

An Ultra-Long Life Aqueous Full K-Ion Battery

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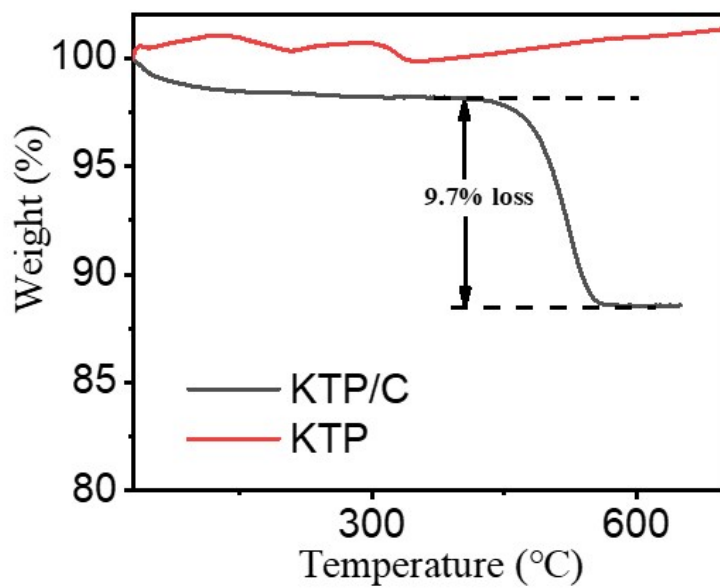


Fig. S1 TGA curves of the KTP and KTP/C nanocomposite.

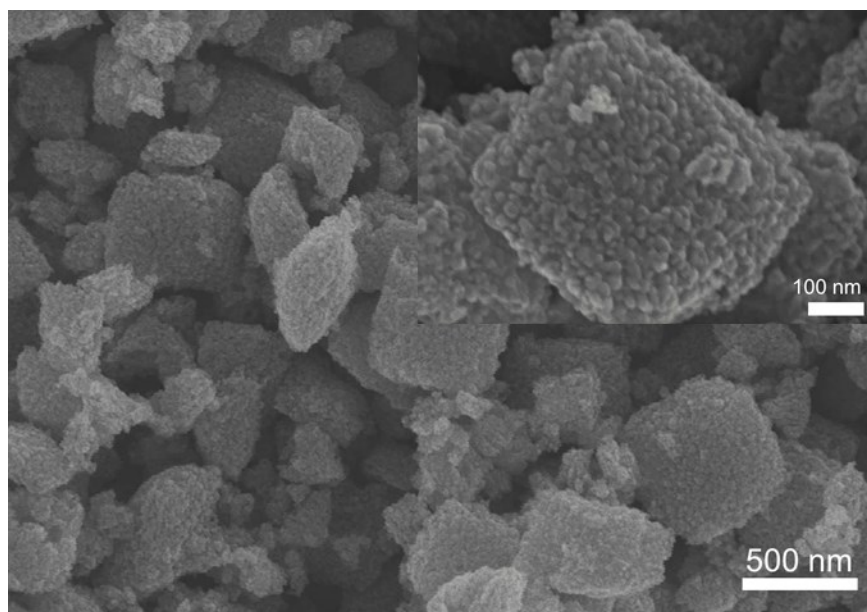


Fig. S2 (a) SEM images of KTP/C in the scale bar of 500 nm and the inset is the high magnification image with a scale bar of 100 nm.

