Supporting information:

Highly defective and conductive Cu-doped 1T/2H-MoS₂ nanosheets as high-capacity cathode materials for enhanced magnesium ion storage

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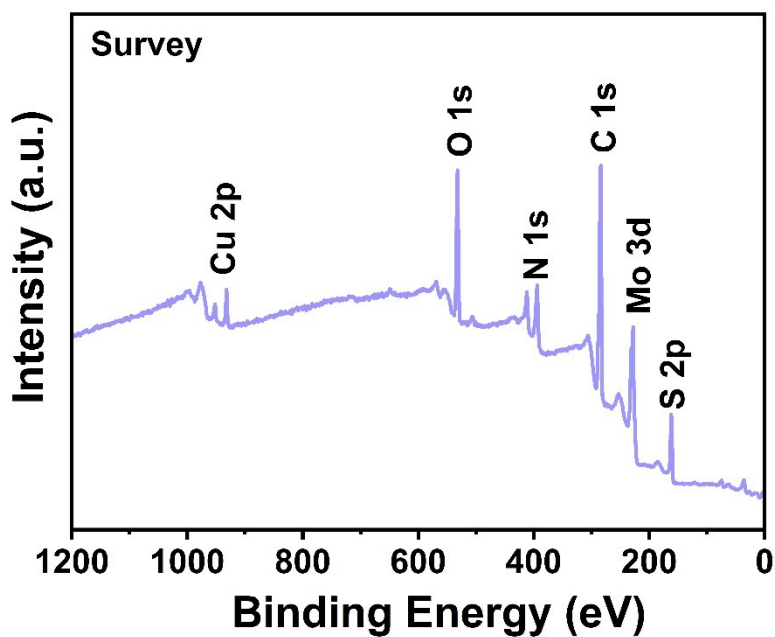*Ao Xu, and Yan Liu were the co-first authors in this work.*
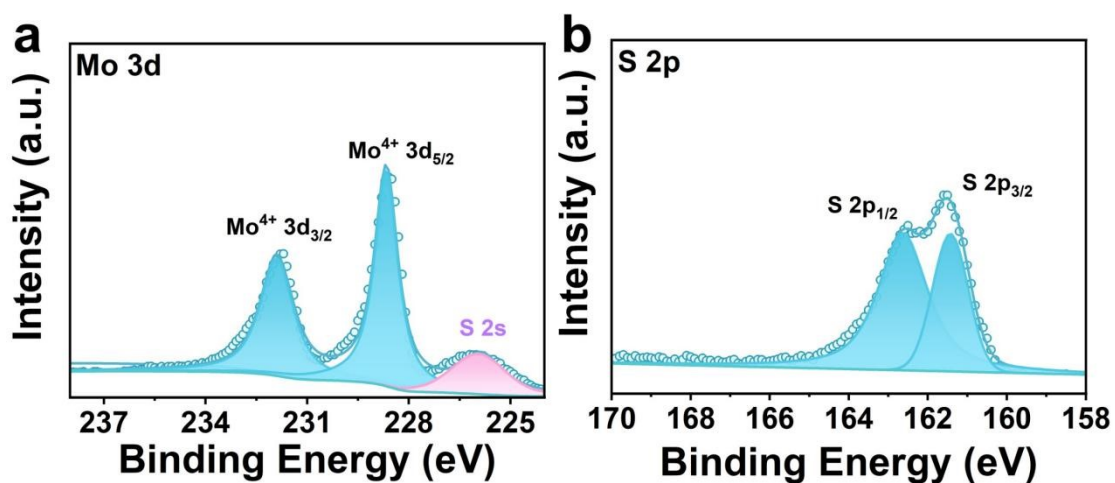
Fig. S1 XPS survey spectrum of Cu-MoS$_2$-2.

