Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

$K_{0.38}(H_2O)_{0.82}MoS_2$ as a universal host for rechargeable aqueous cation (K^+, Na^+, Li^+, NH_4^+, Mg^{2+}, Al^{3+}) batteries

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1. Supplementary figures

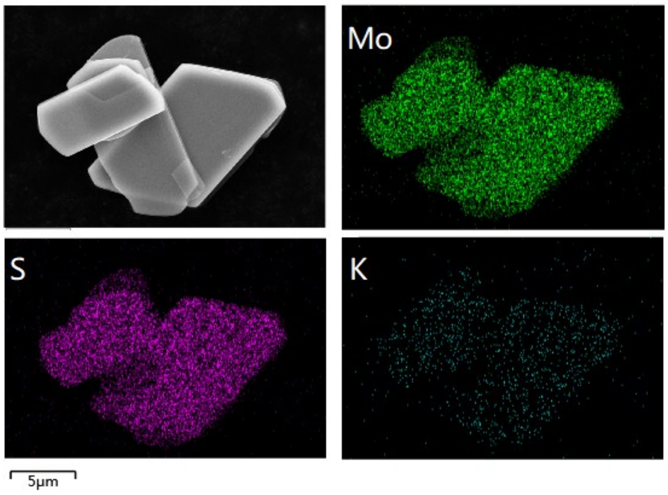

Fig. S1 SEM image and elemental mapping of $K_{0.38}(H_2O)_{0.82}MoS_2$.

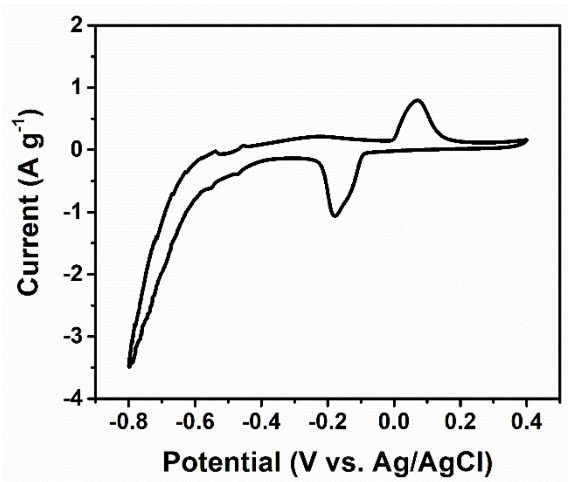

Fig. S2 Cyclic voltammetry curves of KMS electrode for Al^{3+} electrolyte at the scan rate of 1 mV s^{-1} based on the voltage range of -0.8-0.4 V vs. Ag/AgCl.

