

Supporting Information

Li₄Ti₅O₁₂-TiO₂/MoO₂ Nanoclusters-Embedded into Carbon Nanosheets Core/Shell Porous Superstructures Boost Lithium Ion Storage

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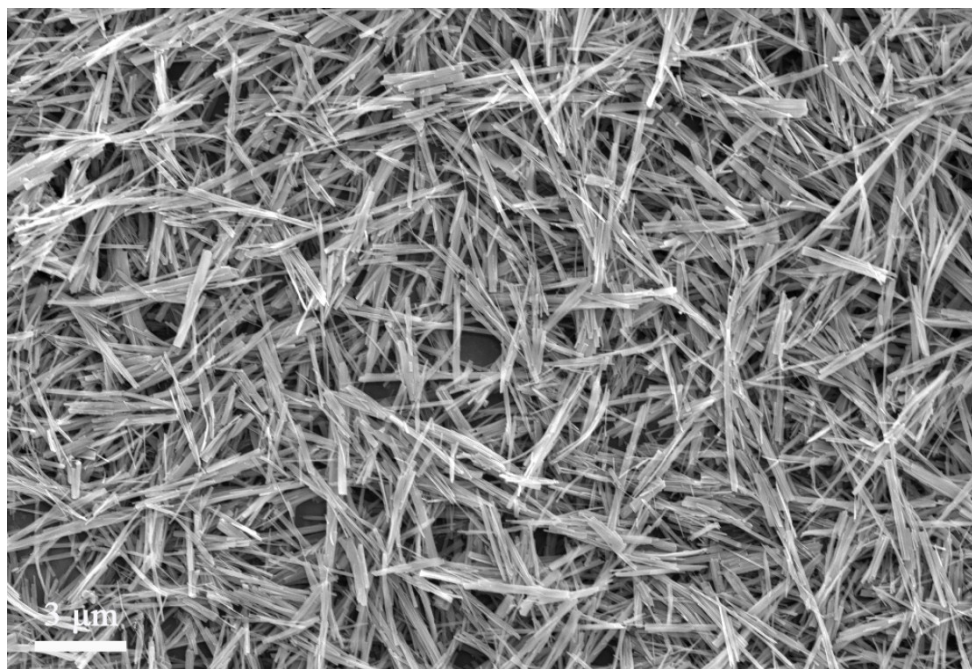


Figure S1. SEM image of LHTO-NWs.

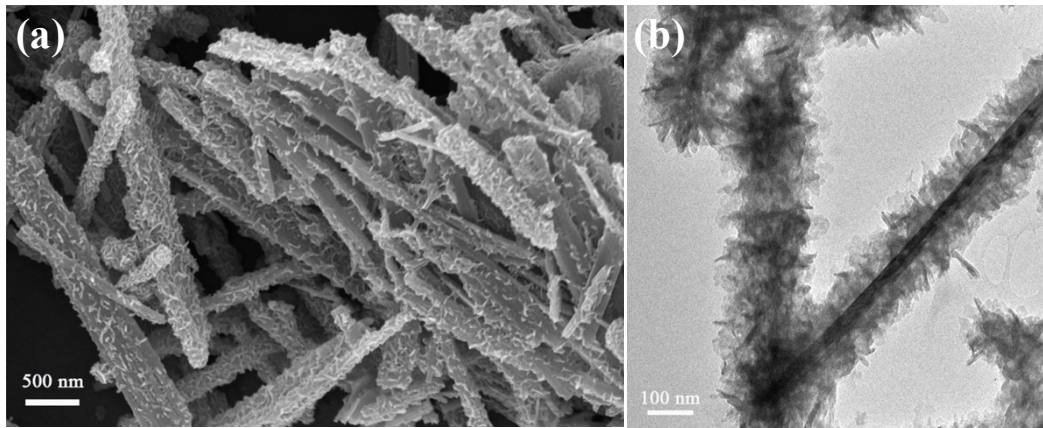


Figure S2. (a-b) SEM and TEM images of as-prepared LHTO/Mo-PDA core/shell composites.

