

Supporting Information

This supporting information includes:

Table S1. Molar attenuation coefficients;

Table S2. Comparison of electrochemical performance of iodine-based batteries;

Table S3. Values of k calculated from UV-Vis spectroscopy and CA

Fig. S1. The size distribution of I_2 solid particles;

Fig. S2. I_2 passivation of 1 M KI + 7.5% ACN;

Fig. S3. Zn dissolution and deposition in a 1M ZnI_2 electrolyte with and without ACN;

Fig. S4. Charging and discharging curves of a Zn- I_2 flow battery with 1M ZnI_2 +1M KI at different current densities;

Fig. S5. Charging and discharging curves of a Zn- I_2 flow battery with 1M ZnI_2 +1M KI +7.5% ACN at different current densities.

Table S1 Molar attenuation coefficients (in L·mol⁻¹·cm⁻¹) calibrated for different solutions in Fig. 3.

Materials	At 288 nm	At 352 nm
1M KI	1.50 x 10 ⁴	0.99 x 10 ⁴
1M KI +7.5% ACN	1.56 x 10 ⁴	1.04 x 10 ⁴
2M KI	1.58 x 10 ⁴	1.04 x 10 ⁴
2M KI +7.5% ACN	1.52 x 10 ⁴	1.04 x 10 ⁴

Table S2 Comparison of electrochemical performance of aqueous iodine-based batteries. For those using different electrolytes in the positive and negative sides, only the positive sides are tabulated.

Electrolyte composition	Current Density (mA/cm ²)	Energy Efficiency (%)	Cycles	Ref.
1M ZnI ₂ + 7.5% ACN	100	60%	170	This work
6M KI + 6M I ₂	10	~80	70	13
2M KI + 1M ZnBr ₂ + 2M KCl	80	82	300	16
4M KI + 2M ZnBr ₂ + 2M KCl	80	80	300	
5M KI + 2.5M ZnBr ₂ + 1M KCl	80	80	1000	
6M KI + 3M ZnBr ₂	80	80	1000	
5M NH ₄ I + 2.5M NH ₄ Cl	80	82	1100	
1M ZnI ₂ + 1M NH ₄ Br	40	85	100	18
6.5M NH ₄ I + 1.5M NH ₄ Cl (total 6.5M I ⁻)	10	78	2500	28
2.5M NH ₄ I + 1.25M NH ₄ Cl (2.5M I ⁻)	20	88	1200	
2.6M NH ₄ I ₃ (NH ₄ I+I ₂) + 3.9M NH ₄ Cl (2.6 M I ₃ ⁻)	20	70	1500	29
(Single flow) Solid I ₂ (cathode)	40	81	500	
6M KI + 3M ZnBr ₂	80	~77	500	
7.5M KI + 3.75M ZnBr ₂	20	~80	100	
3M KI + 1.5M ZnBr ₂ + 2M KCl	80	71	300	

Table S3. Values of *k* calculated from UV-Vis spectroscopy and CA with Eqs. 5 and 6, respectively

K in mol/(cm ² ·s)	Method	UV	CA
	1M KI		1.2*10 ⁻⁶
1M KI+5% EA		/	1.2*10 ⁻⁶
1M KI+5% PC		/	1.1*10 ⁻⁶
1M KI+5% THF		/	1.1*10 ⁻⁶
1M KI+5% MeOH		/	5.8*10 ⁻⁷
1M KI+5% ACN		/	1.2*10 ⁻⁷
1MKI+7.5% ACN		2.1*10 ⁻⁶	1.3*10 ⁻⁶
1M KI+10% ACN		/	1.2*10 ⁻⁷
1M KI+50% ACN		/	3.3*10 ⁻⁷
2M KI		5.1*10 ⁻⁶	2.2*10 ⁻⁶
2MKI+7.5% ACN		3.1*10 ⁻⁵	3.6*10 ⁻⁶

