Supporting information for

Wire-In-Wire TiO_2/C Nanofibers Free-Standing Anodes for Li-Ion and K-Ion Batteries with Long Cycling Stability and High Capacity

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Supplementary Tables and Figures

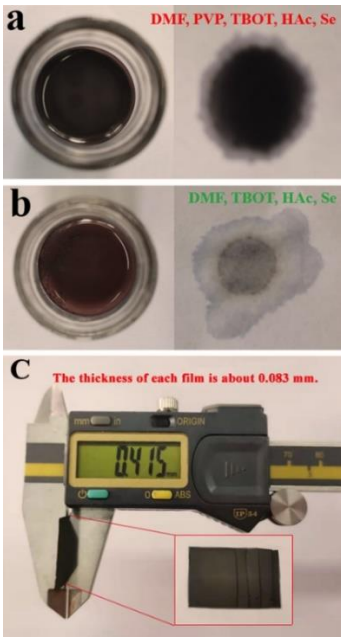

Fig. S1 Digital photos of **(a)** precursor solution (including DMF, PVP, TBOT, HAc, and Se) and **(b)** the solution without PVP, **(c)** the digital photo of the thickness of TiO_2 ww/CN film (There are five films here, thus every film is about 0.083 mm)

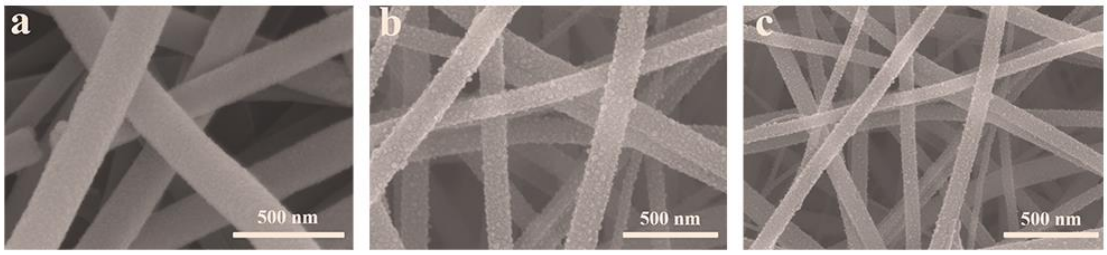

Fig. S2 FE-SEM images of **(a)** the precursor nanofibers of TiO_2 ww/CN; **(b)** the precursor nanofibers and **(c)** the carbonized nanofibers for TiO_2/CN

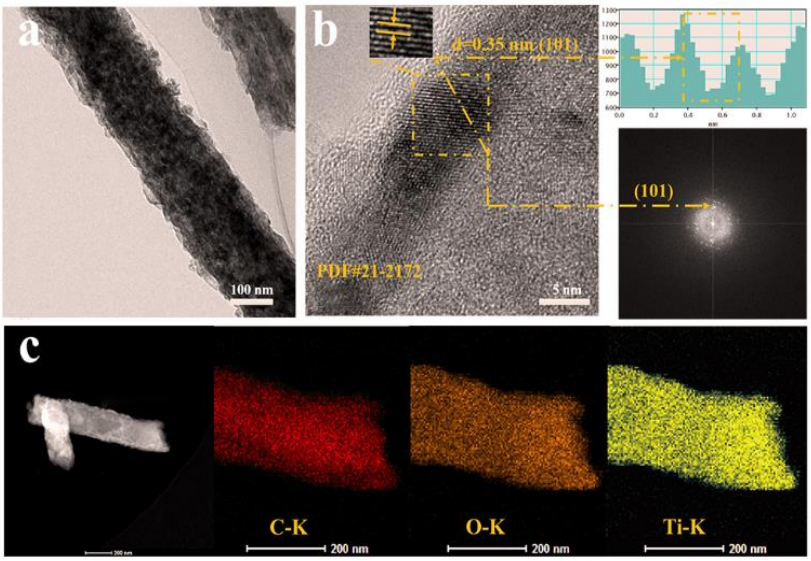

Fig. S3 FE-TEM images of TiO_2/CN: **(a)** FE-TEM image, **(b)** HRTEM images, and **(c)** EDX elemental mapping images of C, O, Ti

