Supporting Information

Niobium Sulfide Nanocomposite as Cathode Materials for All-Solid-State Lithium Batteries with Enhanced Electrochemical Performances

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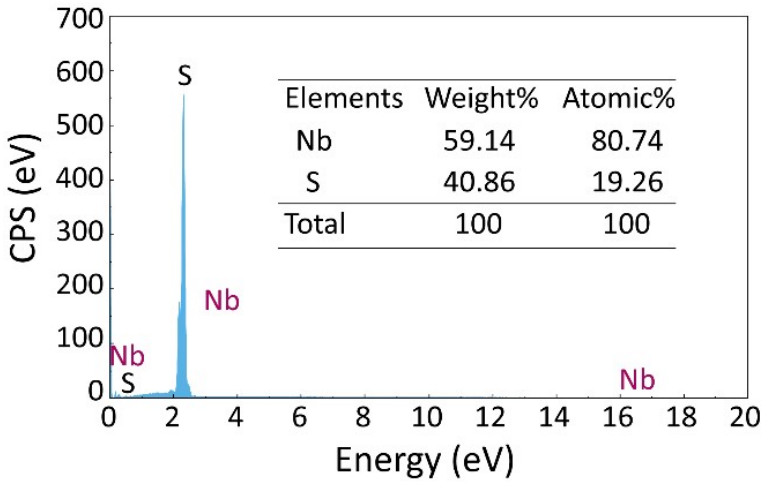

Figure S1. The EDS analysis in SEM and the composition results of NbS_4.

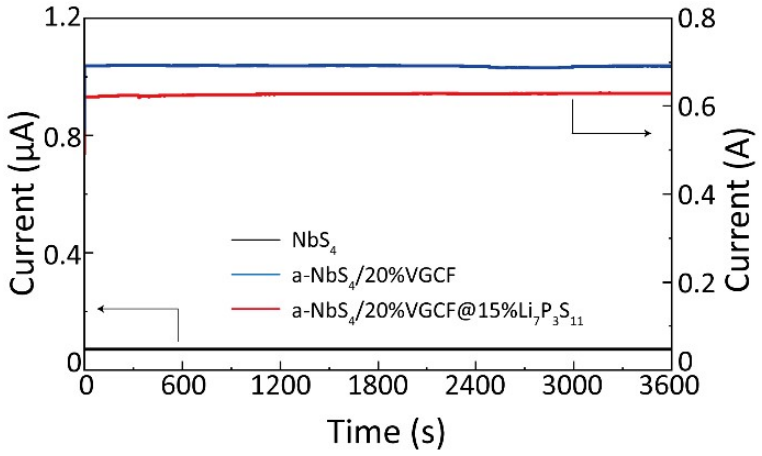

Figure S2. Current-time curves C/NbS_4/C, C/a-NbS_4/20%VGCF/C and C/a-NbS_4/20%VGCF@15%$Li_7P_3S_{11}$/C cells under direct current polarization.