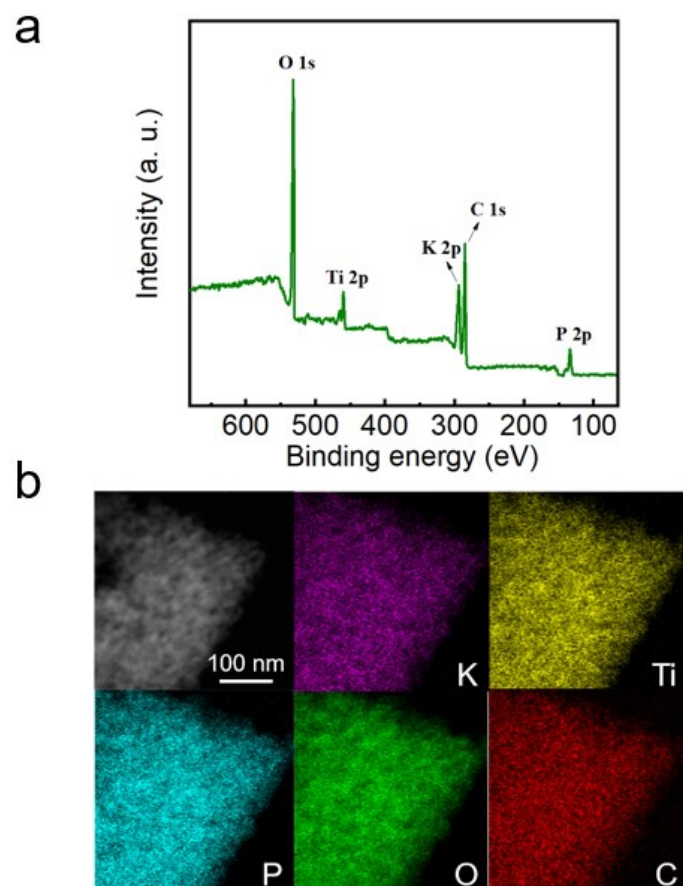


Fig. S3 (a) XPS survey spectrum of the as-prepared KTP/C. (b) EDS elemental mappings of KTP/C.

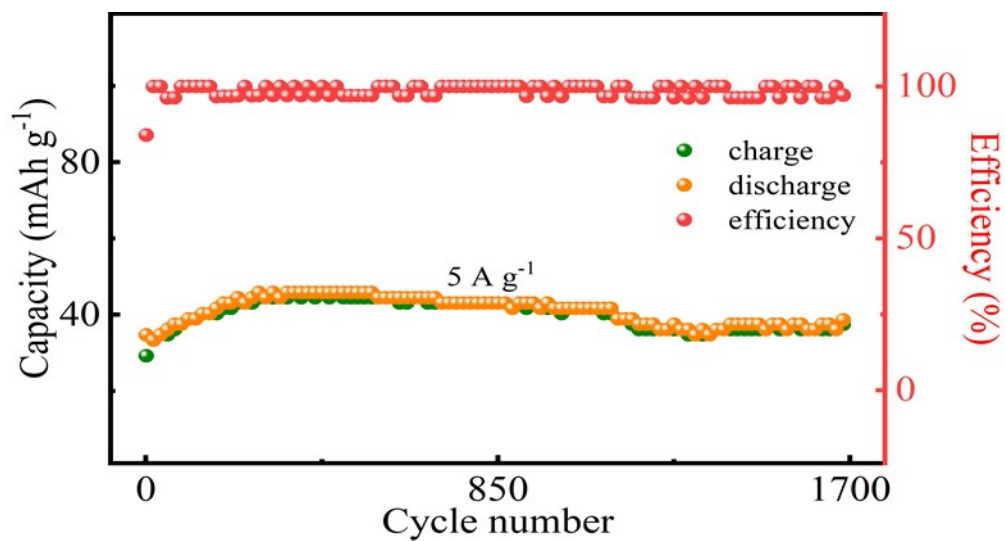


Fig. S4 Long-term cycle performance of the KTP/C electrode at 5 A g⁻¹.