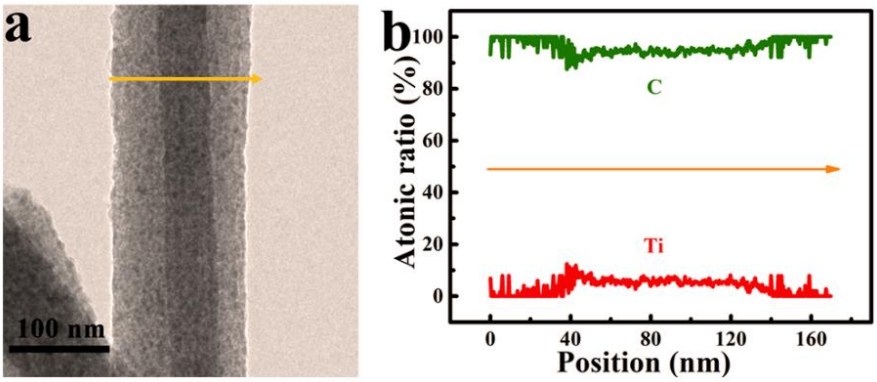

Fig. S4 (a) FE-TEM image and **(b)** the corresponding TEM-EDX lines of the atomic ratio of the elements (C and Ti) of TiO_2 ww/CN

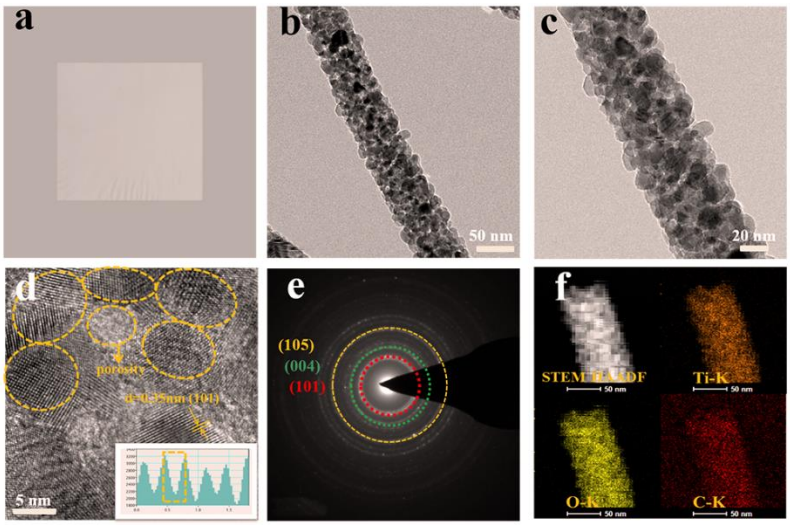

Fig. S5 (a) Digital photo, **(b, c)** FE-TEM images, **(d)** HRTEM images, **(e)** crystal diffraction ring, and **(f)** EDX elemental mapping image of TiO_2 nanowires film obtained from burning TiO_2 ww/CN film in the air at 400 °C for 2h

