Supporting information

Enabling flexible Zn/MnO_2 secondary batteries by fumed silica-doped hydrogel electrolyte

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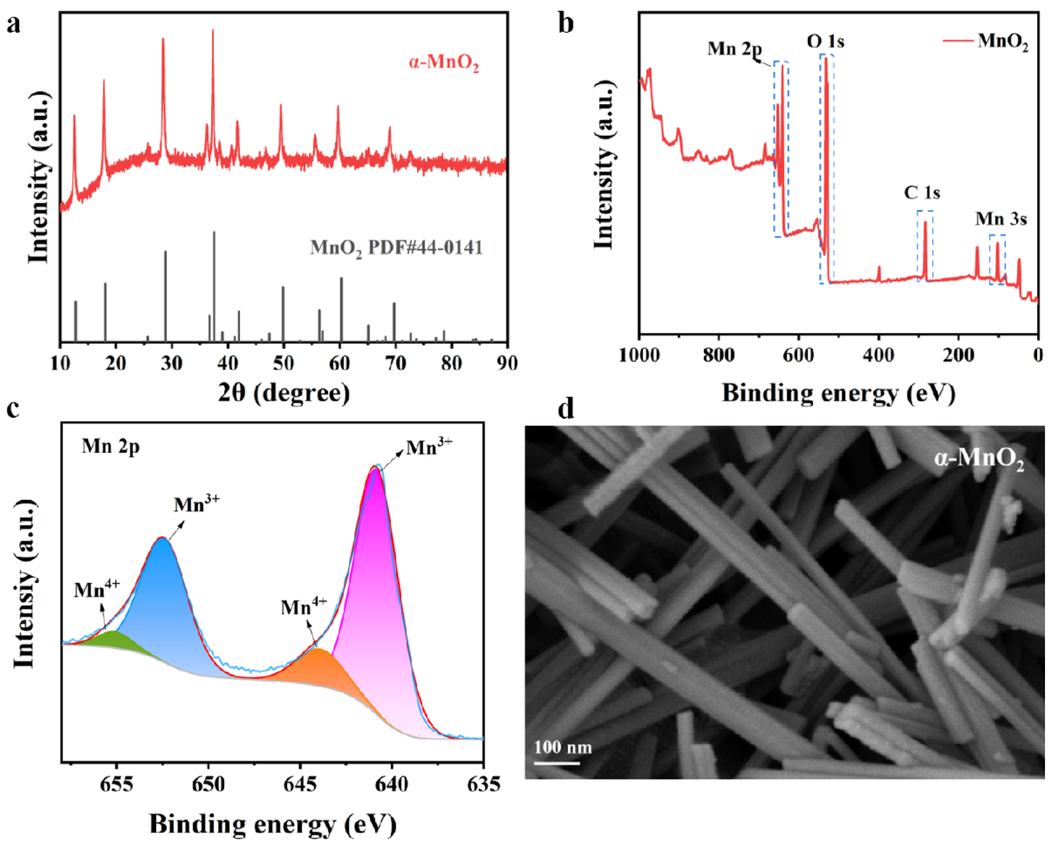

Fig. S1 (a) XRD pattern of α-MnO_2. (b) XPS spectrum of α-MnO_2. (c) Mn 2p XPS spectrum. (d) SEM image of α-MnO_2.

Fig. S1a shows the XRD pattern of the prepared α-MnO_2. The diffraction peaks appeared at 13, 18, 29, 37, 42, 50, 56, 60, and 69°are corresponding to the (110), (200), (310), (211), (301), (411), (600), (521), and (541) crystal planes in the α-MnO_2 standard card (PDF# 44-0141). As shown in Fig. S1b, Mn, O, and C coexist on the surface of the prepared α-MnO_2. For Mn element, peaks near 641.1 and 652.6 eV are attributed to Mn^{3+}, while peaks near 643.8 and 655.2 eV can be attributed to Mn^{4+} (Fig. S1c).[1,2] The SEM image shows that the mophology of the prepared MnO_2 is mostly nanowires and a few are nanorods (Fig. S1d), which is also consistent with the structural characteristics of the reported tunnel type α-MnO_2.[3–5] The α-MnO_2 was synthesized according to the XRD, XPS, and SEM analyses.