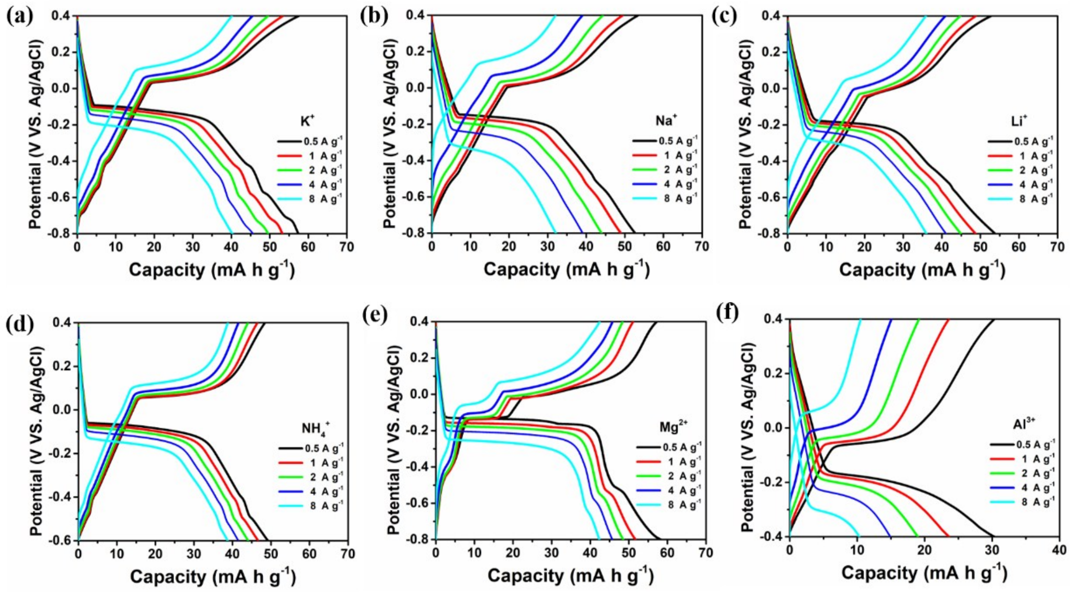

Fig. S3 Galvanostatic discharge-charge profiles of KMS electrode at the current densities of 0.5A g^{-1}, 1 A g^{-1}, 2 A g^{-1}, 4 A g^{-1}, 8 A g^{-1} in 0.5 M sulfate solutions: (a) K_2SO_4, (b) Na_2SO_4, (c) Li_2SO_4, (d) $(NH_4)_2SO_4$, (e) $MgSO_4$, (f) $(Al)_2(SO_4)_3$.

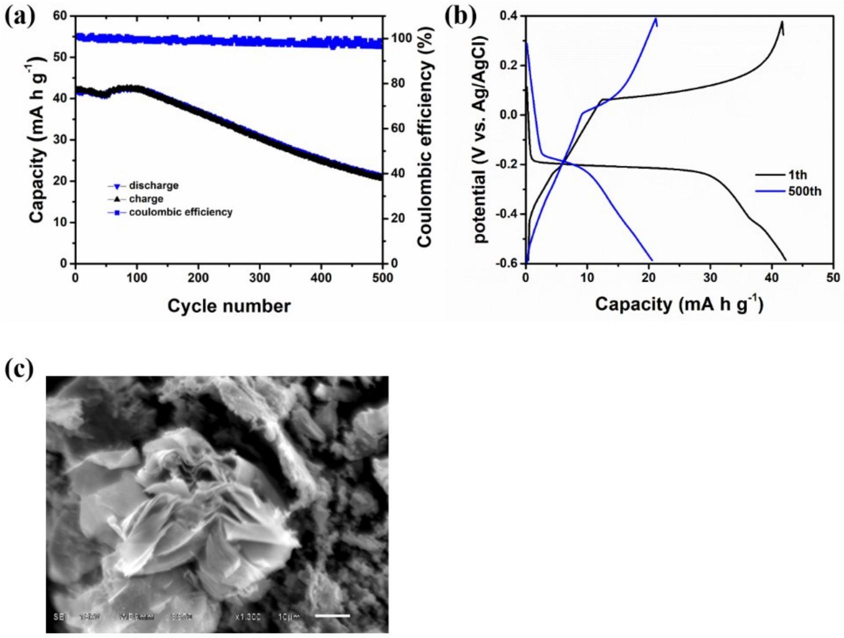

Fig. S4 (a) The cycling stability of KMS electrode in 0.5 M K_2SO_4 aqueous solution at the current density of 5 A g^{-1}, (b) Galvanostatic discharge-charge profiles of KMS at the 1th and 500th cycles, (c) SEM image of KMS electrode after 500 cycles.

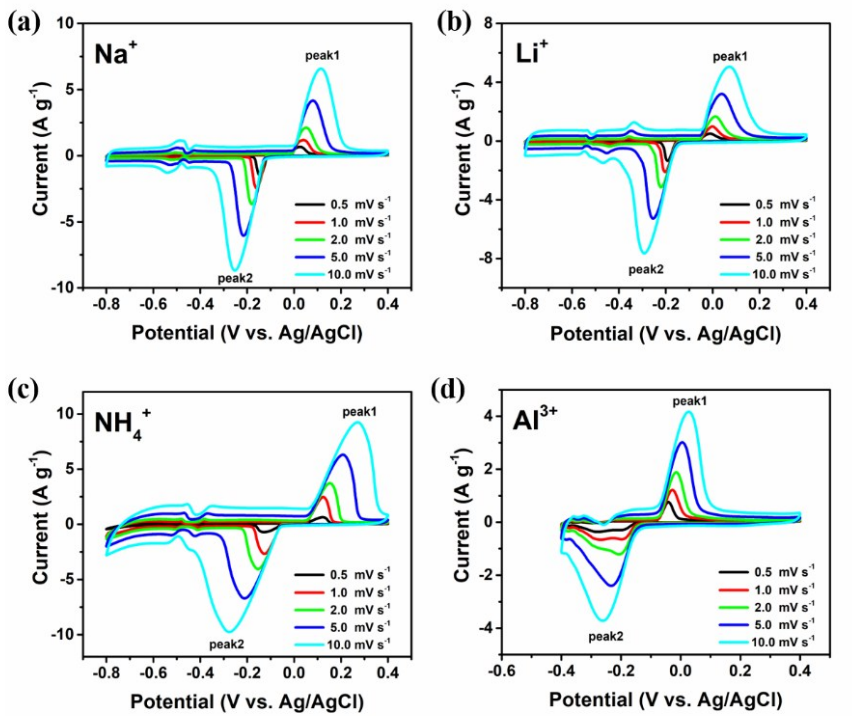

Fig. S5 Sweep voltammetry of KMS electrode at varies scan rates for (a) Li^{+}, (b) Na^{+}, (c) NH_4^{+}, (d) Al^{3+} aqueous electrolytes.