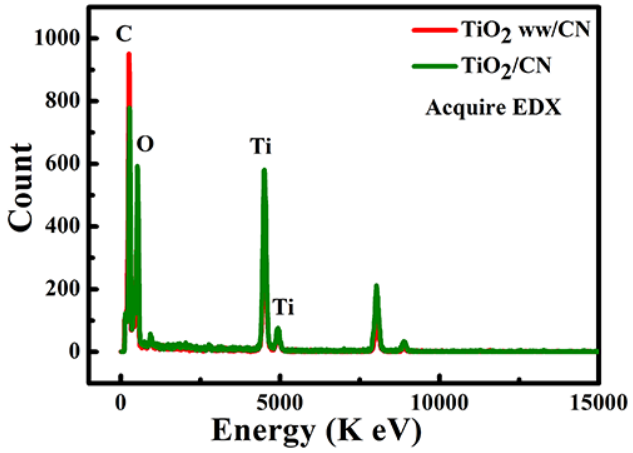

Fig. S6 EDS spectrum form FE-TEM of TiO_2 ww/CN and TiO_2/CN

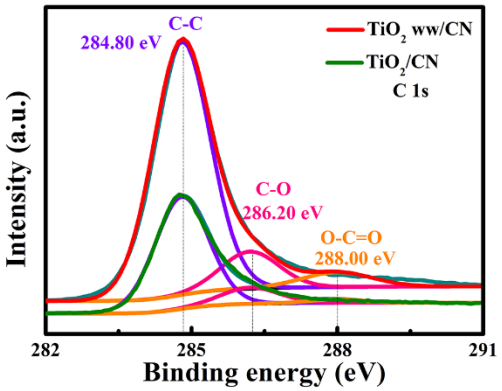

Fig. S7 High resolution C 1s of TiO_2 ww /CN and TiO_2/CN

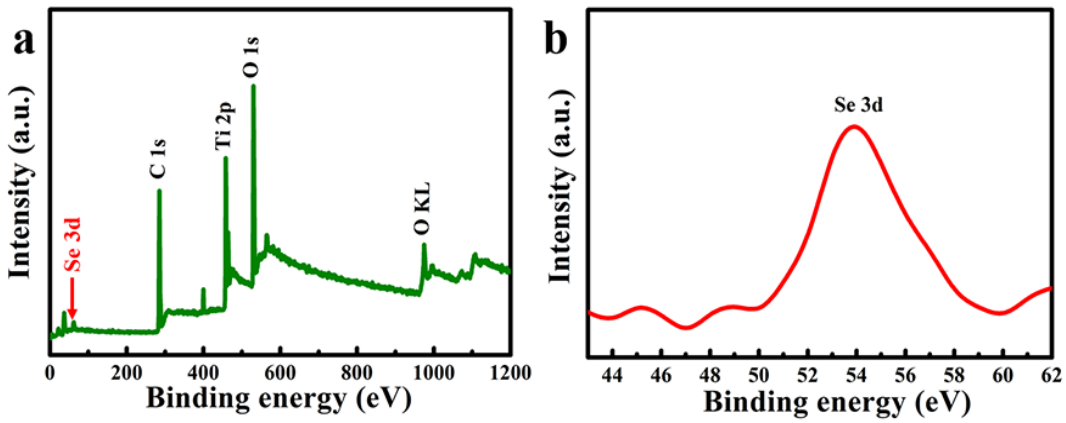

Fig. S8 (a) XPS survey spectra and **(b)** the high resolution Se 3d of the precursor solution of TiO_2 ww/CN

