Electronic Supplementary Material (ESI) for Nanoscale.

$K_2Ti_6O_{13}$/carbon core-shell nanorods as superior anode material for high-rate potassium ion batteries

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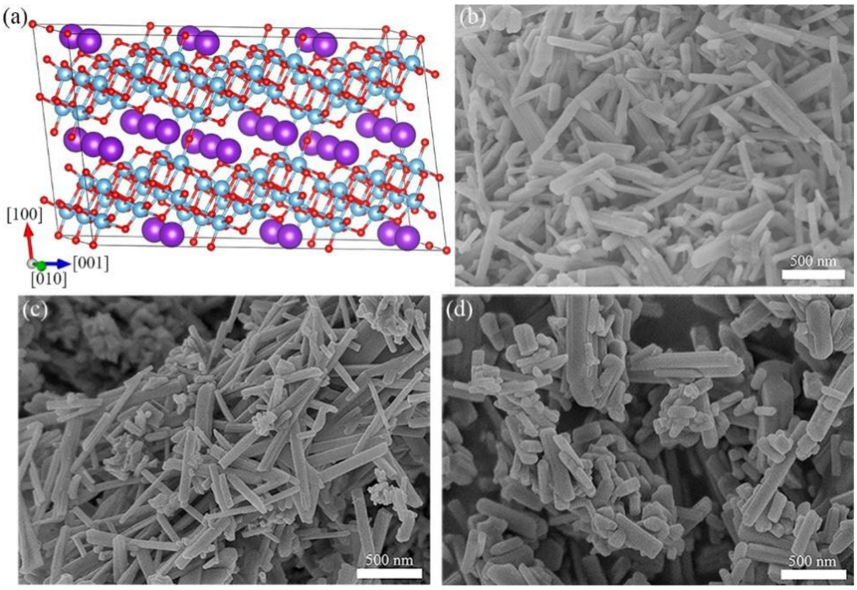
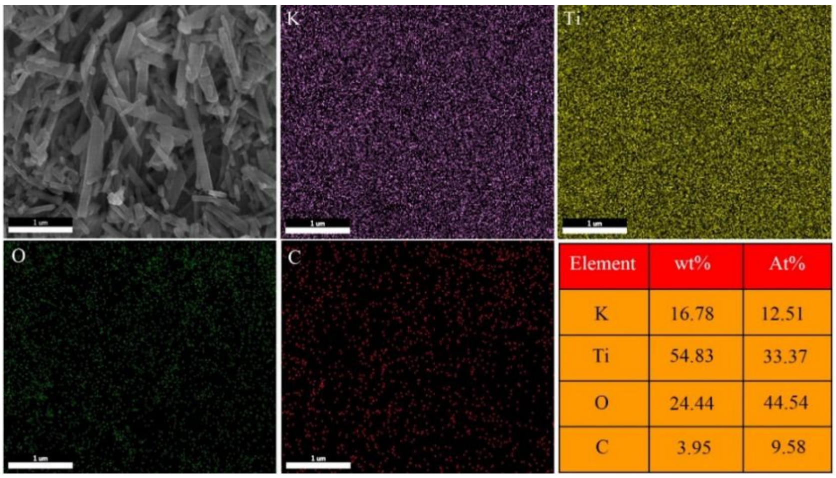


Fig.S1 (a) Ball and stick model of the crystal structure of the $K_2Ti_6O_{13}$ with the space group C2/m (a=15.82428 Å, b=3.82021 Å, c=9.23647 Å); SEM images of as-prepared samples: (b) $K_2Ti_6O_{13}$; (c) KTO/C-600 and (d) KTO/C-800.



