Supporting information

Synthesis of V-MoS_2 Layered Alloys as Stable Li-ion Battery Anodes

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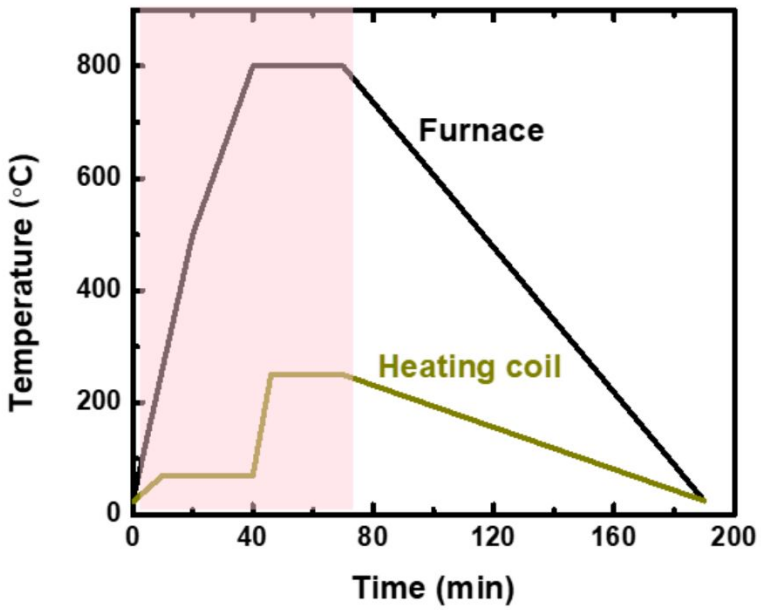

Figure S1 Heating profile showing the time-dependent temperature at the center of the furnace, where the MoS_2 and $V(C_2H_5)_2$ are placed along with that of sulfur powder placed at the entrance of the furnace, independently heated using a heating coil.

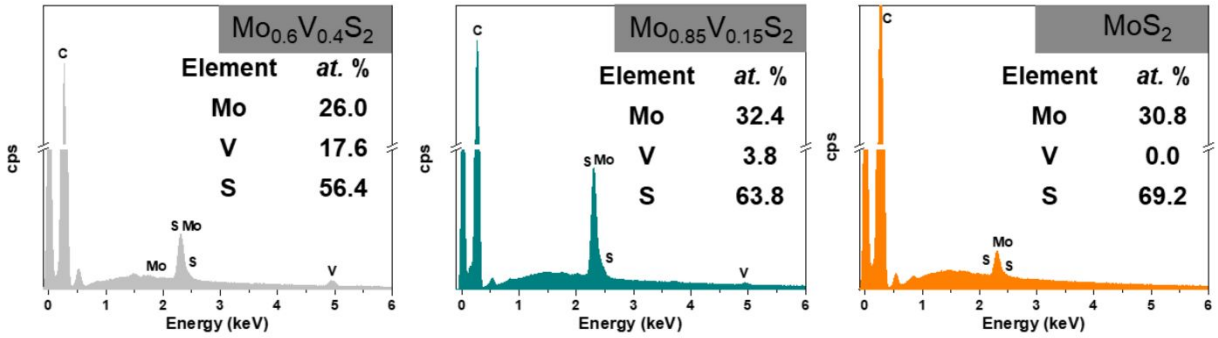

Figure S2 EDS spectra of (a)$Mo_{0.6}V_{0.4}S_2$, (b) $Mo_{0.85}V_{0.15}S_2$, and (c)MoS_2, respectively