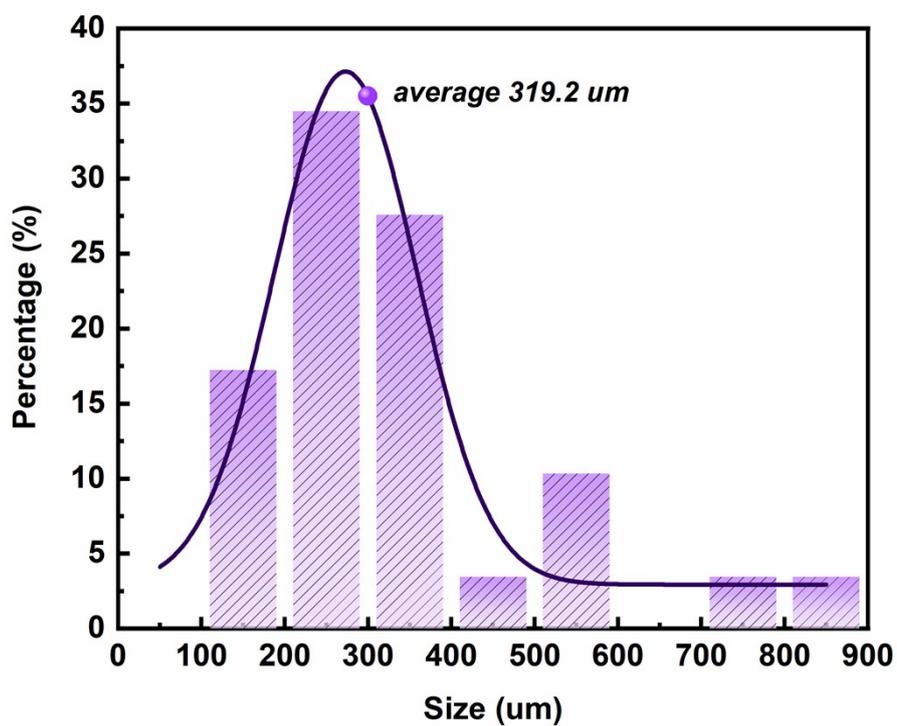


Fig. S1 Size distribution of solid I₂ particles measured by optical microscopy.

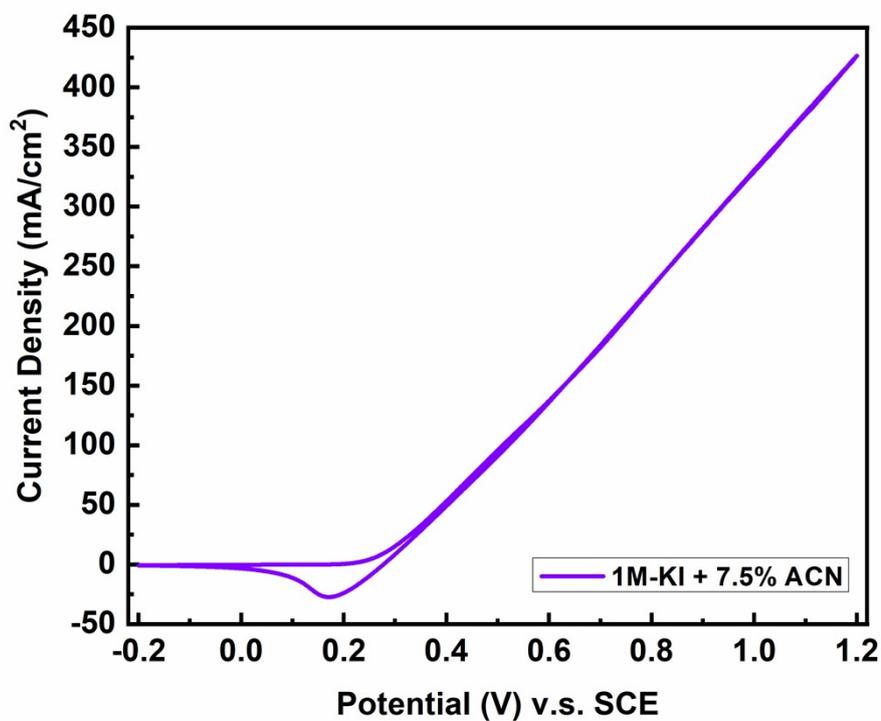


Fig. S2. CV of 1 M KI + 7.5% ACN on a glassy carbon electrode at a scan rate of 50 mV/s. The experimental setup was the same as that of Fig. 2a.

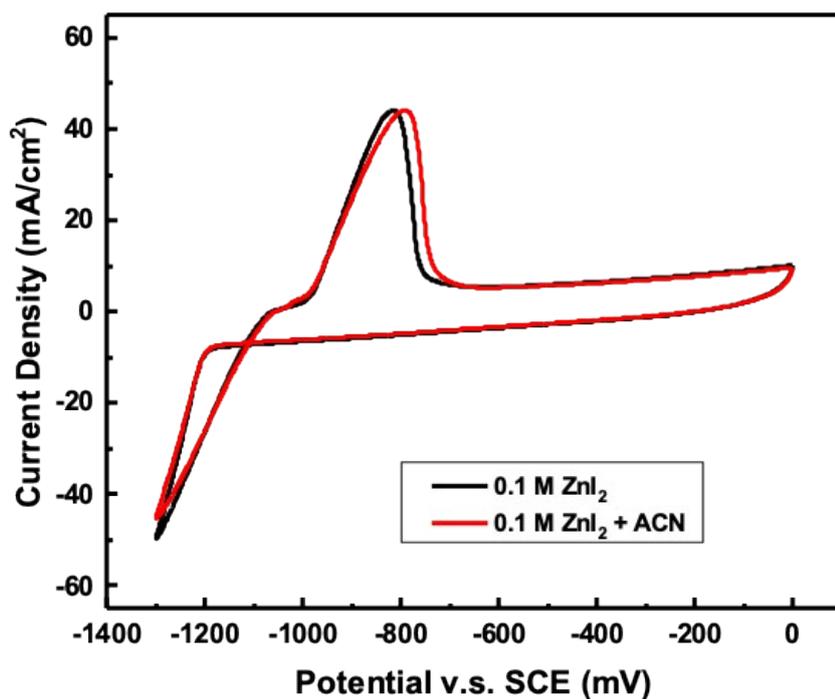


Fig. S3. Zn dissolution and deposition in a 1M ZnI_2 electrolyte with and without ACN, as characterized by CV at 50 mV/s.

