Electronic Supplementary Information

CVD-Assisted Fabrication of Hierarchical Microparticulate Li_2TiSiO_5-Carbon Nanospheres for Ultrafast Lithium Storage

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Supporting information

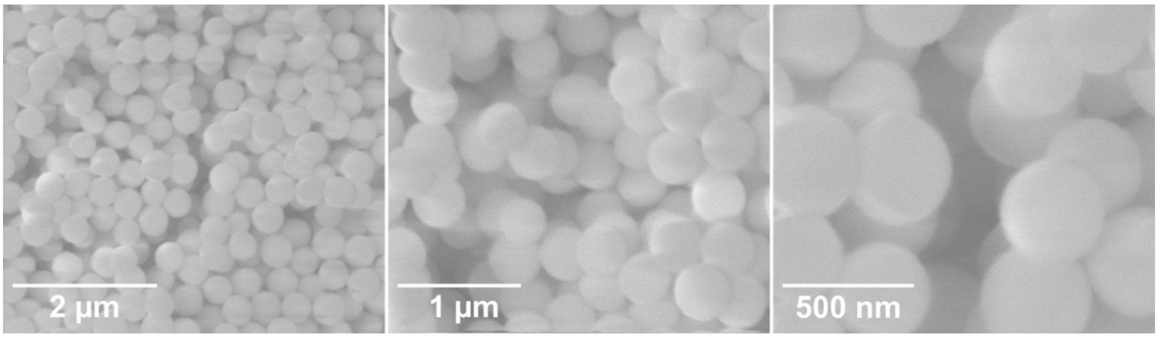

Figure S1. SEM images of SiO_2 template particles.