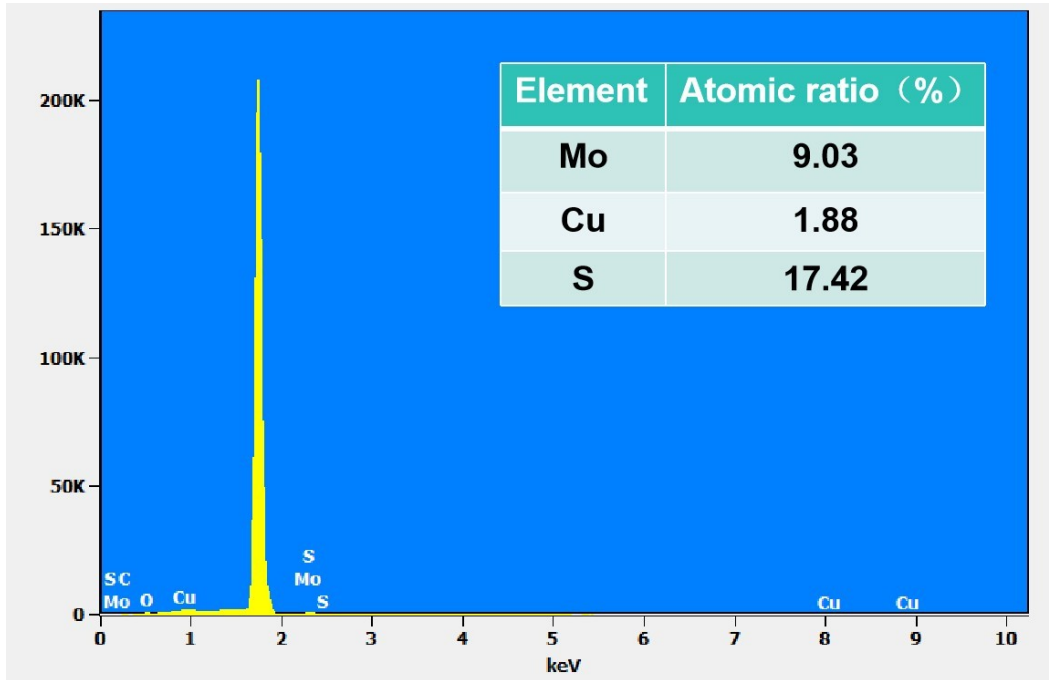
Fig. S2 XPS survey spectrum of MoS$_2$.