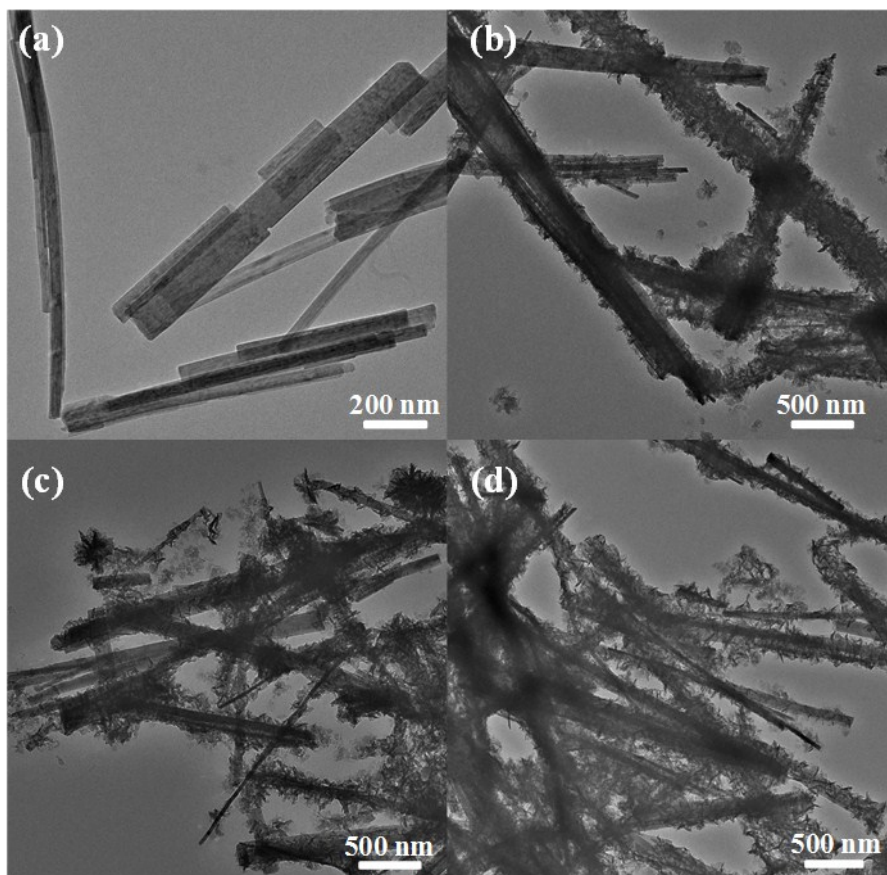


Figure S3. TEM images of LTO-TO@MoO₂/C at different times. (a) 0 h; (b) 1 h; (c) 3 h; (d) 6 h.