Element	wt%	At%
K	16.78	12.51
Ti	54.83	33.37
O	24.44	44.54
C	3.95	9.58

Fig.S2 EDX mapping of KTO/C-700

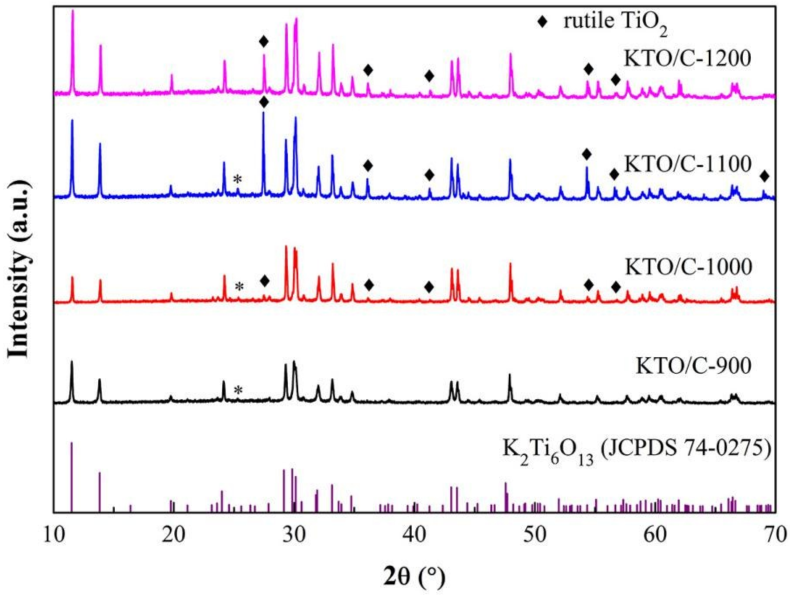


Fig.S3 XRD patterns of the KTO/C-900, KTO/C-1000, KTO/C-1100 and KTO/C-1200