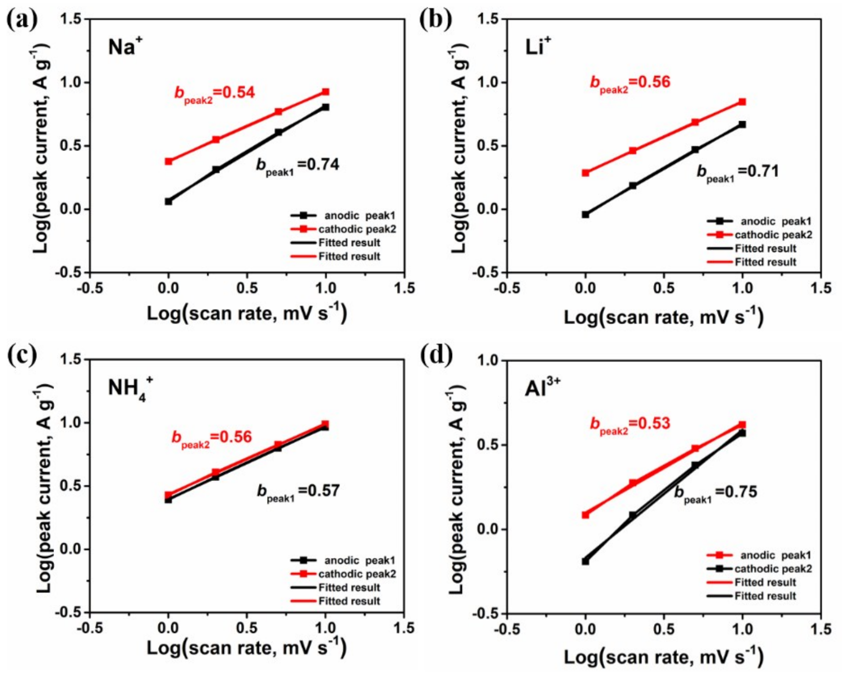

Fig. S6 Relationship between the peak currents and corresponding scan rates for KMS electrode in (a) Li^{+}, (b) Na^{+}, (c) NH_4^{+}, (d) Al^{3+} aqueous electrolytes.

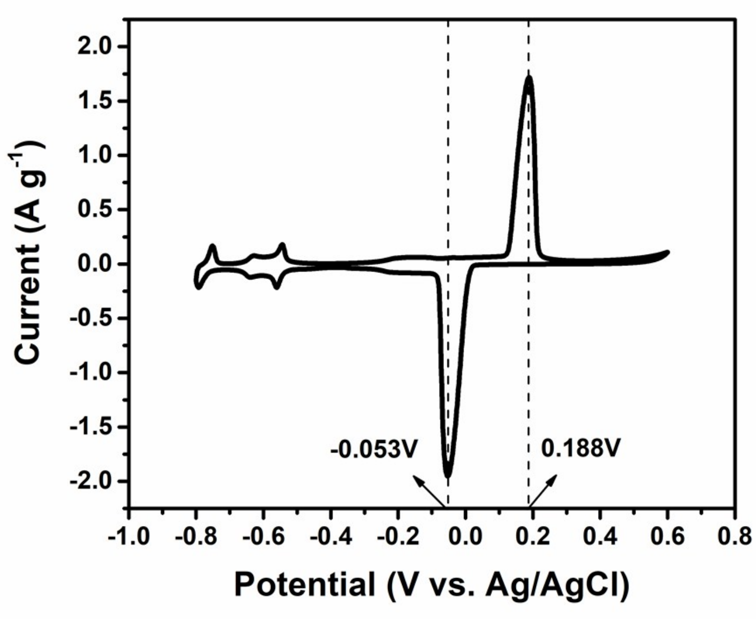

Fig. S7 Cyclic voltammetry curves of KMS electrode at 0.5mV s^{-1} in 1M CsCl.