Fig. S3 EDS spectrum of Cu-MoS$_2$-2.
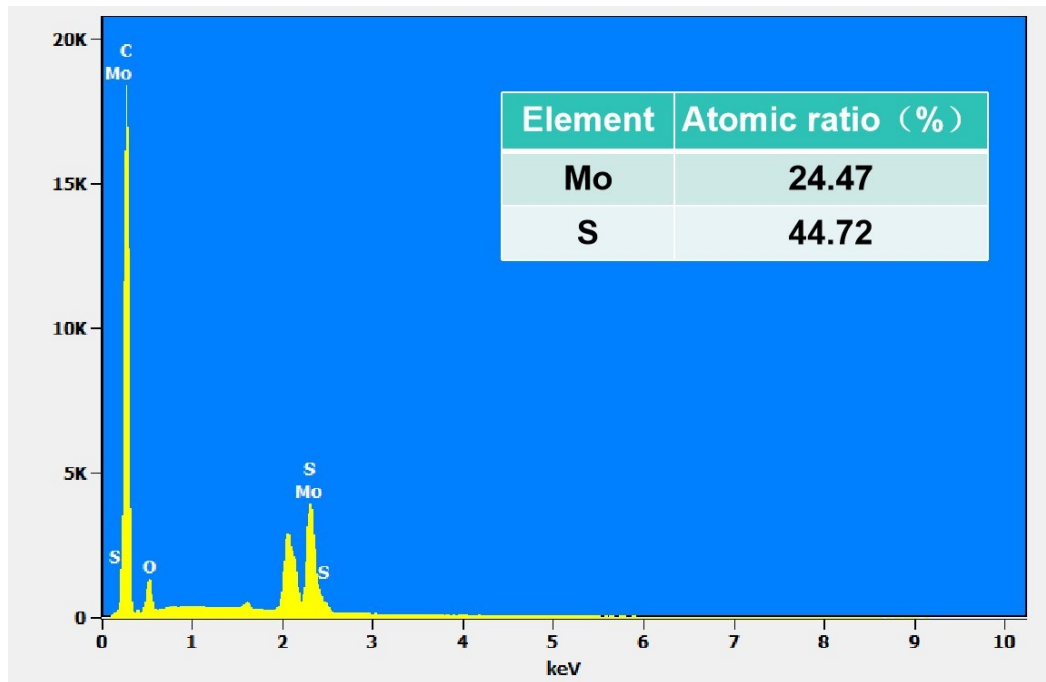

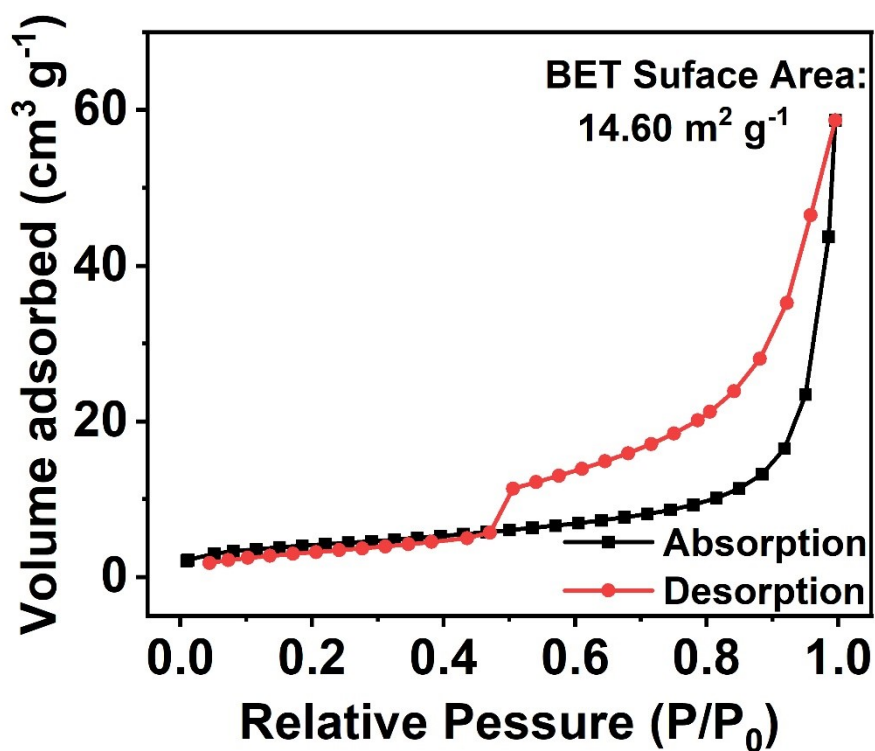
Fig. S4 EDS spectrum of MoS$_2$.

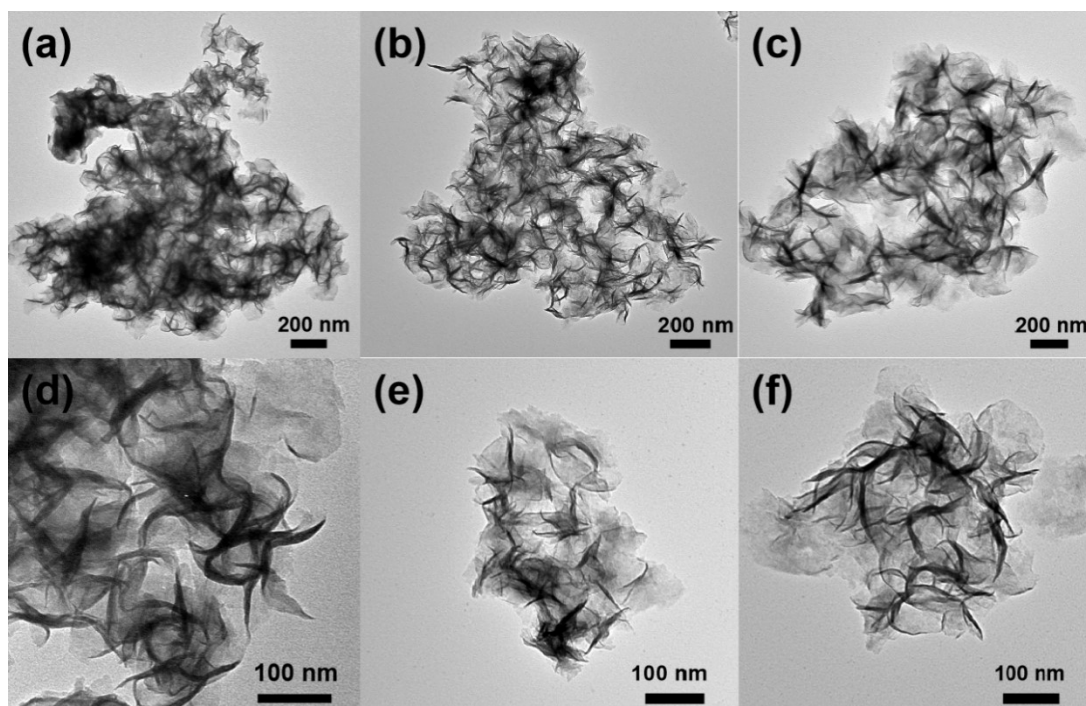**Fig. S5** Nitrogen isothermal adsorption/desorption curves of Cu-MoS$_2$-2.