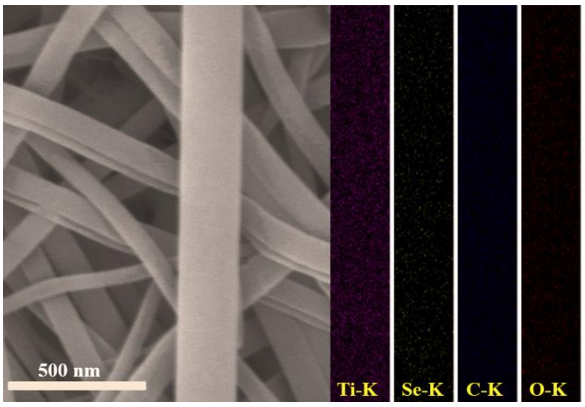

Fig. S9 FE-SEM image EDAX of the precursor nanofibers of TiO_2 ww/CN

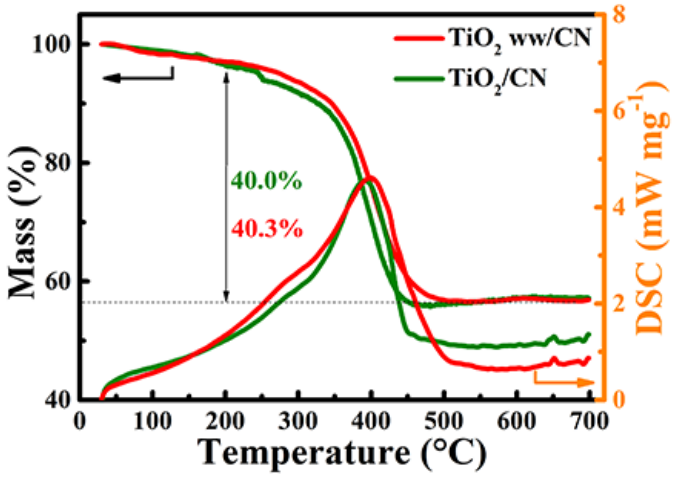

Fig. S10 TG curves in the air at 5 °C min^{-1} of TiO_2 ww/CN and TiO_2/CN

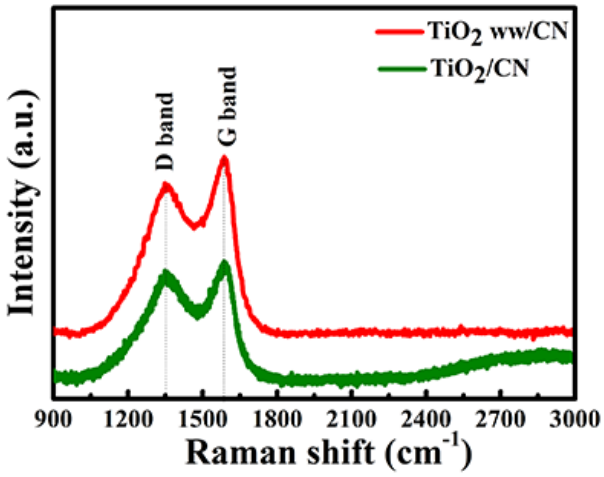

Fig. S11 Raman spectrums of TiO_2 ww/CN and TiO_2/CN

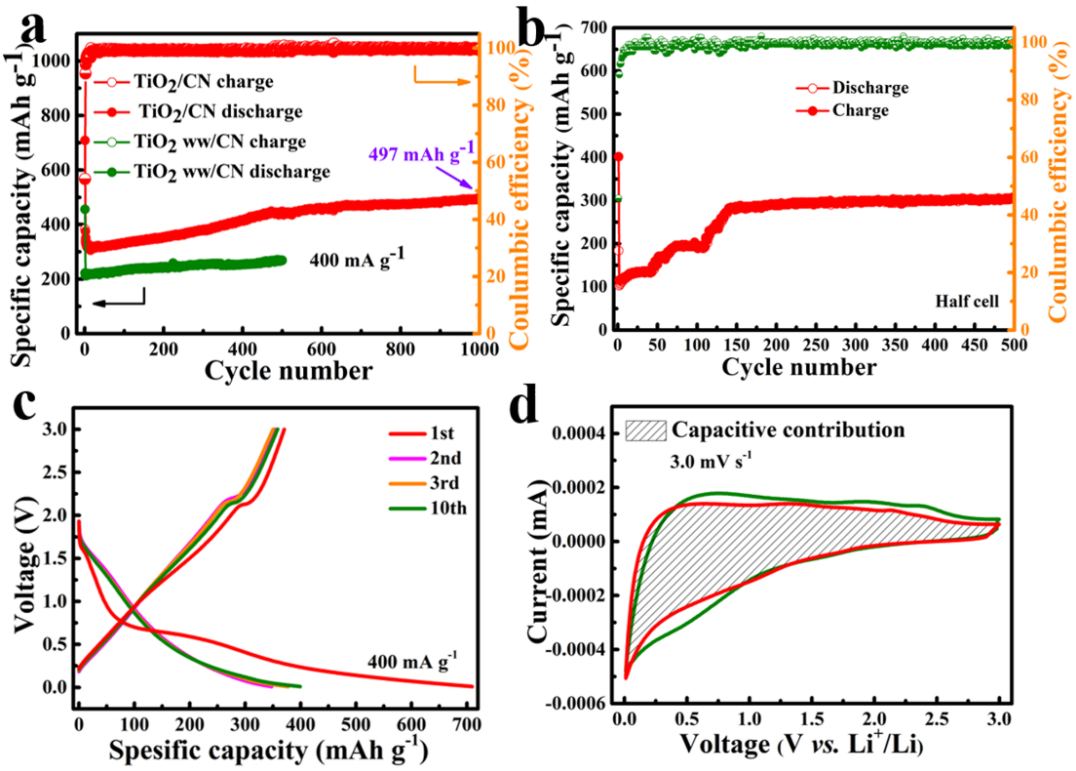

Fig. S12 TiO_2 ww/CN in LHCs: **(a)** cycling stability of TiO_2 ww/CN electrode and TiO_2/CN electrode, **(b)** cycling performance at 5 A g^{-1} for TiO_2 ww/CN electrode at first 500 cycles, **(c)** discharge-charge voltage profiles of TiO_2 ww/CN electrode at 400 mA g^{-1}, and **(d)** the integral area diagram of TiO_2 ww/CN film electrode in 3.0 mV s^{-1}