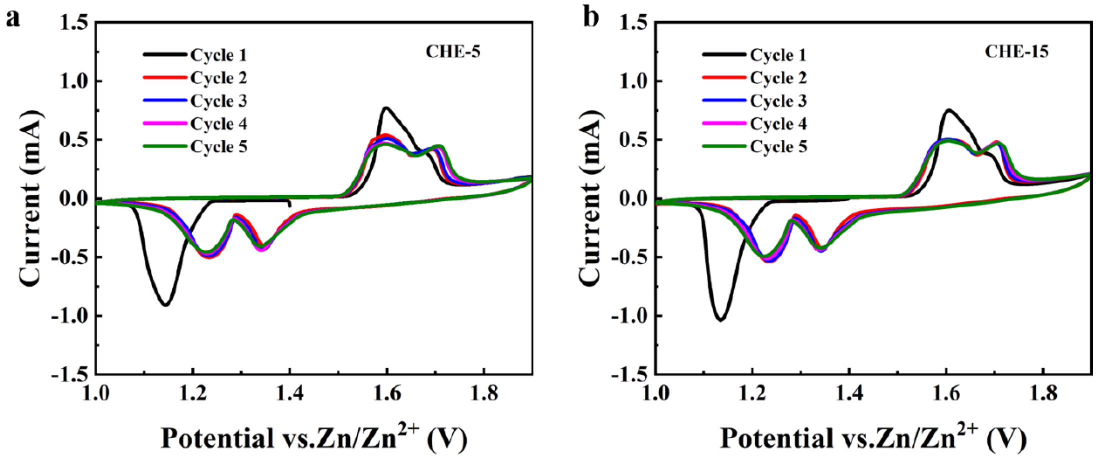

Fig. S2 Cyclic voltammograms of batteries using (a) CHE-5 and (b) CHE-15 from the 1^{st} to 5^{th} scan respectively

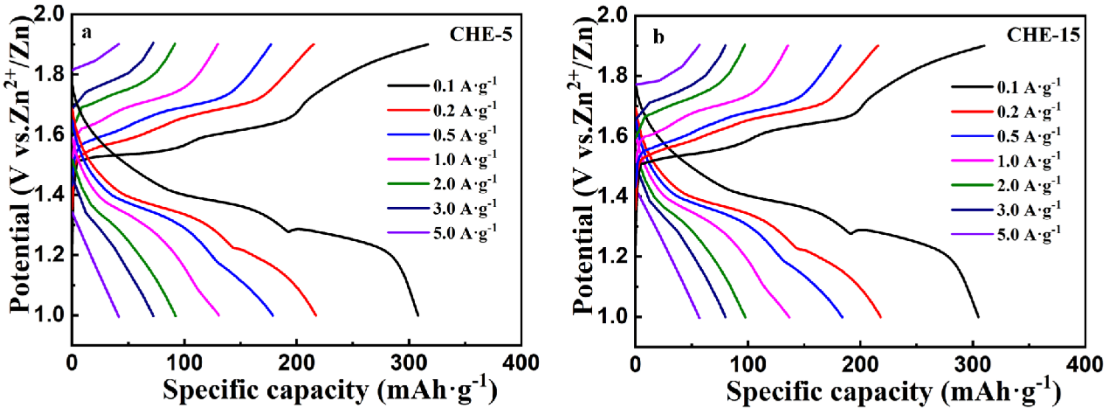

Fig. S3 Charge/discharge profiles of the batteries using (a) CHE-5 and (b) CHE-15

