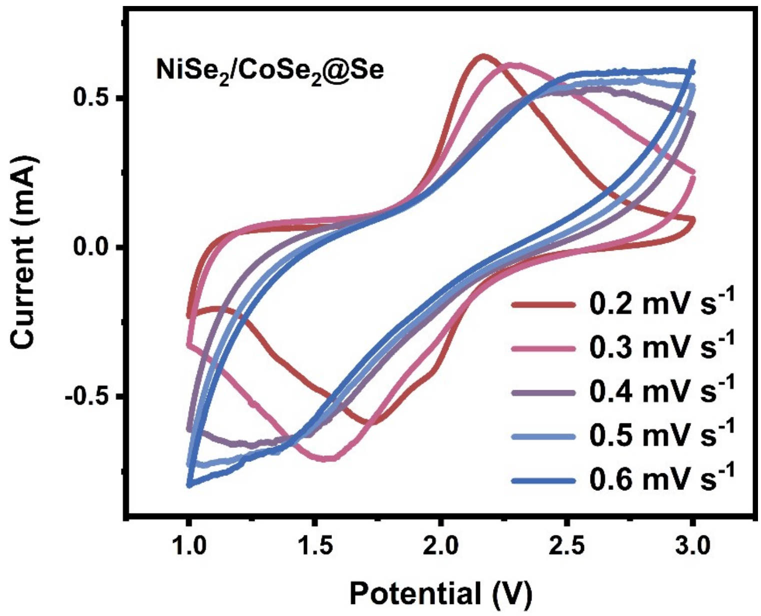

Fig. S16 CV curves of $NiSe_2/CoSe_2$@Se cathode from 0.2 to 0.6 mV s^{-1} in Li-Se batteries.

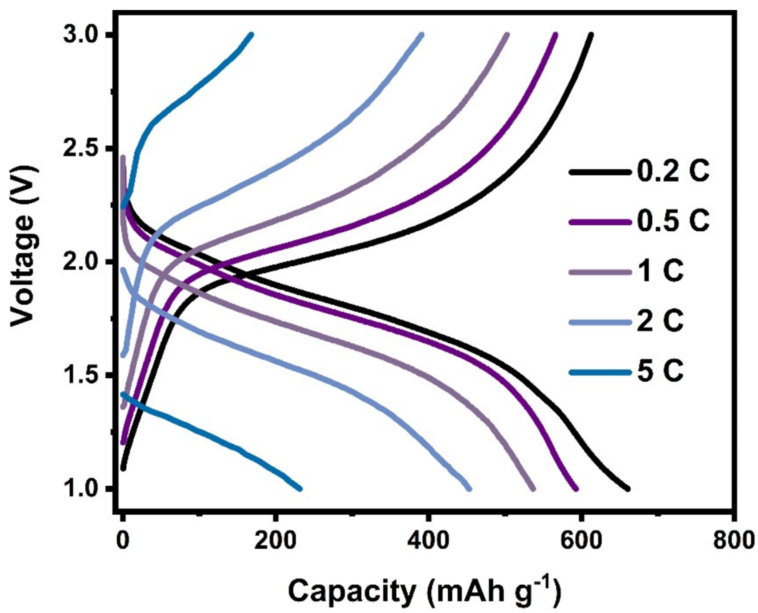

Fig. S17 The galvanostatic charge-discharge curves at 0.2 C of $NiSe_2/Ni_2Co/CoSe_2$@Se.

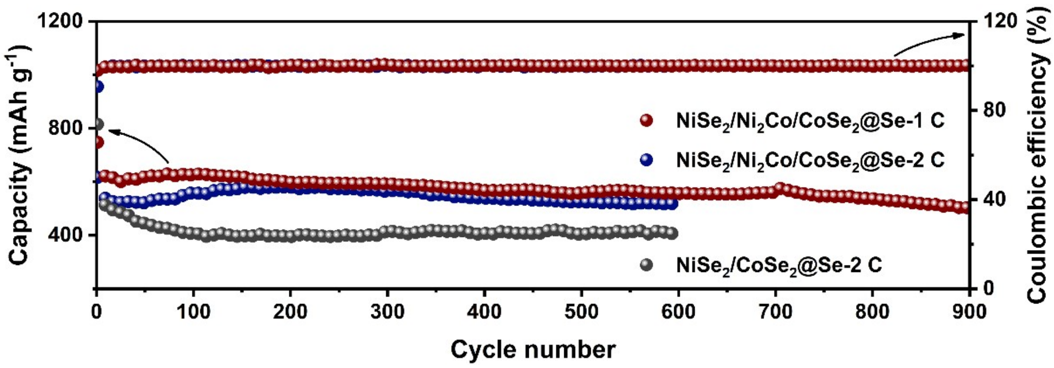

Fig. S18 Cycling performance of $NiSe_2/Ni_2Co/CoSe_2$@Se and $NiSe_2/CoSe_2$@Se (Se loading: 0.9 mg cm^{-2}).

Table S1. Comparison of electrochemical performances of $NiSe_2/Ni_2Co/CoSe_2$@Se with other carbonaceous hosts for Li-Se batteries reported in literatures.

Material	Current density (1C=675mA g^{-1})	Cycle number	Capacity (mAh g^{-1})
Se@$CoSe_2$-PC[1]	1 C	100	408
Se@Co_{SA}-HC[2]	5 C	1500	340
PANI@Se/C-G[3]	2 C	500	528.6
A4-carbon/Se[4]	3 C	2000	343
HPC/Se[5]	2 C	800	451
NS-K-PC/Se[6]	1 C	500	394.2
Se@HHCS[7]	10 C	2000	357
Se/CZIF-5[8]	1 C	700	400
This work	**1 C**	**900**	**503**
	2 C	**600**	**515**
	12 C	**2200**	**324**

References

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