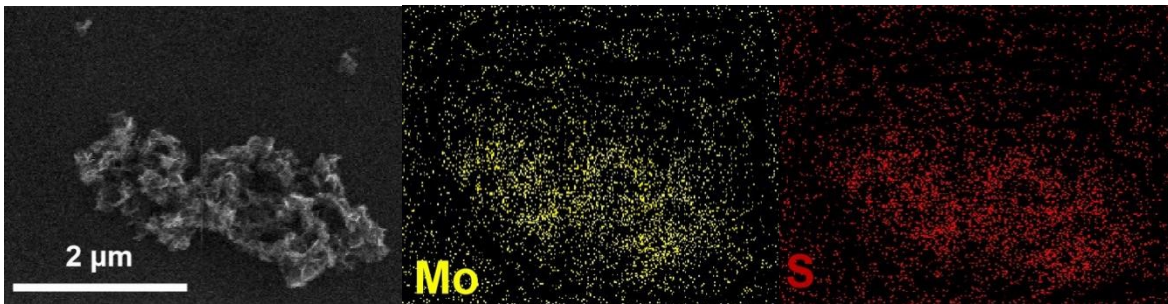**Fig. S6** TEM images of (a-d) MoS$_2$, (b-e) Cu-MoS$_2$-1, and (c-f) Cu-MoS$_2$-3.