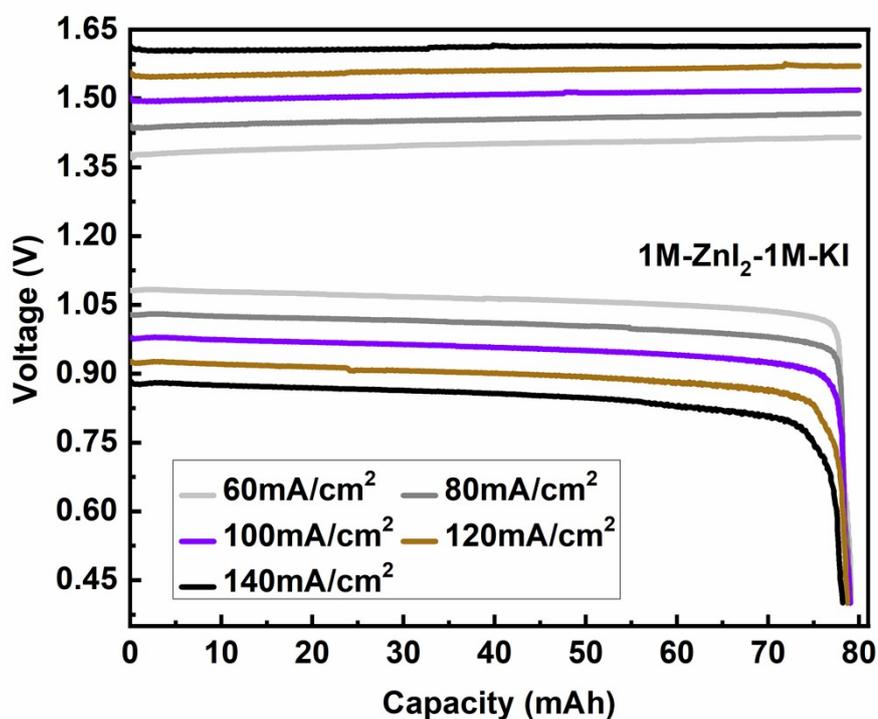


Fig. S4. Charging and discharging curves of a Zn-I_2 flow battery with 1M ZnI_2 + 1M KI at different current densities.

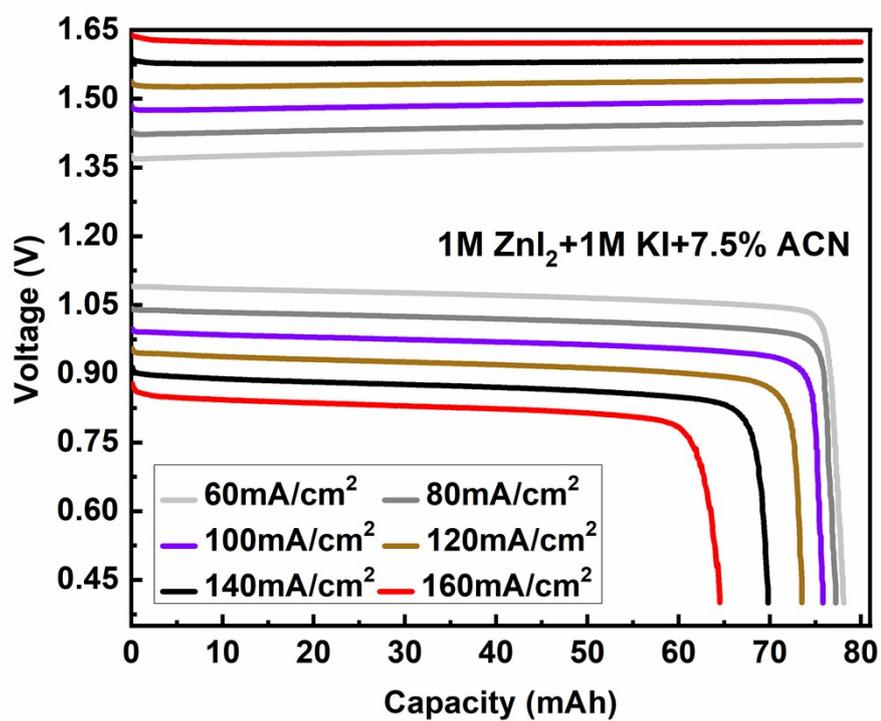


Fig. S5. Charging and discharging curves of a Zn-I₂ flow battery with 1M ZnI₂ + 1M KI + 7.5% ACN at different current densities.