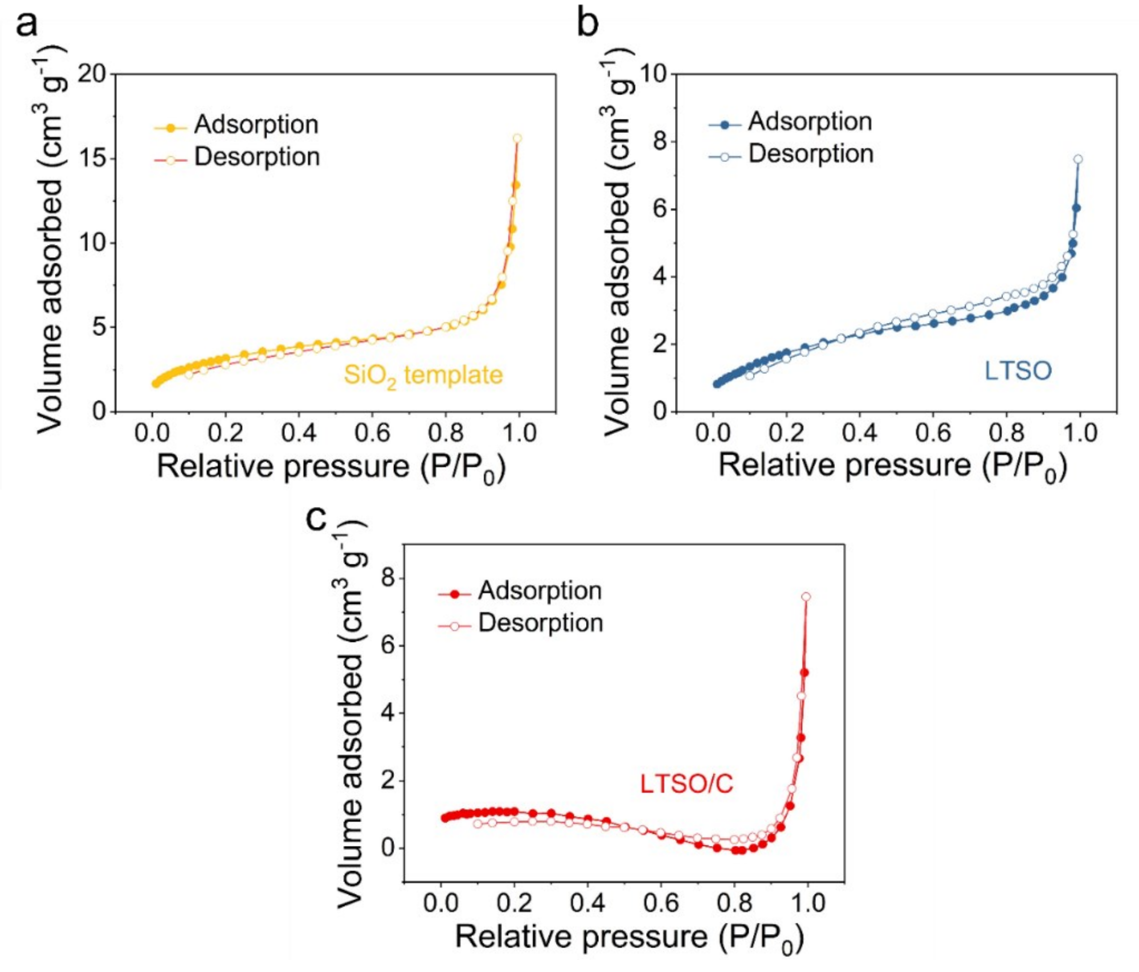

Figure S2. N_2 adsorption/desorption isotherms: a) SiO_2 template; b) LTSO and c) LTSO/C.

Figure S3. Illustration of tape density measurement of 2.5 g LTSO/C in a 4 ml glass vial.

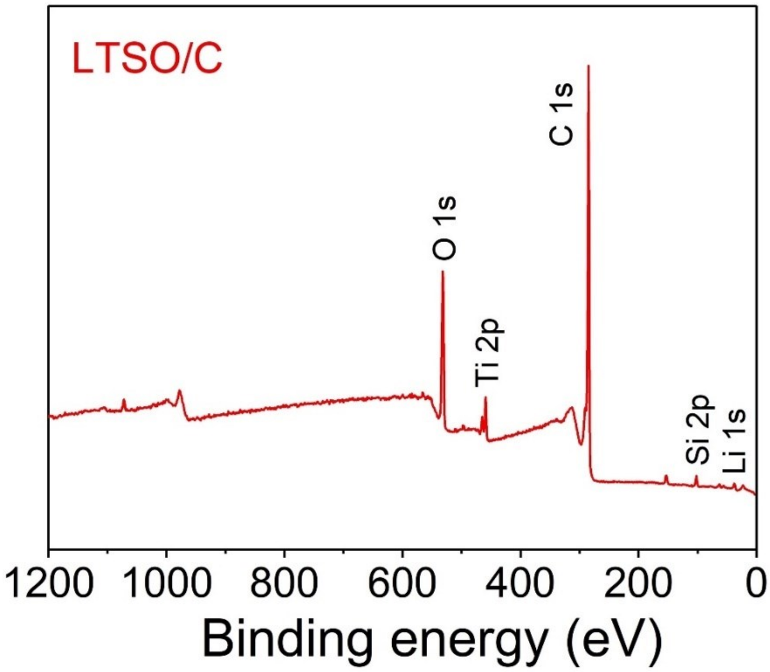

Figure S4. Full XPS spectra of LTSO/C.

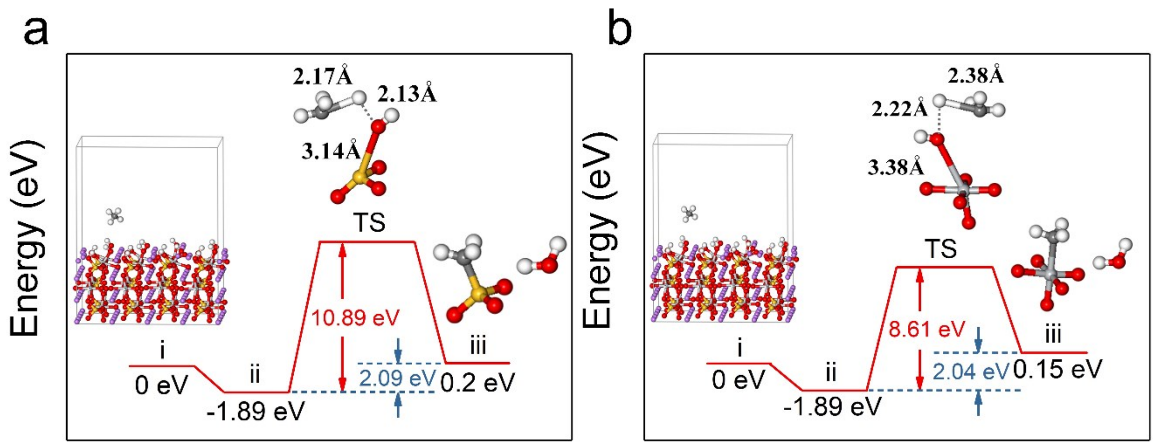

Figure S5. Reaction paths in CVD for LTSO with the different active sites: a) Si–OH group as active site; b) Ti–OH as active site.