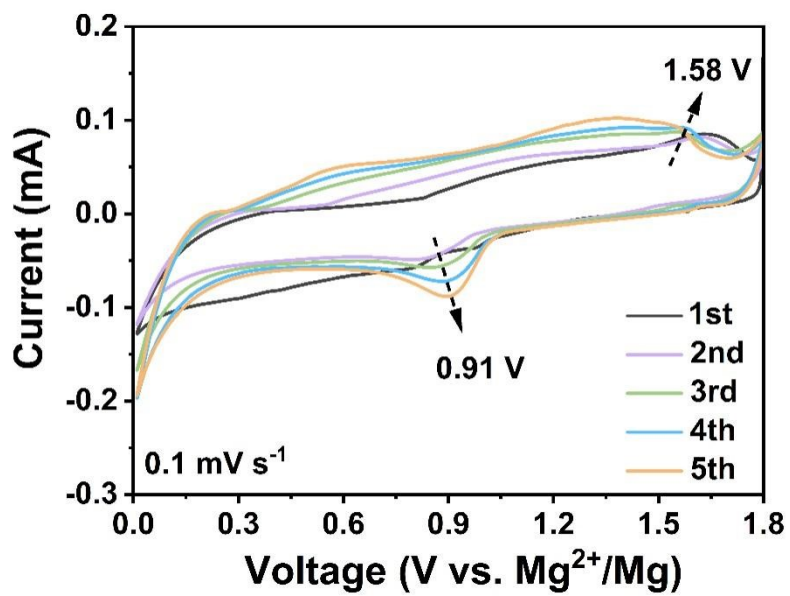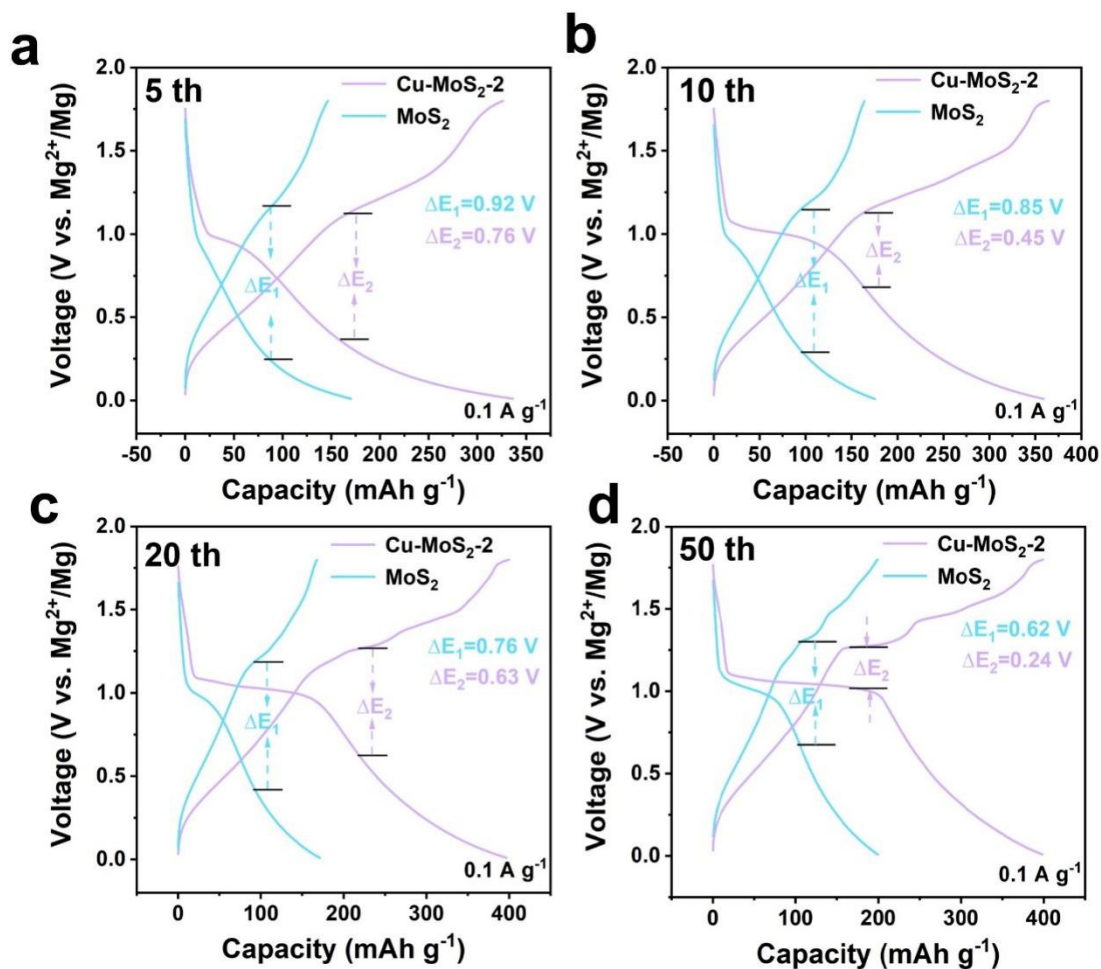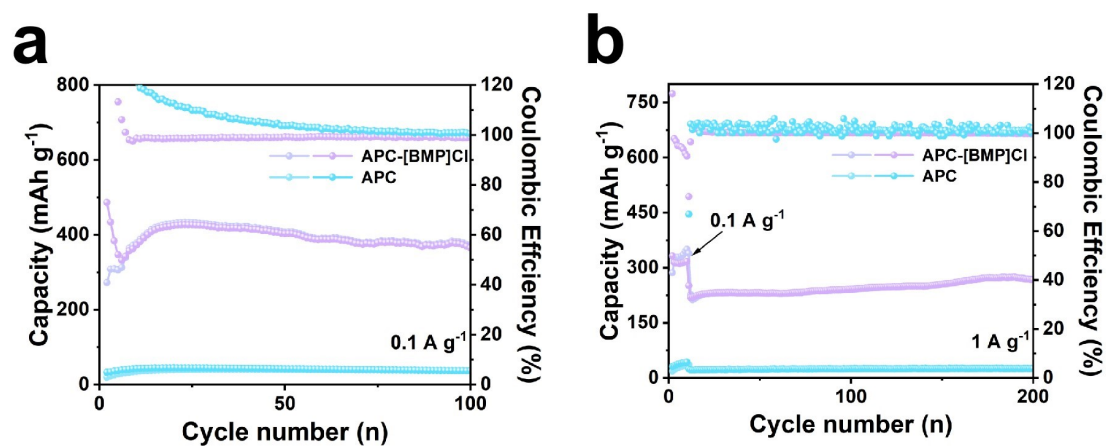
Fig. S7 EDS elemental mappings of MoS$_2$.