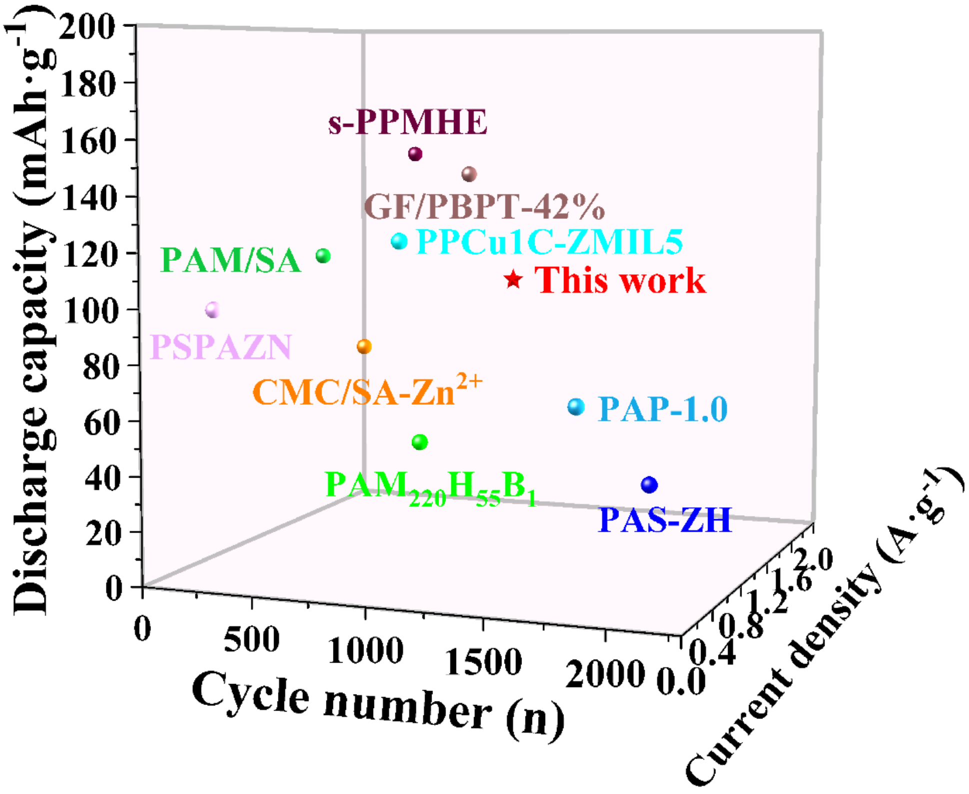

Fig. S4 Comparison of the cycle performance of Zn//MnO_2 battery in this work with recently reported hydrogel electrolyte-based Zn//MnO_2 batteries

Table S1 Comparison of mechanical properties of hydrogel electrolytes

Hydrogel Electrolyte	Tensile stress (MPa)	Tensile strain (%)	References
CSC	0.0542	160	6
Gel/SA-acetate	0.3	500	7
PZD-20%	0.082	690	8
HE-RS	0.02	273	9
PNMA-SA	0.838	200	10
PZDHE	0.796	450	11
PAZPM	0.1	320	12
CHE-10	2.55	465	This work

Table S2 Comparison of the cycle performance of $Zn//MnO_2$ battery in this work with recently reported hydrogel electrolyte-based $Zn//MnO_2$ batteries

Hydrogel Electrolyte	Current density ($A \cdot g^{-1}$)	Discharge capacity ($mAh \cdot g^{-1}$)	Cycle number (n)	References
GF/PBPT-42%	1	145	1000	13
PAM/SA	1	112	300	14
$PAM_{220}H_{55}B_1$	0.5	50	1000	15
s-PPMHE	1.525	150	500	16
PAS-ZH	0.5	40	2000	17
PAP-1.0	0.2	71	1800	18
CMC/SA-Zn^{2+}	1	77	500	19
PPCu1C-ZMIL5	0.308	124.6	1000	20
PSPAZn	0.2	98.6	220	21
CHE-10	1.5	100.5	1000	This work

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