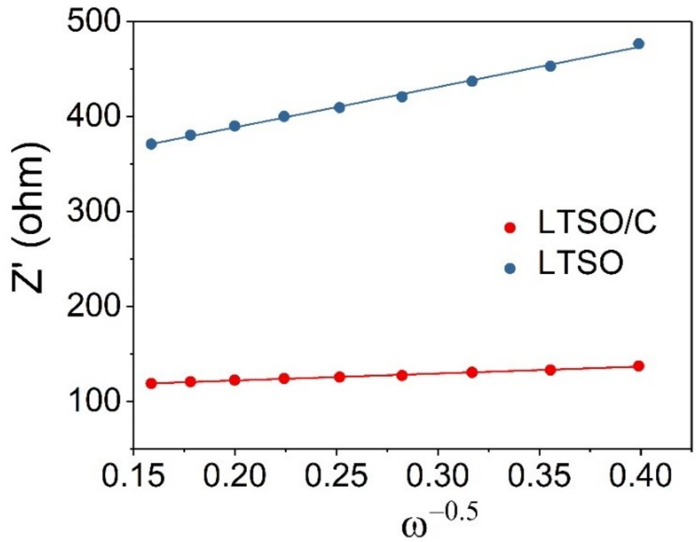

Figure S6. Fitting lines for calculation of Li^+ diffusion coefficient in the Warburg diffusion region.

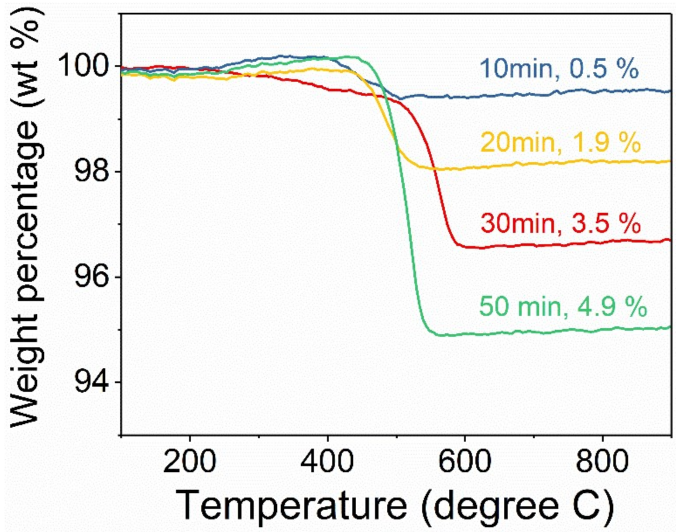

Figure S7. TG results of LTSO/C composites with different CVD treatment durations.

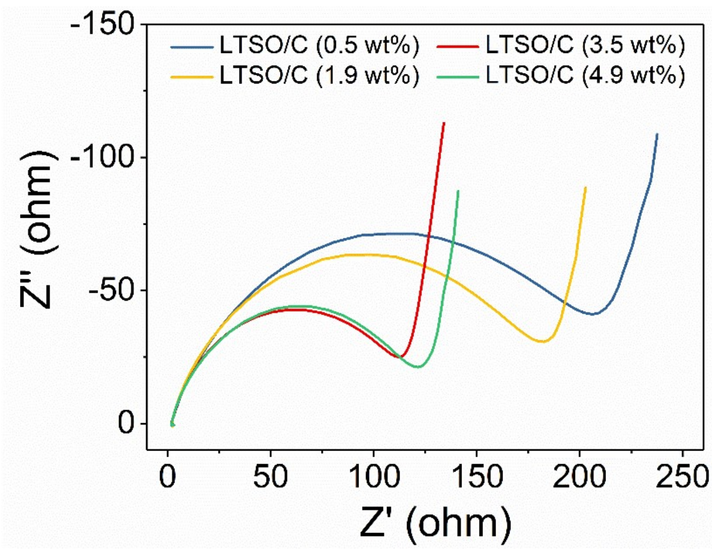

Figure S8. Nyquist plots of LTSO/C composites with different carbon contents.