Fig. S8 CV curves of MoS$_2$ for the first five cycles.

Fig. S9 (a-d) Discharge/charge profiles for different cycles at 0.1 A g^{-1} of Cu-MoS$_2$-2 and MoS$_2$.

Fig. S10 Cyclic performances of Cu-MoS$_2$-2 in APC and APC-[BMP]Cl electrolytes: (a) 0.1 A g^{-1}, and (b) 1.0 A g^{-1}.
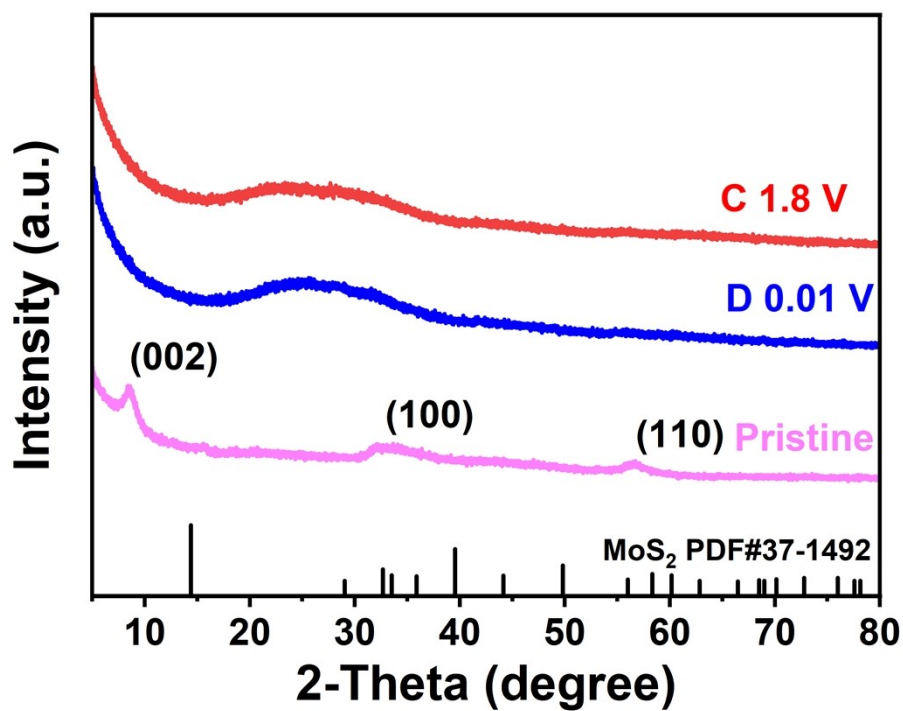
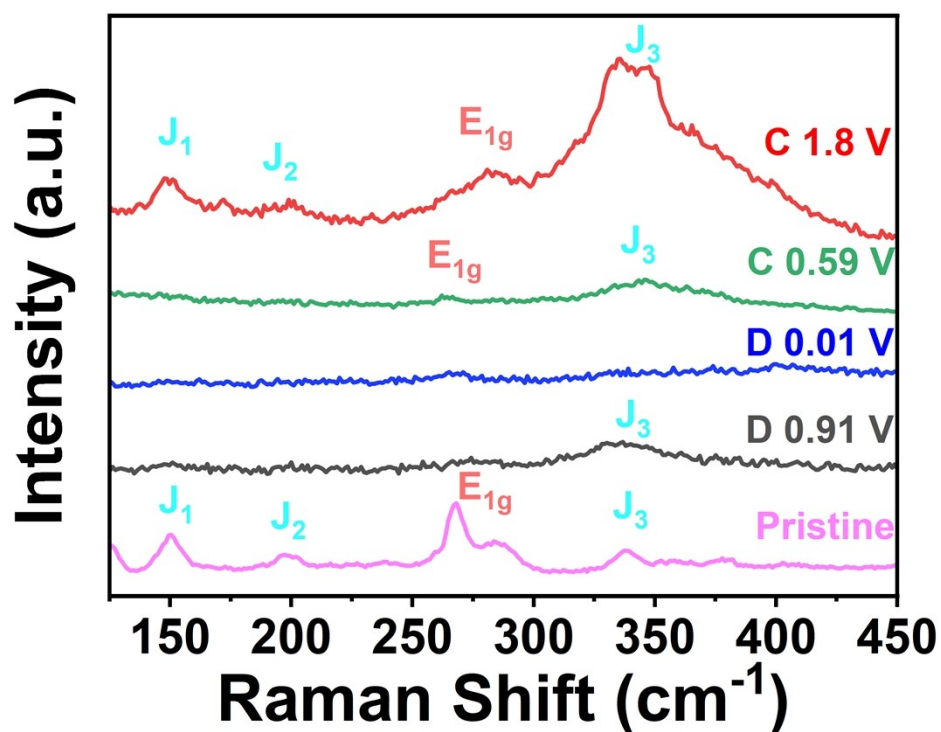**Fig. S11** *Ex-situ* XRD patterns of Cu-MoS$_2$-2 at different discharge/charge states.