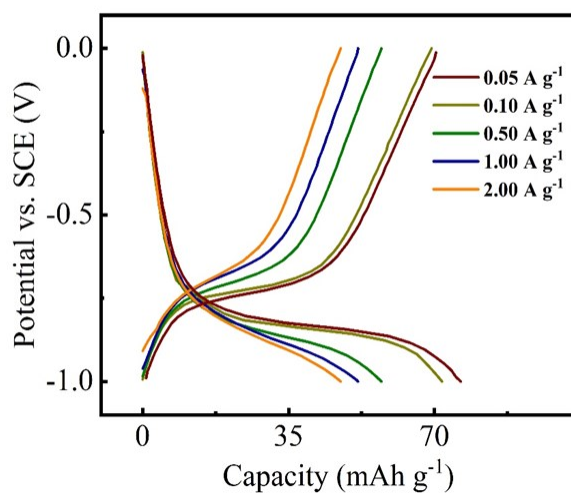


Fig. S5 (a) The charge/discharge curves of KTP/C electrode at various current densities of 0.05, 0.10, 0.50, 1.00 and 2.00 A g⁻¹, respectively, from -1.0 to 0.0 V vs. SCE.

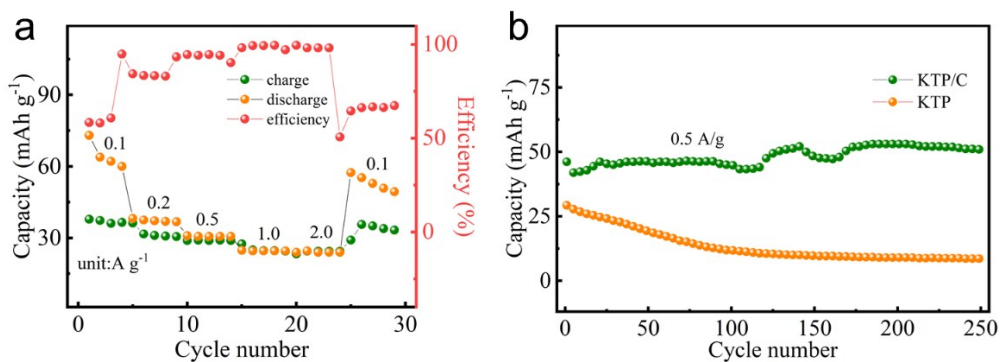


Fig. S6 (a) The rate capability of KTP anode. (b) The comparison of cycling stability between KTP and KTP/C anodes at 0.5 A g⁻¹.

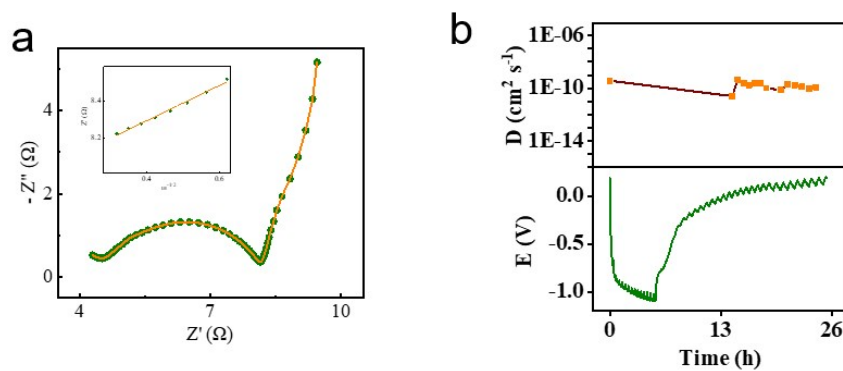


Fig. S7 K^+ diffusion coefficient was investigated through electrochemical impedance spectroscopy (EIS) method (a) and galvanostatic intermittent titration technique (GITT) (b). The D_{K^+} of KTP/C is $3.25 \times 10^{-10} \text{ cm}^2 \text{ s}^{-1}$ calculated from EIS result, which is close to the result from GITT.