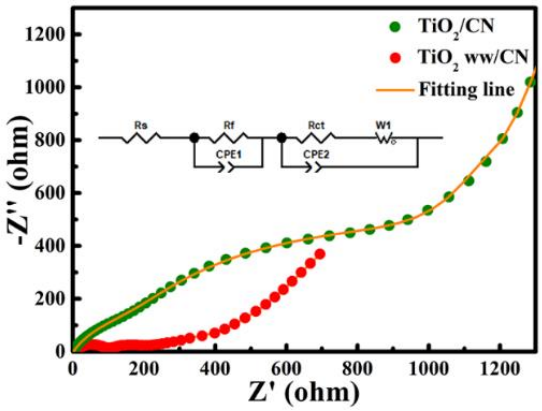

Fig. S13 Nyquist plots of TiO_2/CN and TiO_2 ww/CN after 1 cycle at a current density of 50 mA g^{-1} in LHCs, the insert section is the equivalent circuit

Table S1 Simulated impendence parameters (R_s, $R_{f,}$, and R_{ct}) of both TiO_2 ww/CN and TiO_2/CN in LHCs

Samples	R_s (Ω)	R_f (Ω)	R_{ct} (Ω)
TiO_2 ww/CN	1.3	93.8	115.5
TiO_2/CN	1.5	240.0	405.0

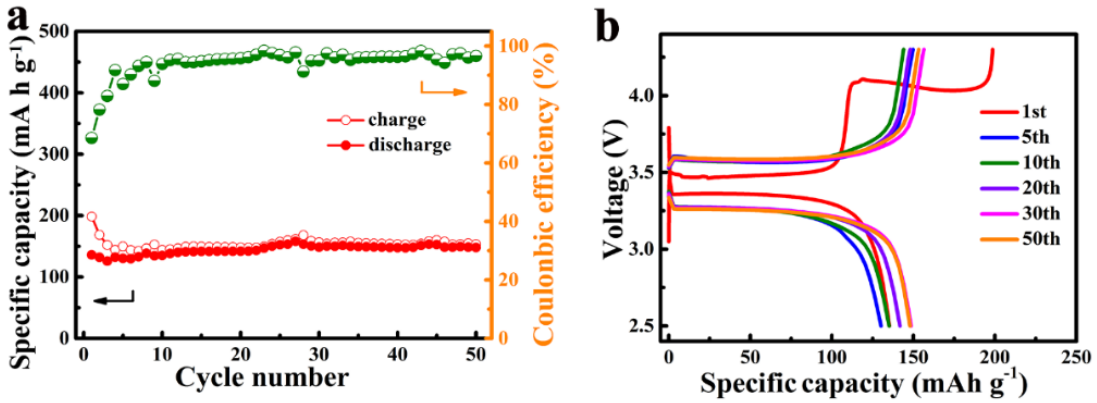

Fig. S14 LFP electrode in LHC: (a) cycling performance at 0.4 A g^{-1} after activating 1 cycle at 0.1 A g^{-1} and **(b)** discharge-charge voltage profiles in the range of 2.5-4.3 V