Fig. S12 *Ex-situ* Raman spectra of Cu-MoS$_2$-2 at different discharge/charge states.
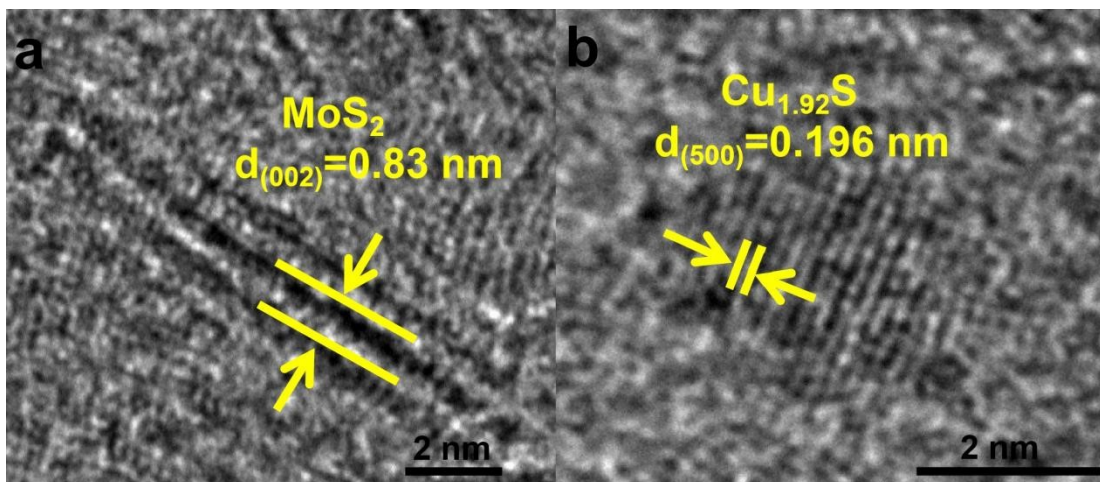
Fig. S13 (a) and (b) HRTEM images of Cu-MoS$_2$-2 after charging to 1.8 V.
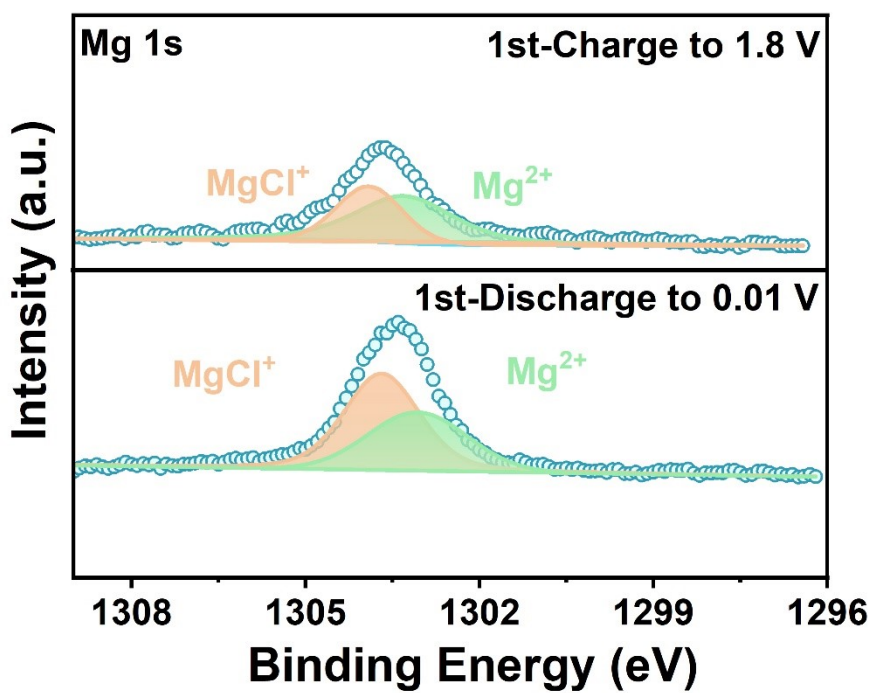

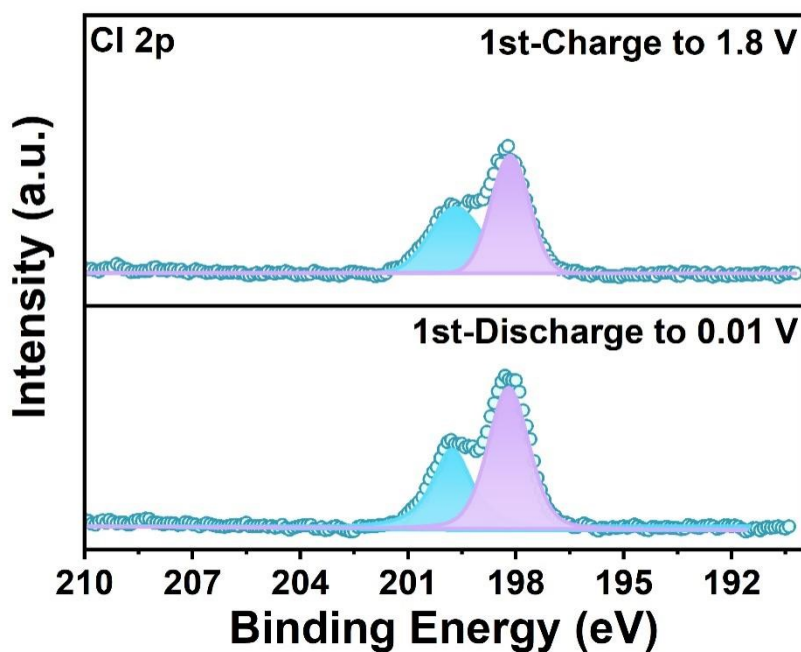**Fig. S14** *Ex-situ* XPS spectra of Mg 1s.