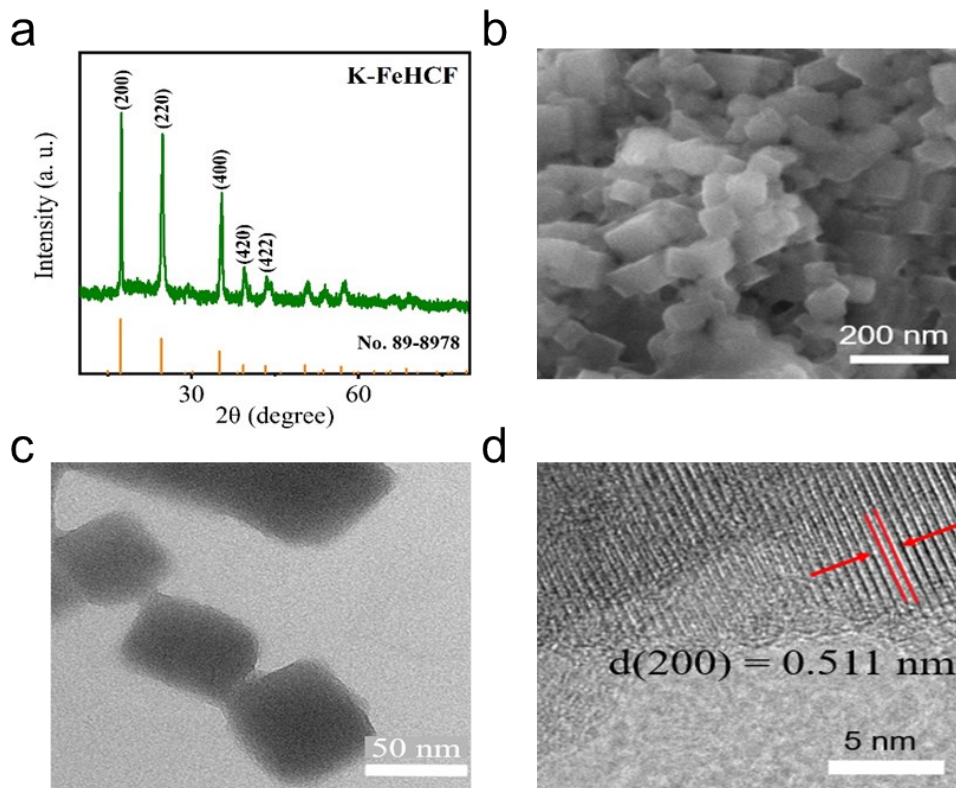


Fig. S8 (a) The XRD pattern of K-FeHCF. The SEM image (b), TEM image (c) and HRTEM image (d) of K-FeHCF in the scale bar of 200 nm, 50 nm and 5 nm, respectively.