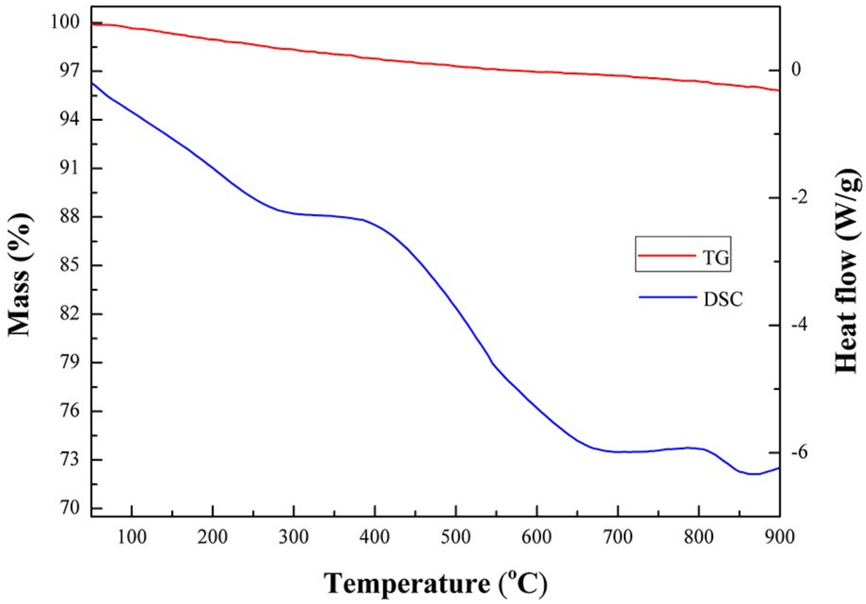


Fig.S4 TGA/DSC of KTO/C precursor at a rate of 10 °C min^{-1} in N_2

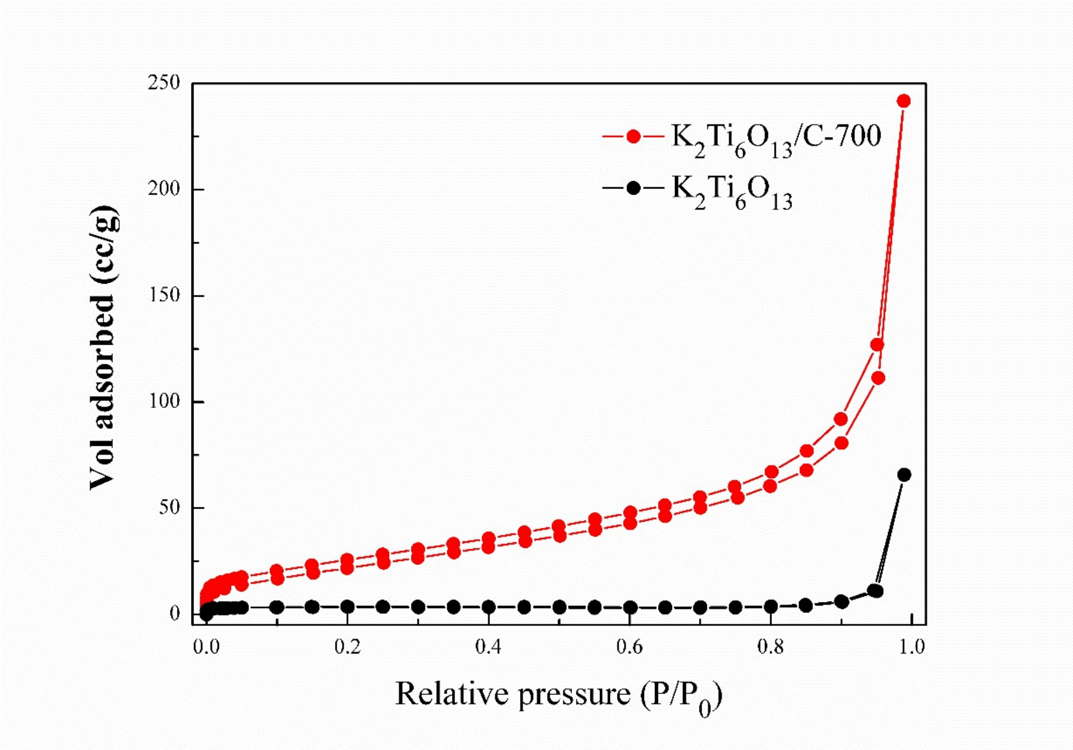


Fig.S5 Adsorption-desorption isotherms of $K_2Ti_6O_{13}$ and $K_2Ti_6O_{13}$/C-700