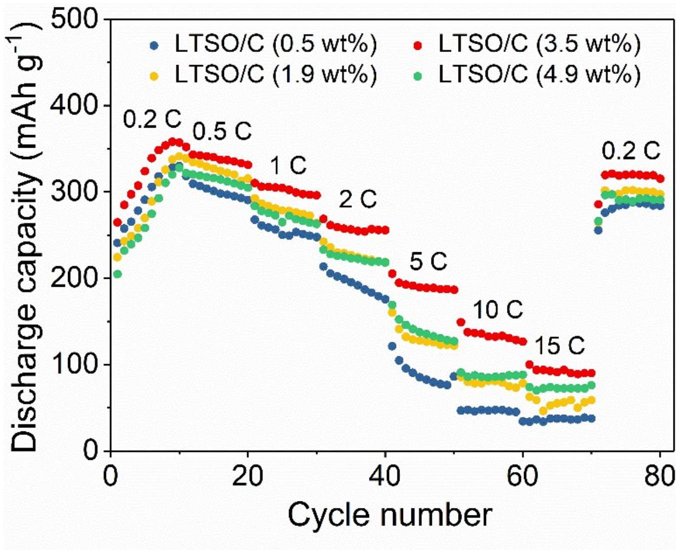

Figure S9. Rate performances of LTSO/C composites with different carbon contents.

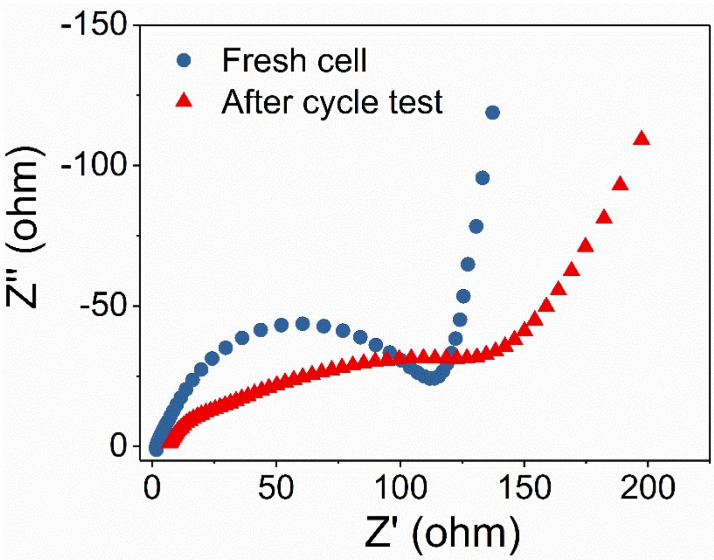

Figure S10. EIS results of fresh and cycled LTSO/C cells.

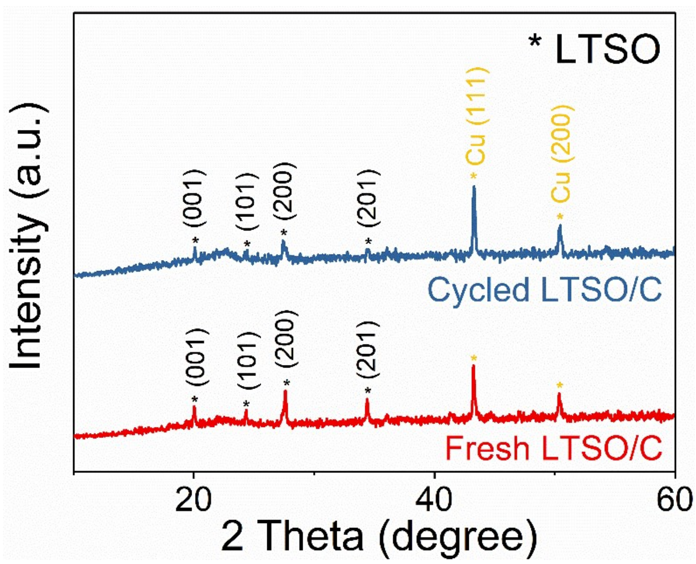

Figure S11. XRD results of fresh and cycled LTSO/C cells.