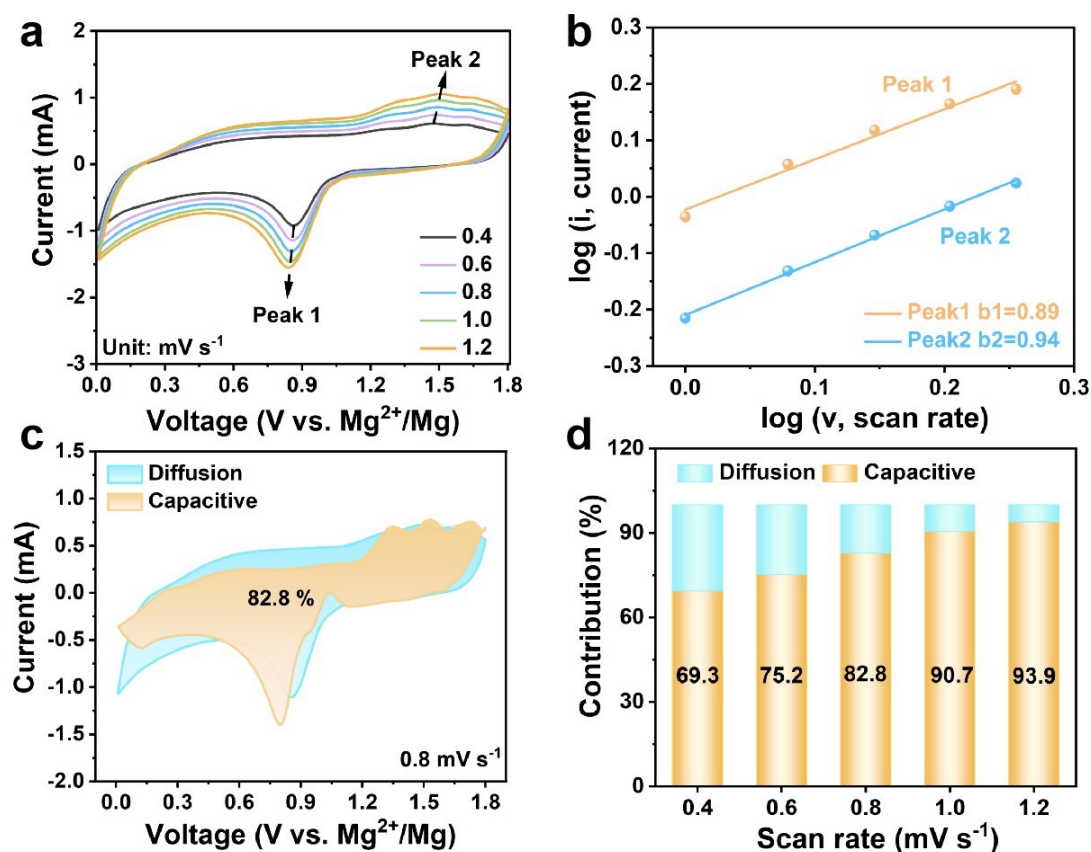**Fig. S15** *Ex-situ* XPS spectra of Cl 2p.

Fig. S16 Kinetic analysis of MoS$_2$: (a) CV curves at different scan rates, (b) *b* values obtained from log *i* versus log *v*, (c) percentage of capacitive contributions at 0.8 mV s^{-1}, (d) percentage of capacitive contributions at different scan rates.

Table S1 Electric conductivity data at different pressures of MoS_2 and Cu-MoS_2-2 via the four probe method.

Electrode materials	Height (mm)	Pressure (Mpa)	Temperature (ºC)	Humidness (%RH)	Electric conductivity (S m^{-1})
MoS$_2$	0.94	18.3	25	50	0.0077
	0.97	16.07	25	50	0.0070
	0.98	14.07	25	50	0.0049
	1	12.07	25	50	0.0042
	1.04	10.17	25	50	0.0037
	1.07	8	25	50	0.0031
	1.1	6.11	25	50	0.0026
	1.12	4.3	25	50	0.0022
	1.14	2.24	25	50	0.0018
Cu-MoS$_2$-2	0.88	18.25	25	50	1.6667
	0.96	16.12	25	50	1.3736
	0.97	14.28	25	50	1.1990
	0.98	12.45	25	50	1.0330
	1	10.24	25	50	0.4545
	1.03	8.33	25	50	0.1852
	1.16	6.06	25	50	0.0980
	1.21	4.22	25	50	0.0390
	1.29	2.34	25	50	0.0128

Table S2 Reaction impedance derived from EIS spectra.

Electrode materials	R_s (Ω)	R_{SEI} (Ω)	R_{ct} (Ω)
MoS$_2$	26.68	18.93	28.17
Cu-MoS$_2$-1	19.38	15.91	26.66
Cu-MoS$_2$-2	18.36	11.17	26.38
Cu-MoS$_2$-3	19.21	12.41	25.66
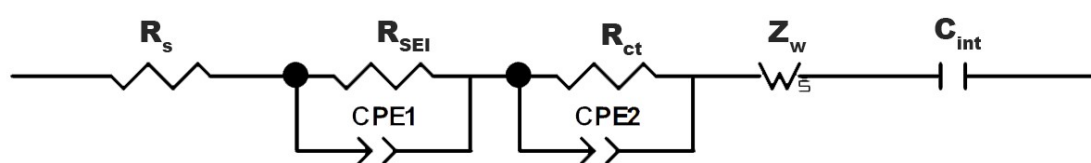
Fig. S17 Diagram of equivalent circuit.