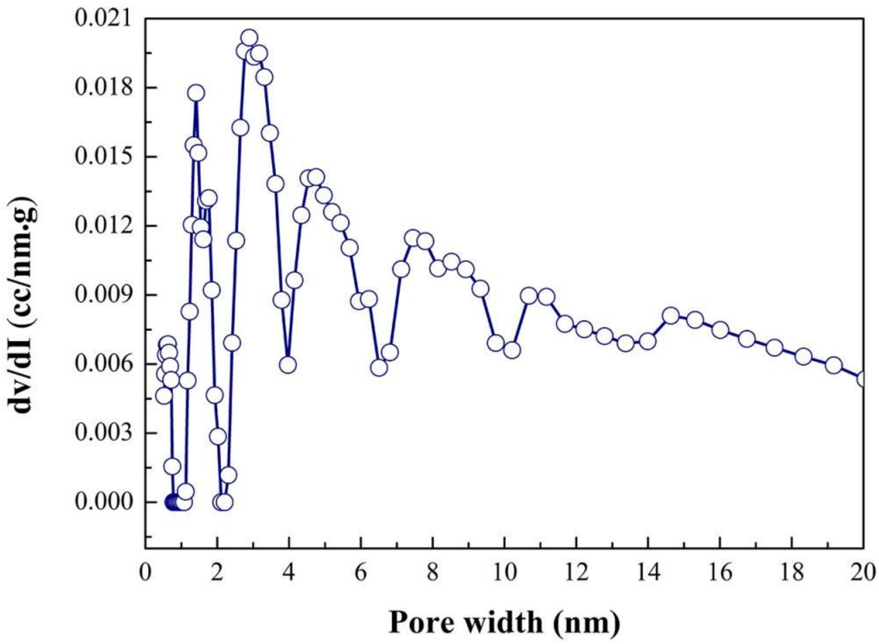


Fig.S6 Pore size distributions of KTO/C-700

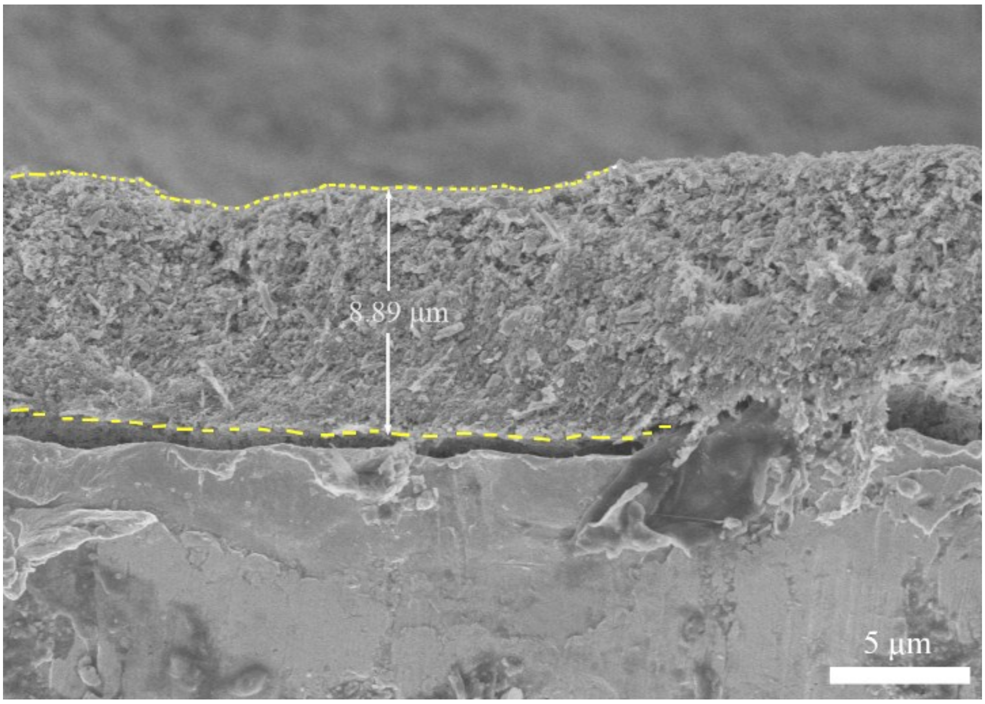


Fig.S7 SEM image of cross-section of electrode for $K_2Ti_6O_{13}$/C-700

The mass loading of the active materials were about 1.1 mg cm^{-1}. As shown in Fig.S5, a typical electrode thickness was about 8.89 µm. Thus, the density of the electrode was about 1.77 g cm^{-3} (based on the total mass including active material, super-p carbon and PVDF, except for copper collector). In order to precisely characterize the compaction density of the as-prepared products themselves, the obtained powders were pressed into green bodies (Fig.S6) under 10 MPa pressure by using a manually tablet machine (769YP-15A, Tianjin KeQi High & New Technology Corporation, Tianjin, China). The obtained values are shown in the table S1.