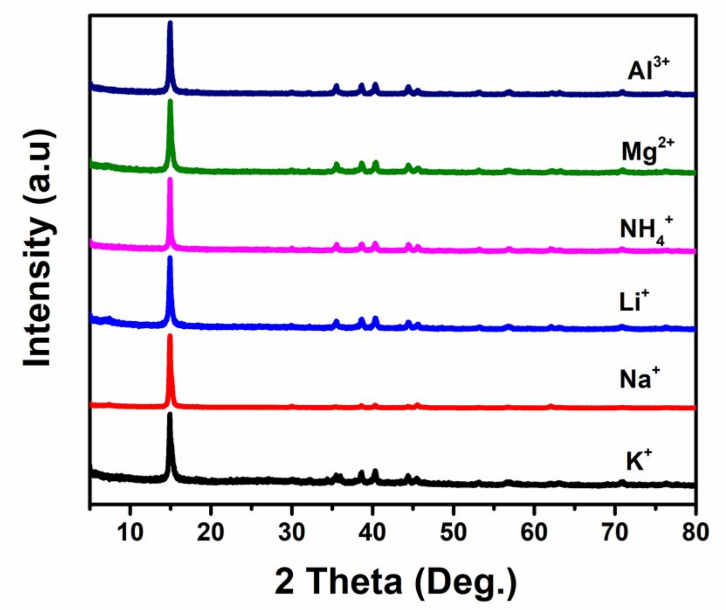

Fig. S8 XRD patterns of the charged state for KMS electrode in different aqueous electrolytes.

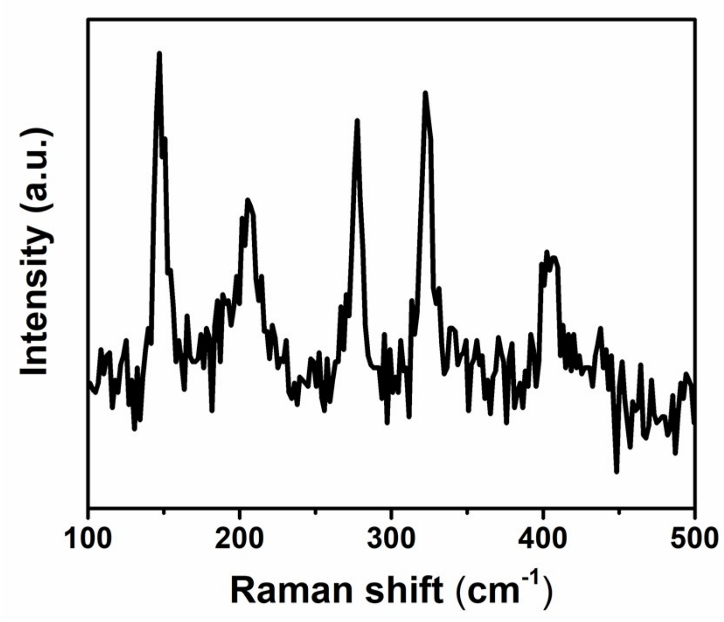

Fig. S9 Raman spectrum of charged state for KMS electrode

2. Supplementary tables

Table. S1 Initial discharge capacity and the second charge capacity of different interaction cations at 0.5 A g^{-1} along with calculated capacity fade rate.

Cation inserted	***discharge capacity(mA h g^{-1})***	***charge capacity(mA h g^{-1})***	***Coulombic efficiency (%)***	***Capacity fade(%/cycle)***
Li^+	51.39	51.92	98.97	0.68
Na^+	60.94	62.08	98.16	0.72
K^+	64.37	68.01	94.64	0.88
NH_4^+	50.74	53.90	94.14	0.56
Mg^{2+}	54.39	56.38	96.47	0.59
Al^{3+}	32.16	34.03	94.50	0.80

Table. S2 The summary of calculated b-values of KMS electrode in varies electrolytes.

Ion type	**K^+**	**Na^+**	**Li^+**	**NH_4^+**	**Mg^{2+}**	**Al^{3+}**
Anodic peak1	0.67	0.74	0.71	0.57	0.77	0.75
Cathodic peak2	0.59	0.54	0.56	0.56	0.59	0.53

Table. S3 Physical and thermodynamic characteristics of selected cations.

Ion type	***K^+***	***Na^+***	***Li^+***	***NH_4^+***	***Mg^{2+}***	***Al^{3+}***
Ionic radius(nm)	0.152	0.102	0.078	0.148	0.066	0.053
Hydrated radius (nm)	0.331	0.358	0.382	0.331	0.428	0.48
Hydrated free energy (KJ mol^{-1})	-343	-405	-544	-	-1922	-4665