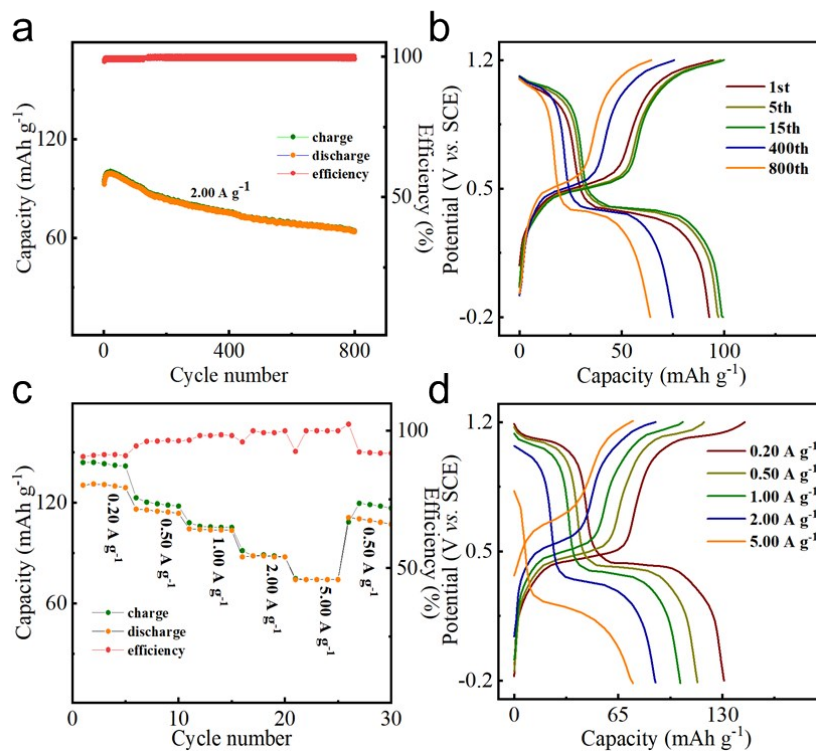


Fig. S9 (a) The long cycle performance of K-FeHCF electrode at a current density of 2.0 A g⁻¹ and the 1st, 5th, 15th, 400th and 800th charge/discharge curves (b) in a voltage range of -0.2 to 1.2 V vs. SCE. (c) The specific capacities of K-FeHCF electrode at various current densities (0.2 to 5.0 A g⁻¹) and the charge/discharge curves (d) in a voltage range of -0.2 to 1.2 V vs. SCE. All data in (a-d) were measured by a three-electrode system with K-FeHCF, active carbon and SCE as working, counter and reference electrode, respectively.

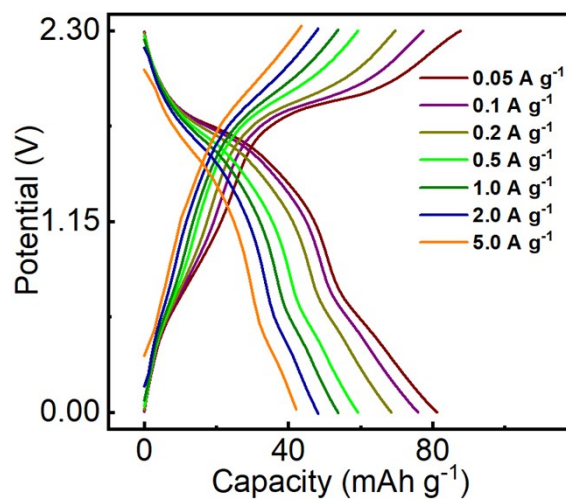


Fig. S10 The charge/discharge curves of K-FeHCF//21 m KCF₃SO₃//KTP/C full cell at various current densities (0.05 to 5.0 A g⁻¹) in a voltage range of 0.0 to 2.3 V (all data were based on KTP/C).

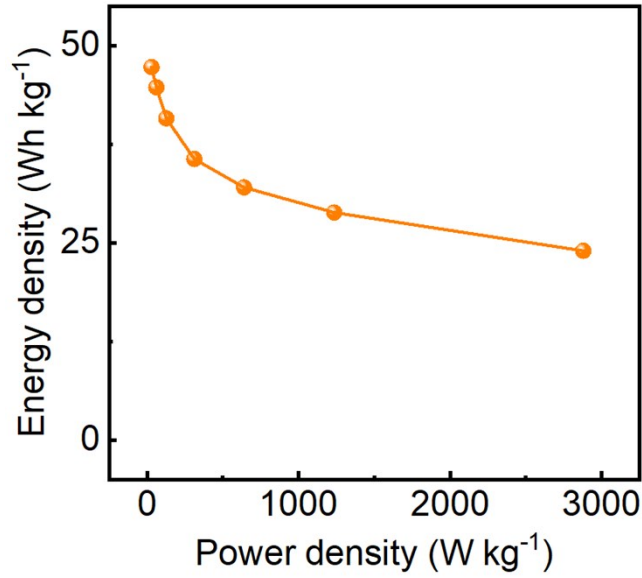
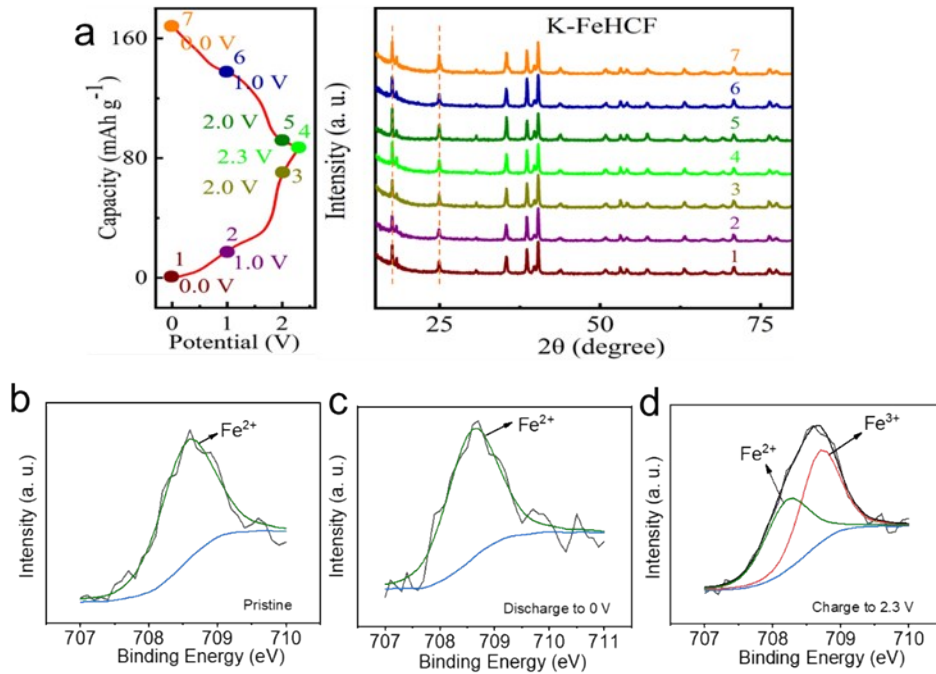