Table S1. Fitting results of electrochemical impedance spectroscopy (EIS).

Materials	R_s (ohm)	R_{ct} (ohm)
LTSO	2.1	350.8
LTSO/C	1.7	115.6

Equation S1. Lithium-ion diffusion coefficient at open circuit.

The Li^+ diffusion coefficient can be figured out through the following equation:

$$D_{Li^+} = R^2 T^2 / 2 A^2 n^4 F^4 C^2 A_w^2$$

Where D_{Li^+} represents the Li^+ diffusion coefficient in LTSO ($cm^2\ s^{-1}$), R represents the gas constant (8.31 J $mol^{-1}\ K^{-1}$), T represents the absolute temperature (298 K), A represents the surface area of the electrode (0.785 cm^2), n represents the number of electrons transferred per molecule during the electrochemical reaction, F represents the Faraday constant (96485 C mol^{-1}), C represents the molar concentration of Li^+ in LTSO, and A_w represents the Warburg coefficient associated with $Z`$ and $\omega^{-0.5}$.

Equation S2. Randles-Sevcik equation.

$$I_p = 2.69 \times 10^5\, n^{1.5}\, A\, D_{Li^+}^{0.5}\, C\, v^{0.5}$$

Where I_p represents the peak current in amps, n represents the number of electrons transferred during the redox reaction per molecule, A represents the surface area of the electrode (cm^2), C represents the concentration of Li^+ in LTSO ($mol\ cm^{-3}$), D_{Li^+} represents the diffusion coefficient of Li^+ in LTSO ($cm^2\ s^{-1}$), and v represents the scanning rate ($V\ s^{-1}$). According to this principle, D_{Li^+} is proportional to I_p^2.

	LTSO/C						Graphite						Ref 39 - Graphite[1]			
Tap density (g mL^{-1})	1.3						1.1						1.1			
Carbon content	Graphitic carbon / 3.5 wt%						Graphite						Graphite flakes			
Current density (A g^{-1})	0.15	0.3	0.6	1.5	3	4.5	0.2	0.5	1	2	5	10	0.2	0.5	1	2
Volumetric capacity (mAh cm^{-3})	441.1	393.1	335.5	248.6	174.6	120.1	418	363	275	91.3	46.2	14.3	385	297	176	77

	Ref 40 - LTO[2]					Ref 41 - LTO[3]						Ref 42 - LTO[4]				Ref 43 - LTO[5]				
Tap density (g mL^{-1})	1.23					0.82						1.4				1.78				
Carbon content	Carbide / 1.88 wt%					Carbide / 6 wt%						N/A				Carbide / 28 wt%				
Current density (A g^{-1})	0.175	0.35	0.875	1.75	3.5	0.16	0.32	0.64	1.28	1.6	3.2	0.175	0.35	0.525	0.875	0.175	0.35	0.875	1.75	3.5
Volumetric capacity (mAh cm^{-3})	199.8	195.3	180.3	170	136.5	123	118.9	113.2	109.1	105.8	103.3	233.8	214.2	200.2	169.4	329.3	284.8	208.3	178	142.4

	Ref 44 - TiO_2[6]				Ref 45 - TiO_2[7]				Ref 46 - TiO_2[8]					Ref 47 - TiO_2[9]				
Tap density (g mL^{-1})	N/A				1.1				1.06					0.63				
Carbon content	N/A				N/A				Graphene oxide / 1.2 wt%					Graphene oxide / 4.4 wt%				
Current density (A g^{-1})	0.1675	0.335	0.67	1.34	0.2	0.5	1	2	0.168	0.336	0.84	1.68	3.36	0.5	1	1.5	2	3
Volumetric capacity (mAh cm^{-3})	370	260	155	75	315	245	195	145	200.4	177	144.6	107.8	79.5	130.2	120.3	115.2	112.8	106.8

Table S2. Detailed data sheets of electrochemical performance comparison result for Fig. 5d in the main text.

References

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