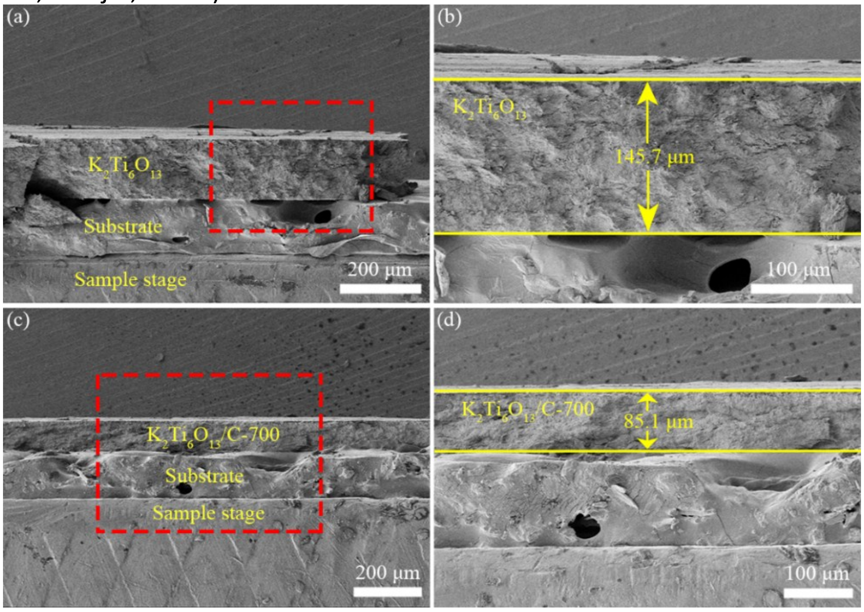


Fig.S8 SEM images of cross-sections of green bodies of (a, b) $K_2Ti_6O_{13}$ and (c, d) $K_2Ti_6O_{13}$/C-700 with a manually tablet machine (769YP-15A, Tianjin KeQi High & New Technology Corporation, Tianjin, China) under about 10 MPa pressure.

Table S1. Compacted density of the several common anode materials

Morphology	Synthesis method	Compacted density (g cm^{-3})	Pressure (MPa)	Application	Ref.
Sulfur and nitrogen dual-doped graphene	Chemical vapor deposition	0.4	10	LIBs	[1]
Reduced graphene oxide	Solvent evaporation method	1.3	15	Supercapacitors	[2]
SiO_x@Fe_3O_4@FLG	Ball milling	1.86	16	LIBs	[3]
Si@SiO_2	High pressure and ball milling	1.11	17.6	LIBs	[4]
$Li_4Ti_5O_{12}$	Pyrolysis	1.7	-	LIBs	[5]
Epanded graphite	-	1.68	7	Fuel cells	[6]
Carbon nanotubes	-	0.58	0.3-0.4	-	[7]
Carbon nanowires	-	0.52	0.3-0.4	-	[7]
$K_2Ti_6O_{13}$	**hydrothermal process**	**1.91**	**10**	**PIBs**	**This work**
$K_2Ti_6O_{13}$/C	**hydrothermal process**	**1.88**	**10**	**PIBs**	**This work**

