Supporting Information

Manganese ion pre-intercalated hydrated vanadium oxide as a highperformance cathode for magnesium ion batteries

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Fig. S1 The XRD patterns of MnVO, MnVO-400 and HVO respectively.

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Fig. S2 (a) Survey XPS spectrum and (b) high-resolution XPS spectrum of V 2p peak of the MnVO.



Fig. S3 (a, c) SEM images of $Mn_{0.04}V_2O_5$. (b, d) SEM images of $V_2O_5 \cdot nH_2O_1$



Fig. S4 (a, b) TEM image of HVO and MnVO-400. (c, d) SAED pattern of HVO and MnVO-400.



Fig. S5 Energy dispersive X-ray (EDX) spectrum of the MnVO.



Fig. S6 (a) CV curve of Mg $|Mg(TFSI)_2/AN|Mo$ cell at 50 mV s⁻¹ in -1.0-3.0 V. (b) The charge/discharge curves of MnVO $|Mg(TFSI)_2/AN|Mg$ cell at 20 mA g⁻¹.



Fig. S7 The SEM image of MnVO after 50 cycles at 0.1 A g^{-1} .



Fig. S8 (a) SAED pattern and TEM image of MnVO after 50 cycles at 0.1 A $g^{\text{-}1}$.



Fig. S9 Cycling performances of MnVO at 1 A g^{-1} .



Fig. S10 Cycling performances (a, c) and charge-discharge curves (b, d) of MnVO at 0.2 and 0.5 A g^{-1} .



Fig. S11 (a, b) The charge-discharge curves of MnVO under different cycle times is at 2 A g⁻¹.



Fig. S12 (a, b) Cycling performances of MnVO, MnVO-400 and HVO at 0.2 and 1 A g^{-1} .



Fig. S13 (a, b) Charge-discharge curves of MnVO, MnVO-400 and HVO at 0.2 and 1 A g^{-1} .



Fig. S14 (a, b, c) The CV curves of MnVO,MnVO-400 and HVO at scan rates of 0.1 mV s⁻¹.



Fig. S15 (a, b) log(i) versus log(v) plots of the cathodic current response at four peaks shown in (Fig 3c,d).



Fig. S16 (a-c) The electrochemical impedance spectra (EIS) of MnVO in initial and fifth cycles.



Fig S17 1D In-situ XRD pattern.



Fig S18 (005) crystal plane in the pristine material.



Fig S19 Ex-TEM mapping of MnVO.



Fig S20 (a) EDX spectrum of charge/discharge states of MnVO. (b) The *ex-situ* ICP of MnVO in different cycle phase.

Element Sample	Mn (mg/L)	V (mg/L)
#1	2.891	147.6
#2	2.98	134

Table S1 The ICP-OES analysis of MnVO.