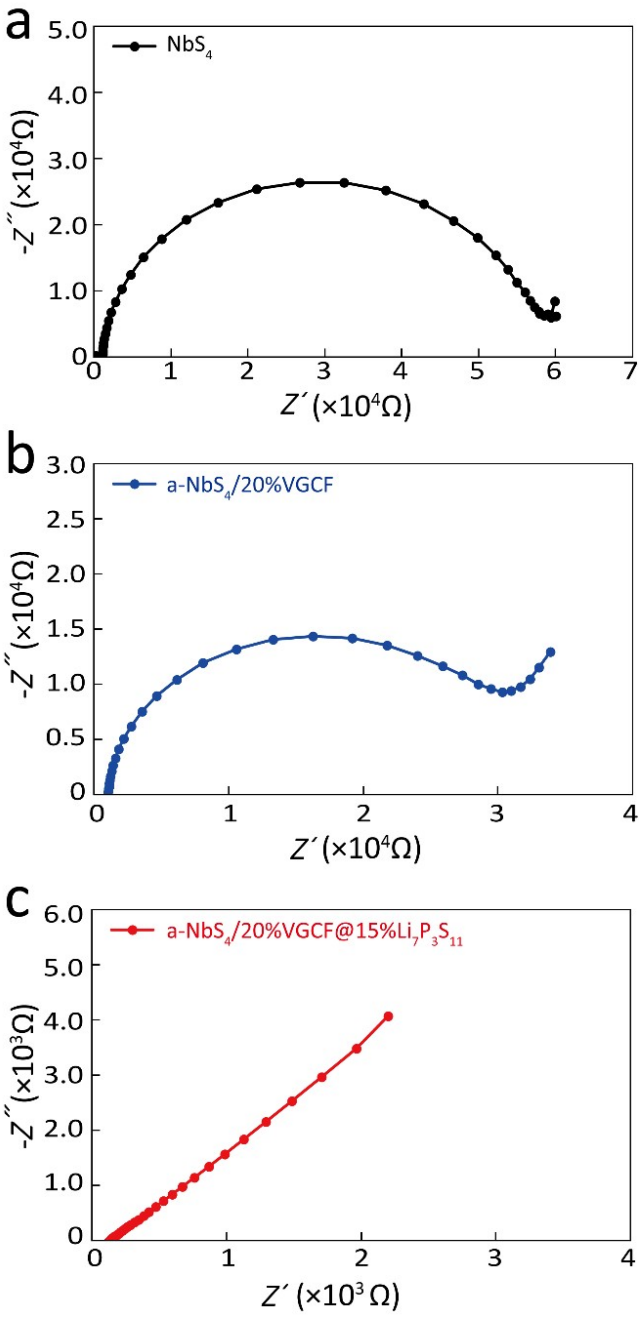

Figure S3. Impedance spectra of the (a) $Li_{10}GeP_2S_{12}/NbS_4/Li_{10}GeP_2S_{12}$, (b) $Li_{10}GeP_2S_{12}$/a-NbS_4/20%VGCF/$Li_{10}GeP_2S_{12}$ and (c) $Li_{10}GeP_2S_{12}$/a-NbS_4/20%VGCF@15%$Li_7P_3S_{11}$/$Li_{10}GeP_2S_{12}$ cells.

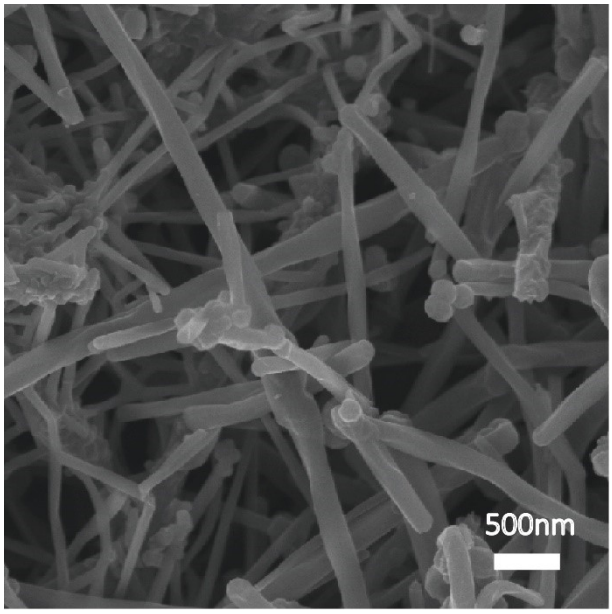

Figure S4. SEM image of VGCF.

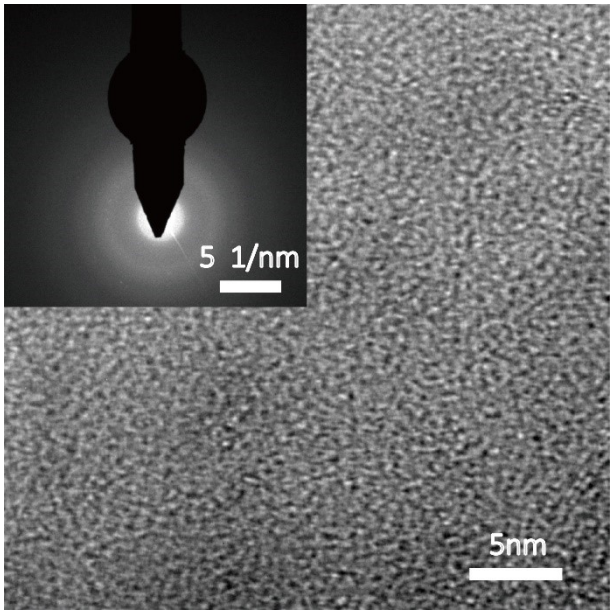

Figure S5. HRTEM image and SAED pattern of a-NbS_4/20%VGCF.