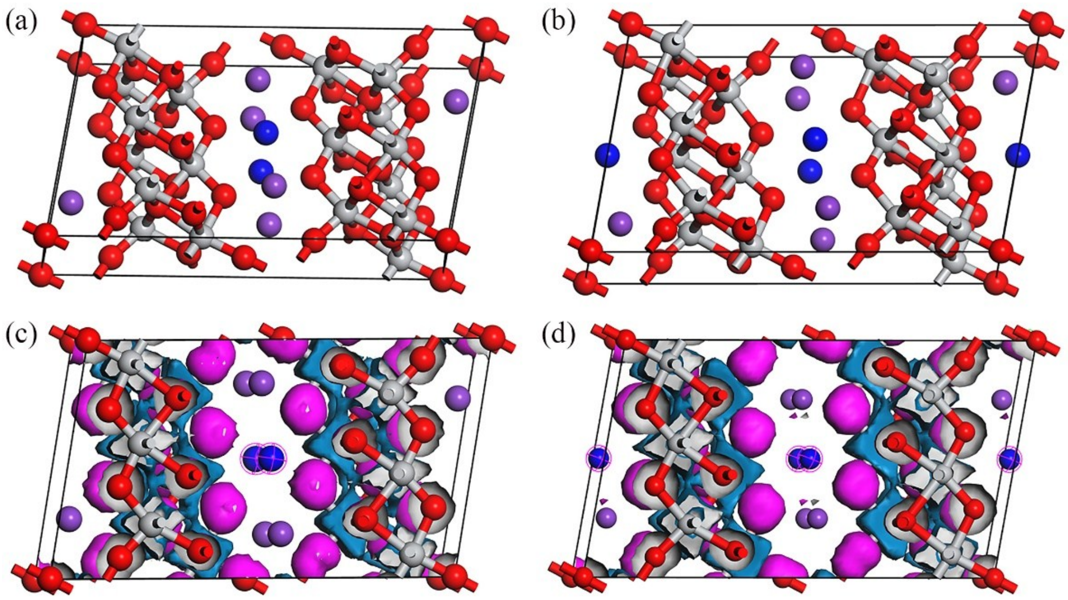


Fig.S9 DFT predicted crystal structures of $K_{2+x}Ti_6O_{13}$. (a) $K_{2+0.5}Ti_6O_{13}$, (b) $K_{2+1}Ti_6O_{13}$ and (c,d) the corresponding electron density difference plots.

Table S2 Lattice parameters of $K_{2+x}Ti_6O_{13}$ collected at various potassium compositions

	a	*b*	*c*	*β*	*Cell vol*	*x in $K_{2+x}Ti_6O_{13}$*
orignal	17.099	3.727	9.686	100.407	607.068	0
Sample A	16.730	4.012	9.581	99.629	633.985	0.5
Sample B	16.470	4.035	9.755	100.549	637.374	1

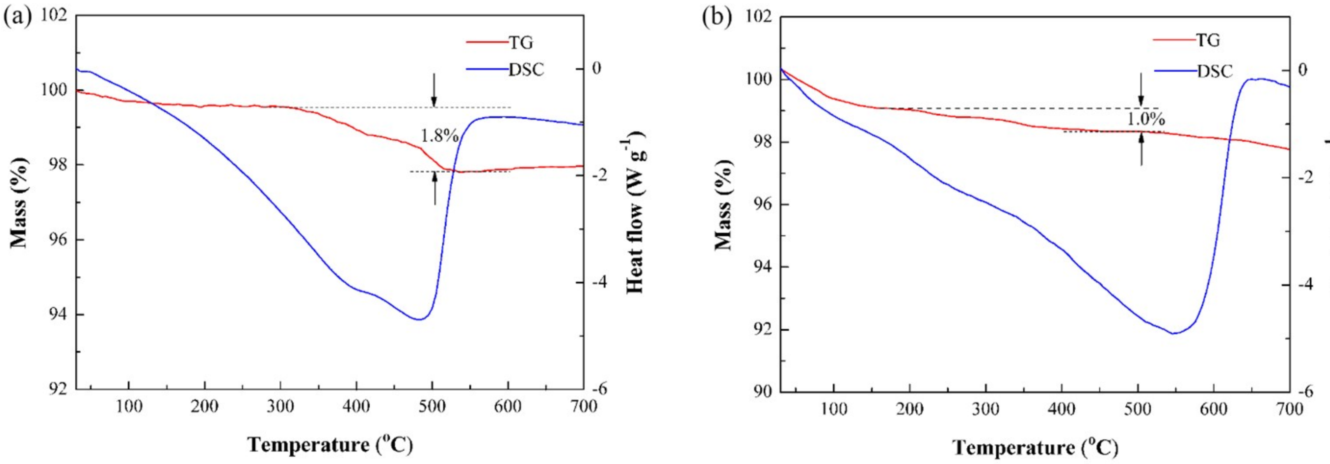


Fig.S10 TGA/DSC of (a) KTO/C-700 and (b) KTO/C-800 at a rate of 10 °C min^{-1} in Air

Table S3 Nyquist Analysis of $K_2Ti_6O_{13}$, KTO/C-600, KTO/C-700 and KTO/C-800 anodes before cycling

Sample	R_s (Ω)	R_{ct} (Ω)
$K_2Ti_6O_{13}$	2.90	16877
KTO/C-600	2.68	9987
KTO/C-700	2.13	3078
KTO/C-800	3.79	8487

Refer

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