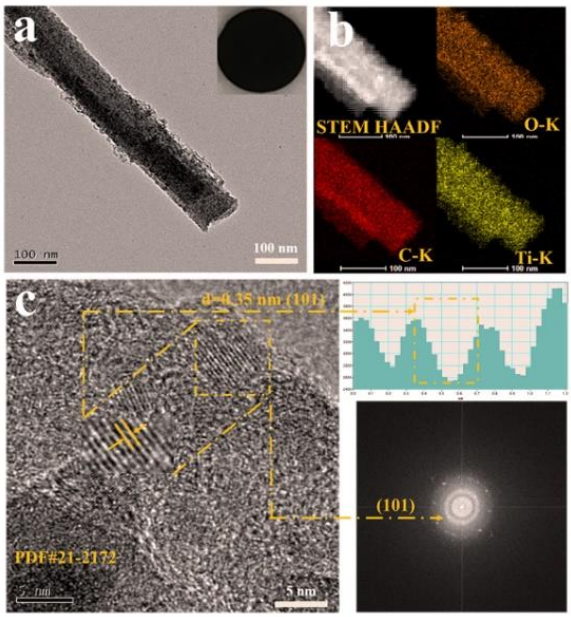

Fig. S15 **(a)** TEM image and the shape of after-cycled electrodes (insert section), **(b)** EDX elemental mapping images, and **(c)** HRTEM images for the TiO_2 ww/CN electrode after 1000 cycles in LHC

Table S2 Electrochemical performance comparison of TiO_2 ww/CN electrode with other partly reported binder-free and free standing TiO_2 anode materials in LHCs in recent five years

Samples	Synthetic method	Current density (mA g^{-1})	Capacity	Voltage range (V)	Refs.
rGO modified N-doped carbon foam supporting TiO_2	rGO to wrap around the 3D NCF by hydrothermalpyrolysis	335	214 mAh g-1 after 150 cycles	1.0-3.0	10.1016/j.electacta.2019.04.136
Foam-like, 3D mesopore N-doped carbon assembling TiO_2 nanoparticles	boiling bubbles as template	168	223 mAh g^{-1} after 200 cycles	0.01-3.0	10.1016/j.jpowsour.2019.02.094
Thick mesoporous TiO_2 films	sol–gel templating using pluronic F127 surfactant	~110	254 mAh g^{-1} after 200 cycles	1.0-3.0	10.1002/adfm.201801849
Preferentially oriented TiO_2 nanotubes	two-step anodization process	16.8	145 mAh g^{-1} after 330 cycles	1.1-3.0	10.1021/acsami.7b11388

TiO_2 layer on N-doped carbon foams	foams as template, then hydrolysis	1000	149 mAh g-1 after 100 cycles	1.0-3.0	10.1002/smll.201602179
TiO_2/super-aligned C nanotube	SACNT array with TBOT via sol-gel	10110	~100 mAh g^{-1} after 1000 cycles	1.0-3.0	10.1021/acssuschemeng.7b03671
EOG/TiO_2(B) nanosheets	EOG foam loaded with oriented TiO_2 (B) nanosheets	500	~325.5 mAh g^{-1} after 10000 cycles	1.0-3.0	10.1016/j.nanoen.2016.01.010
N-doped TiO_2/RGO hybrids	ultrasonication	1675	182.7 mAh g^{-1} after 10000 cycles	1.0-3.0	10.1021/acsaem.8b00836
TiO_2 ww/CN	**electrospun**	**400 and 5000**	**497 mAh g^{-1} after 1000 cycles and 303 mAh g^{-1} after 6000 cycles**	**0.01-3.0**	**This work**

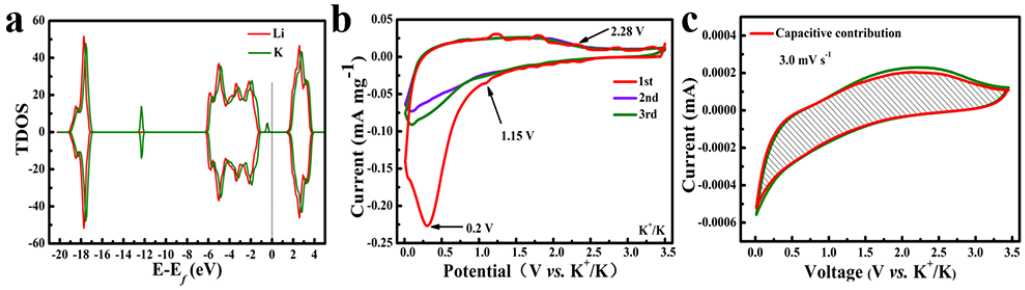

Fig. S16 The TiO_2 ww/CN electrode and TiO_2/CN electrode of **(a)** TDOS of dilute Li and K in TiO_2, **(b)** CV curves of TiO_2 ww/CN film in KHC at 0.1 mV s^{-1}, and **(c)** the integral area diagram of TiO_2 ww/CN film electrode in KHC at 3.0 mV s^{-1}