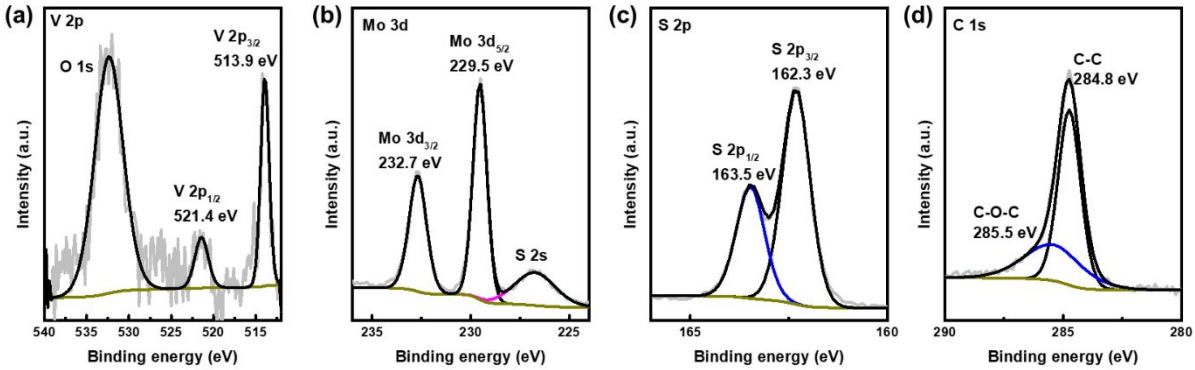

Figure S3 High resolution XPS spectra of $Mo_{0.6}V_{0.4}S_2$, (a)V 2p; (b) Mo 3d; (c) S 2p; and (d) C 1s peaks.

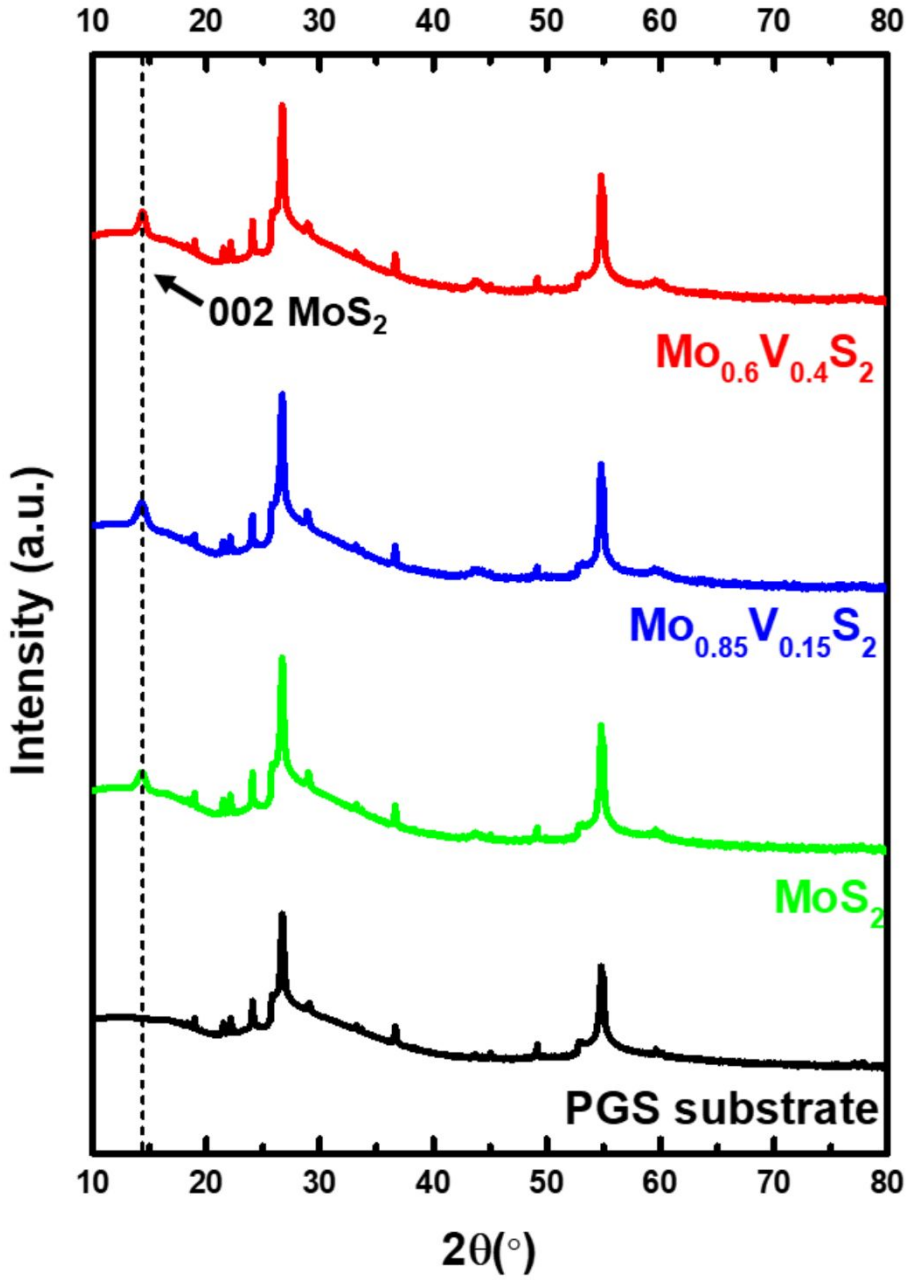

Figure S4 XRD patterns of $Mo_{0.6}V_{0.4}S_2$, $Mo_{0.85}V_{0.15}S_2$, MoS_2, and the carbon substrate. Only (002) peak of MoS_2 is found in $Mo_{0.6}V_{0.4}S_2$, $Mo_{0.85}V_{0.15}S_2$ and MoS_2, besides the peaks from the substrates. Y-axis is in Log scale.