Fig. S11 A Ragone plot of the K-FeHCF//21 m KCF₃SO₃//KTP/C full cell, the energy and power densities were calculated based on the total mass weights of the cathode and anode active materials.



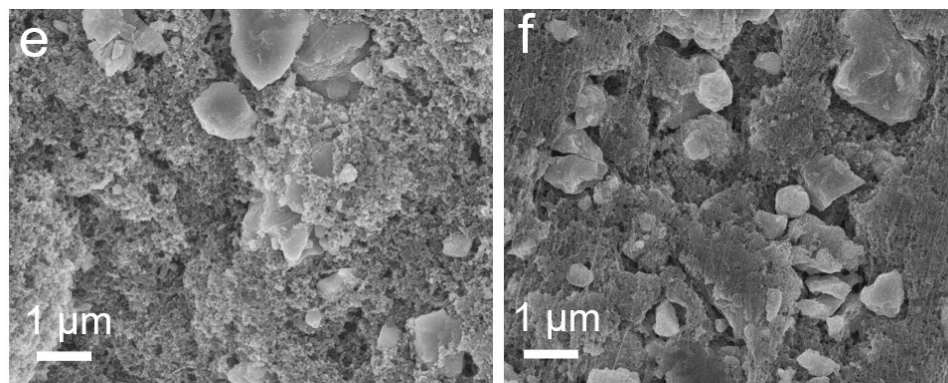


Fig. S12 (a) The ex-situ XRD patterns of K-FeHCF in the full cells at different states, the cells were first cycled 10 cycles then charged/ discharged to desired states at 0.05 A g^{-1} , the marked dots from 1 to 7 in the GCD curves (left) represent the states measured by ex-situ XRD (right). XPS spectra of the Fe 2p in pristine (b), discharge to 0 V (c), and charge to 2.3 V (d). SEM images of K-FeHCF cathode in pristine (e) and after 1000 cycles (f). Only one Fe 2p signal around 708.5 eV in the pristine and full discharged state can be obtained, which should be assigned to the Fe^{2+} . When the full cell was charged to 2.3 V, there are two Fe 2p signals can be assigned to Fe^{2+} and Fe^{3+} ($\text{Fe}^{2+}:\text{Fe}^{3+}=46:44$). Only 44% of the Fe^{2+} is oxidized to Fe^{3+} meaning that the positive electrode (K-FeHCF) is in a shallow charge and discharge state (low SOC state), which also reflects in the ex-situ XRD results because only a part of the potassium ions are involved in the (de)intercalation. Besides, the morphology of the K-FeHCF cathode did not change after 1000 cycles at 0.5 A g^{-1} .