Supporting information

A shear-thickening colloidal electrolyte for aqueous zinc-ion batteries with resistance on impact

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Experimental section

Shear thickening electrolyte fabrication

The shear-thickening suspension electrolyte was prepared by forming a stable suspension with 55wt% cornstarch in 3 M ZnSO₄ and 0.2 M MnSO₄ aqueous electrolyte. The colloid electrolyte is viscous if the stirring rate is higher than 100 rpm. The cornstarch is purchased from Argo 100% pure starch, and other chemicals are from Innochem.

Electrode fabrication

For general electrochemical tests, cathode materials were fabricated by casting the commercial MnO_2 active materials on a hydrophilic carbon paper. Super P carbon and polyvinylidene difluoride (PVDF) were mixed with the active material in the weight ratio of 2:1:7. The casted carbon paper was dried in a vacuum oven for 12 h at 70 °C. The average mass loading for the dried cathode is 1.5~2.5 mg cm⁻². Regarding to the anode, zinc metal foil was used after fully polishing to remove the surface ZnO.

Materials Characterisation

X-ray diffraction (XRD) patterns were examined by a STOE SEIFERT diffractometer with detected angular range of $2^{\circ} < 2\theta < 45^{\circ}$ under the radiation source of metal Mo. X-ray photoelectron spectra (XPS) were obtained from Thermo scientific K-alpha photoelectron spectrometer. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) used to exploit the morphology were tested by Carl Zeiss EVO MA10 and JEOL-JEM-2100, respectively. Fourier transform infrared spectroscopy was measured by Shimadzu IRTracer-100 from the wavenumber from 400 to 4000 cm⁻¹.

Electrochemical Characterisation

Battery galvanostatic charge-discharge tests were measured by NEWARE battery testing systems. Cyclic Voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS) were investigated by the VMP3 Biologic electrochemical workstation.



Figure S1. FTIR of cornstarch



Figure S2. CV for Zn||Zn symmetric cell test



Figure S3. EIS plots before and after cycling.



Figure S4. Overpotential comparison for STE and aqueous electrolyte



Figure S5. Galvanic charging/discharging test for Zn|STE|commercial MnO₂ with 3M ZnSO₄.



Figure S6. Electrochemical performances for the full cell Zn|aqueous electrolyte|commercial MnO_2 a) cyclic voltammetry test at scan rate 0.1, 0.2, 0.3, 0.4, 0.5, 1, 2, 5 mV s⁻¹; b) b values calculated from the log-log plot of

current (i) and scan rate (v) of four peaks in CV curves; c) bar chart of diffusion-capacitive contribution integrated at different scan rate (v); d) galvanic charging/discharging rate test at current density 0.1, 0.2, 0.5, 1, 2, 5 A g⁻¹



Figure S7. SEM images (a) bare Zn anode before cycling, (b) Zn anode in aqueous electrolyte after cycling, (c) Zn anode in cornstarch suspension electrolyte after cycling.



Figure S8. Transference number with different polarisation time for STE. (a) 1200s, (b) 2400s, (c) 4000s, (d) Zn transference number at corresponding polarisation time.



Figure S9. (a) Coulombic efficiency for STE and aqueous electrolyte for Zn plating/stripping profiles for Zn $\|$ Cu at 0.5 mA cm⁻², (b) voltage and capacity profile with overpotential for STE, (c) voltage and capacity profile with overpotential for aqueous electrolyte.



Figure S10 Viscosity performance related to shear stress for both cornstarhc electrolyte and pristine cornstarch colloid.



Figure S11 a) EIS plot before chronoamperometry test; b) EIS plot after chronoamperometry test; c) chronoamperometry test a potentiation polarisation ($\nabla V = 10 \text{ mV}$)



Figure S12 Galvanostatic cycling test for $Zn|STE|MnO_2$ under sudden impact at 0.5 A g⁻¹.