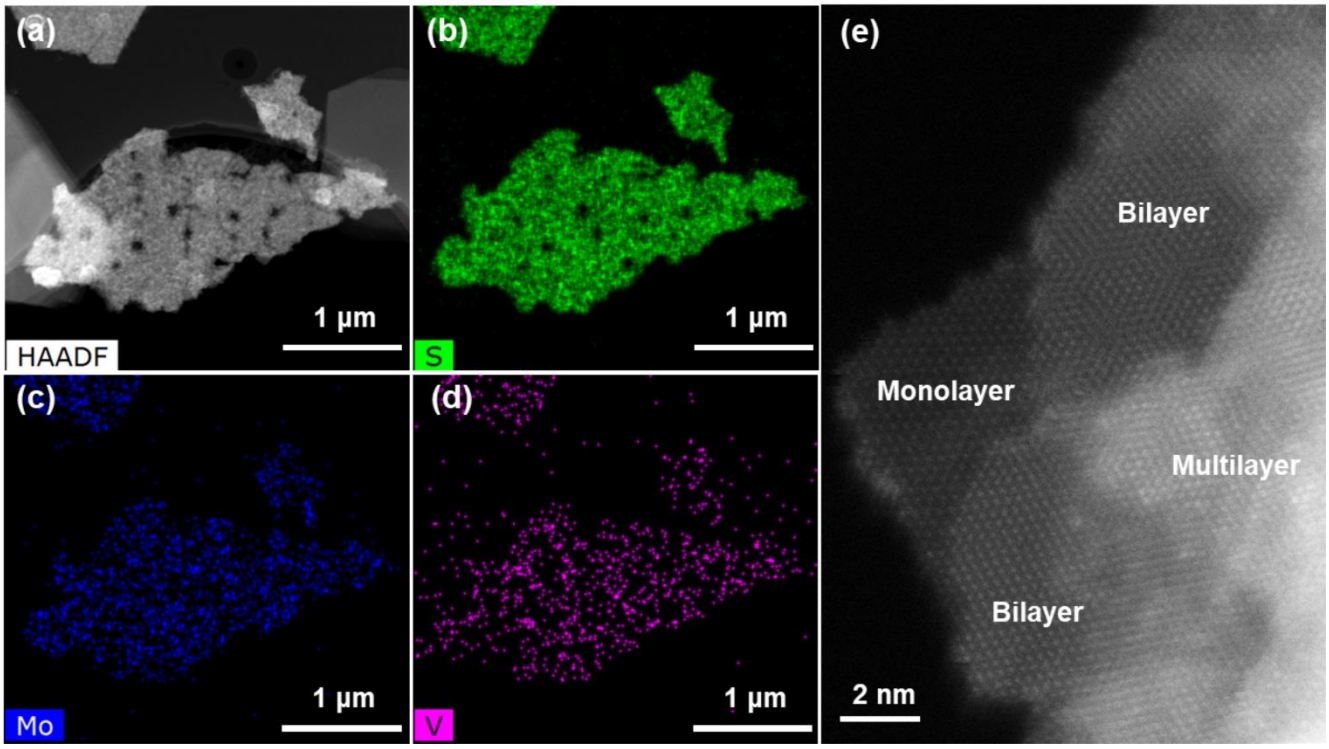

Figure S5. (a) HAADF-STEM image of the $Mo_{0.6}V_{0.4}S_2$, and the corresponding EDS mappings for (b)S, (c) Mo, and (d)V. (e) STEM image of $Mo_{0.6}V_{0.4}S_2$ shows monolayer, bilayer, and multilayer regions.