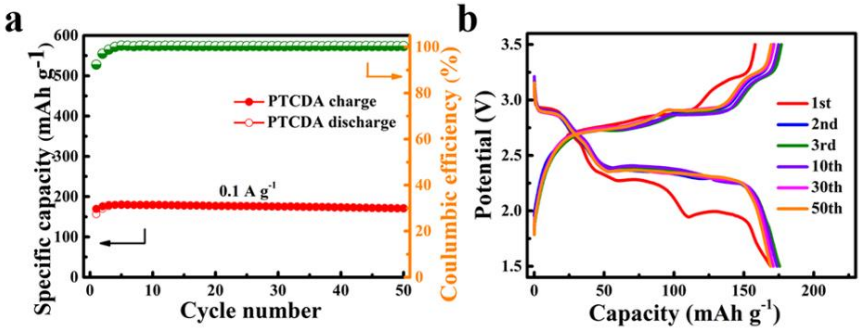

Fig. S17 PTCDA electrode in KHCs: (a) cycling performance at 0.1 A g^{-1} and **(b)** discharge-charge voltage profiles in the range of 1.5-3.5 V

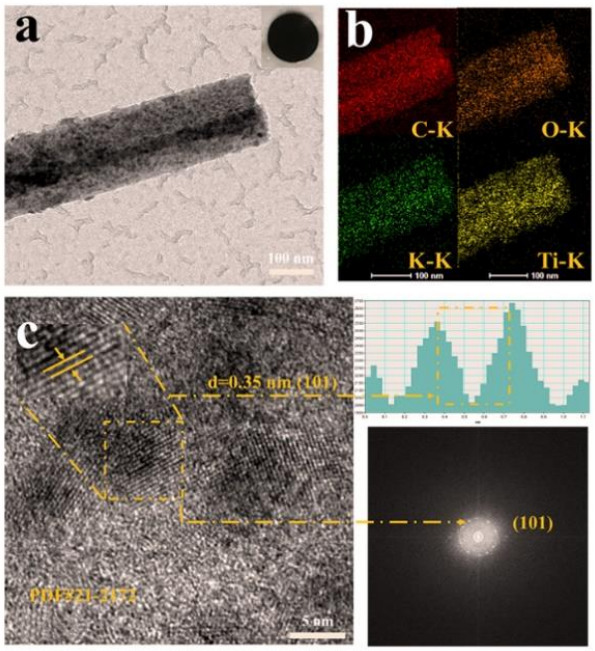

Fig. S18 **(a)** FE-TEM image and the shape of the after-cycled electrode (upper light), **(b)** EDX elemental mapping image, and **(c)** HRTEM images for TiO_2 ww/CN after 1000 cycles in KHC

Table S3 Electrochemical performance comparison of the TiO_2 ww/CN electrode with other reported TiO_2 anode materials in KHCs

Samples	A: B: C * (wt. %)	Current density (mA g^{-1})	Capacity	Voltage range (V)	Reference
Lepidocrocite-Type Layered TiO_2	80: 10: 10	25	37 after 45 cycles	0.01-2.0	10.1021/acsaem.8b00170
MXene-derived TiO_2/RGO	80: 10: 10	200	155 mAh g^{-1} after 200 cycles	0.01-3.0	10.1039/C8TA12069B
Hierarchical TiO_2-C micro-tubes	super P and CMC in water	500	133 mAh g^{-1} after 1200 cycles	0.01-3.0	10.1016/j.nanoen.2019.03.002
TiO_2 ww/CN	**Binder free and free standing**	**50**	**259 mAh g^{-1} after 1000 cycles**	0.01-3.5	**This work**

* A: B: C = active materials: binder: conductive additive