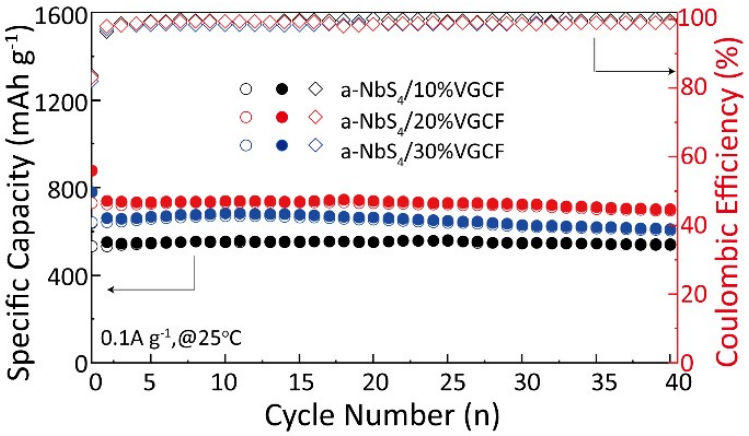

Figure S6. Cyclic performances of a-NbS_4/10%VGCF, a-NbS_4/20%VGCF and a-NbS_4/30%VGCF cathodes at 0.1 A g^{-1}.

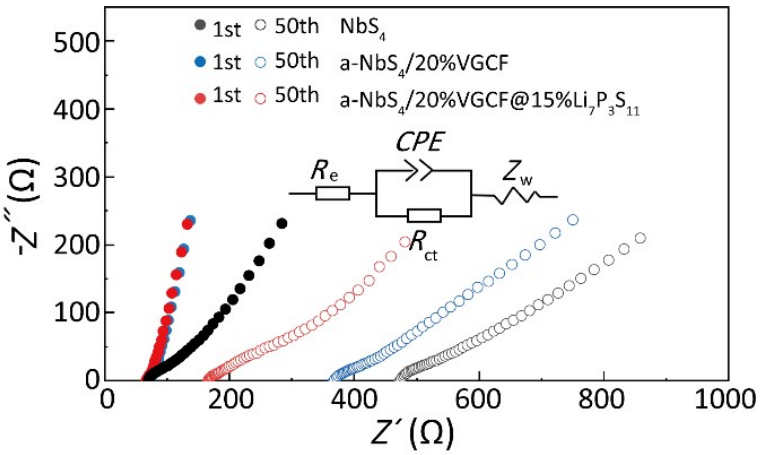

Figure S7. Nyquist plots of NbS_4, a-NbS_4/20%VGCF and a-NbS_4/20%VGCF@15%$Li_7P_3S_{11}$ electrodes cycled at 0.1 A g^{-1} after the 1st and 50th cycles. The inset is the equivalent circuit model.

Table S1. Comparsion of energy densities of commericalized cathode materials with NbS_4.

Material	Theoretical specific capacity (mAh g^{-1})	Actual specific capacity (mAh g^{-1})	Operating voltage (V)	Energy density (Wh Kg^{-1})	Ref.
4.5 V $LiCoO_2$	274	190	4	760	[S1]
$LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$	273~285	210	3.7	777	[S1]
$LiNi_{0.5}Mn_{1.5}O_4$	147	135	4.75	641	[S1]
Li-Rich 300	300~450	300	3.5	1050	[S1]
$LiFePO_4$	170	165	3.45	569	[S2]
$LiMn_2O_4$	148	120	3.7	444	[S3]
NbS_4	970	920.8	~1.8	~1630	This work

Table S2. The fitted results of EIS plots for NbS_4, a-NbS_4/20%VGCF and a-NbS_4/20%VGCF@15%$Li_7P_3S_{11}$ cathodes after 1st and 50th cycles at 0.1 A g^{-1}.

sample	after 1st cycle		after 50th cycle	
	R_e (Ω)	R_{ct} (Ω)	R_e (Ω)	R_{ct} (Ω)
NbS_4	70.10	40.02	476.35	165.19
a-NbS_4/20%VGCF	69.84	/	386.95	131.54
a-NbS_4/20%VGCF@15%$Li_7P_3S_{11}$	66.33	/	164.31	58.68

References

S1 W. Li, H. Xu, Q. Yang, J. Li, Z. Zhang, S. Wang, J. Peng, B. Zhang, X. Chen, Z. Zhang, M. Yang, Y. Zhao, Y. Geng, W. Huang, Z. Ding, L. Zhang, Q. Tian, H. Yu and H. Li, *Energy Storage Science and Technology*, 2020, **9**, 448-478.

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