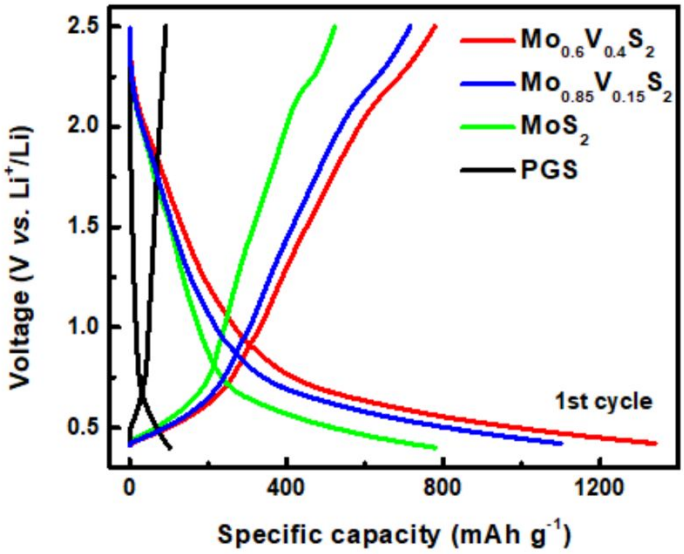

Figure S6 The 1st charge and discharge profiles of $Mo_{0.6}V_{0.4}S_2$, $Mo_{0.85}V_{0.15}S_2$, MoS_2, and PGS from 0.4 V to 2.5 V *vs.* Li^+/Li when the current density is 50 mA g^{-1}.

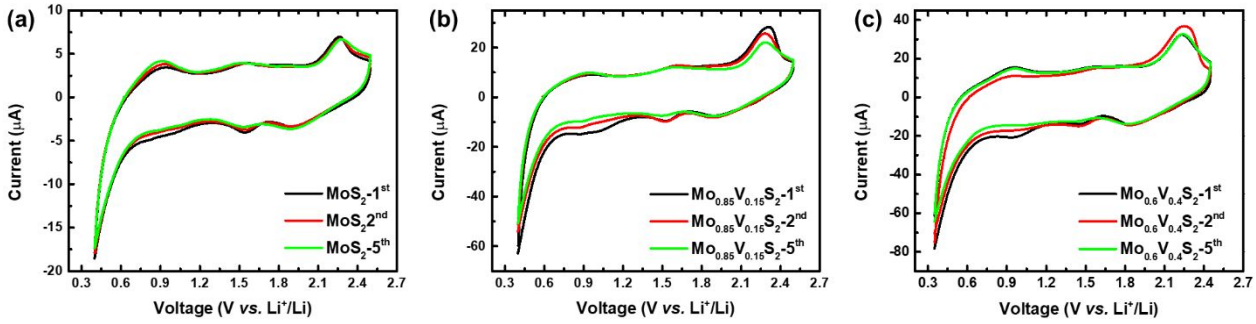

Figure S7 Cyclic voltammetry of the MoS_2, $Mo_{0.85}V_{0.15}S_2$, and $Mo_{0.6}V_{0.4}S_2$ at a scan rate of 1 mV s^{-1} in the voltage range of 0.4 to 2.5 V *vs.* Li^+/Li.

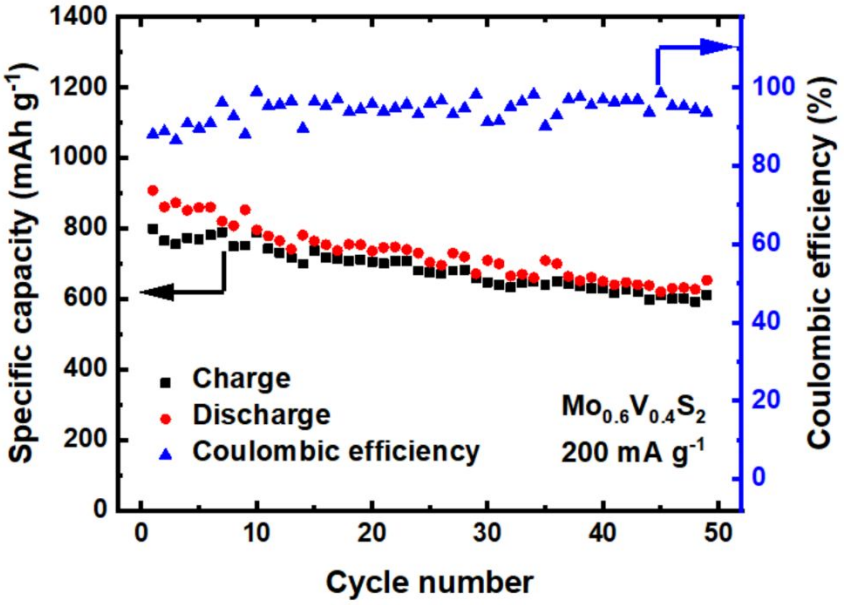

Figure S8 Cycling performance of $Mo_{0.6}V_{0.4}S_2$ at 200 mA g^{-1}.

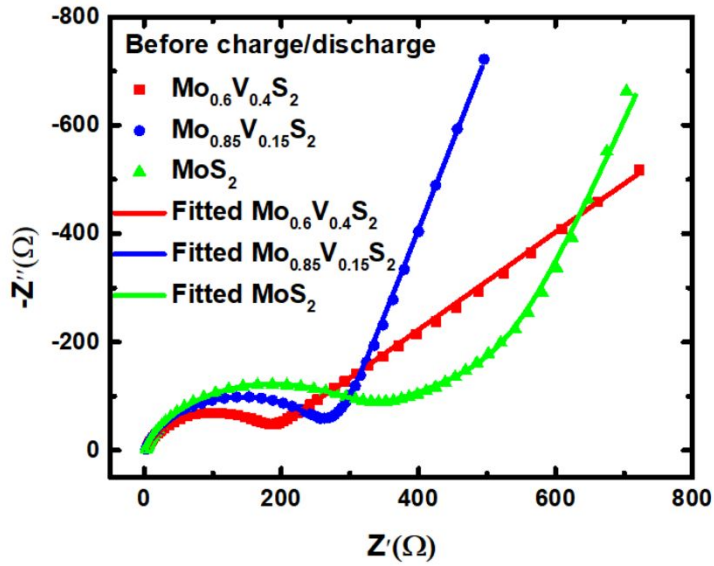

Figure S9 EIS spectra of $Mo_{0.6}V_{0.4}S_2$, $Mo_{0.85}V_{0.15}S_2$, and MoS_2 before charge/discharge.

Table S1 XPS summary of $Mo_{0.6}V_{0.4}S_2$

	Mo *at.* %	V *at.* %	S *at.* %
$Mo_{0.6}V_{0.4}S_2$	24.8	17.9	57.3

Table S2 Comparison of V-MoS_2 with other reported MoS_2 related materials' performance as the anode materials for the lithium-ion battery (LIB)

	Synthetic Method	Discharge Specific Capacity (mAh g^{-1})	Current Density (mA g^{-1})	Voltage Range (V)	Ref.
$Mo_{0.6}V_{0.4}S_2$	Electrodeposition/solid state reaction	1086	50	0.40-2.50	This work
$Mo_{0.85}V_{0.15}S_2$		917			
MoS_2		666			
Exfoliated MoS_2	Exfoliation	500	50	0.01-3.00	1
Bulk MoS_2	As-received	200	50	0.01-3.00	1
Amorphous MoS_2	Atomic layer deposition	851	148	0.01-3.00	2
MoS_2 nanowalls/carbon/cellulose	Wet chemical approach/thermal treatment	880	100	0.01-3.00	3
MoS_2 nanosheets	Hydrothermal	705.8	50	0.01-3.00	4
Ordered mesoporous MoS_2	Nano-casting approach	645	50	0.01-3.00	5
MoS_2 nanourchin/carbon	Solvothermal	721	50	0.01-3.00	6
Carbonized MoS_2 nanosheets/cellulose nanofibrils hybrid film	Solution-based papermaking process/carbonization	740	50	0.01-3.00	7
Mesocarbon microbead (MCMB)	As-received	362	50	0.00-2.00	8

Table S3 Charge transfer resistance (R_{ct}), the resistance associated to SEI film and the contact at the interface (R_s), and internal resistance of the test battery (R_1) with the different cathodes before and after charge/discharge ($Mo_{0.6}V_{0.4}S_2$, $Mo_{0.85}V_{0.15}S_2$, or MoS_2; the anode is Li metal)

Testing condition	**Sample**	**R_{ct} (Ω)**	**R_s (Ω)**	**R_1 (Ω)**
Before charge/discharge	$Mo_{0.6}V_{0.4}S_2$	43.0	111.3	3.3
	$Mo_{0.85}V_{0.15}S_2$	56.5	168.5	2.0
	MoS_2	91.7	184.5	2.3

After charge/discharge	$Mo_{0.6}V_{0.4}S_2$	50.0	130.9	2.4
	$Mo_{0.85}V_{0.15}S_2$	73.6	200.0	1.9
	MoS_2	254.8	210.5	3.8

Reference

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