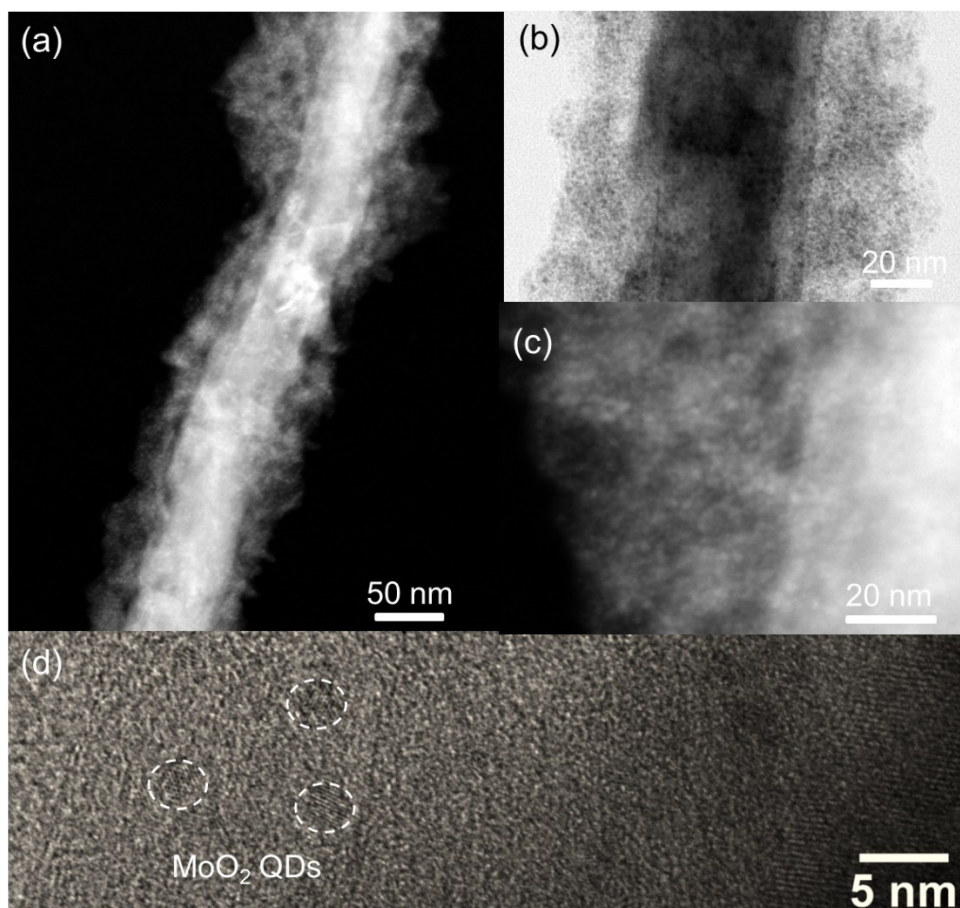


Figure S4. (a, c) STEM and (b, d) HRTEM images of LTO-TO@MoO₂/C.

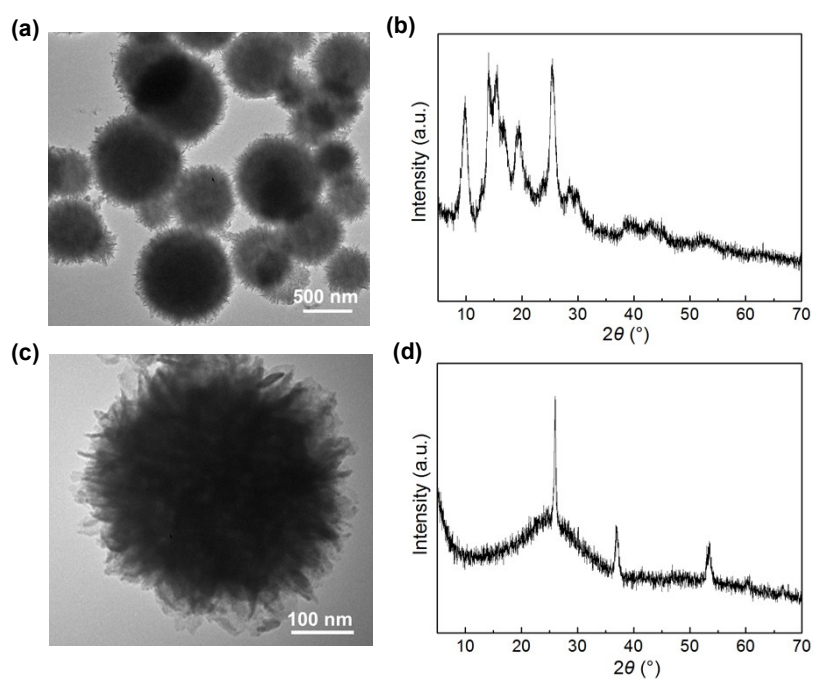


Figure S5. (a) TEM image and (b) XRD pattern of solid Mo-PDA nanospheres; (c) TEM image and (d) XRD pattern of MoO₂/C nanospheres.

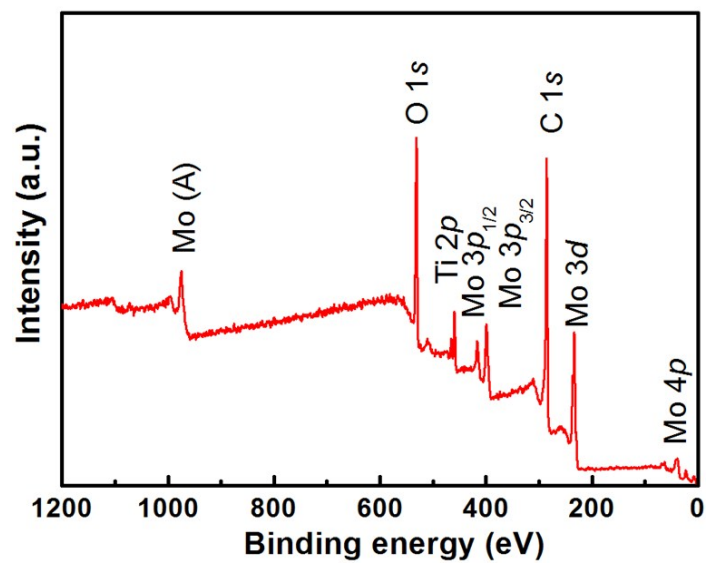


Figure S6. XPS spectrum of as-prepared LTO-TO@MoO₂/C composite.

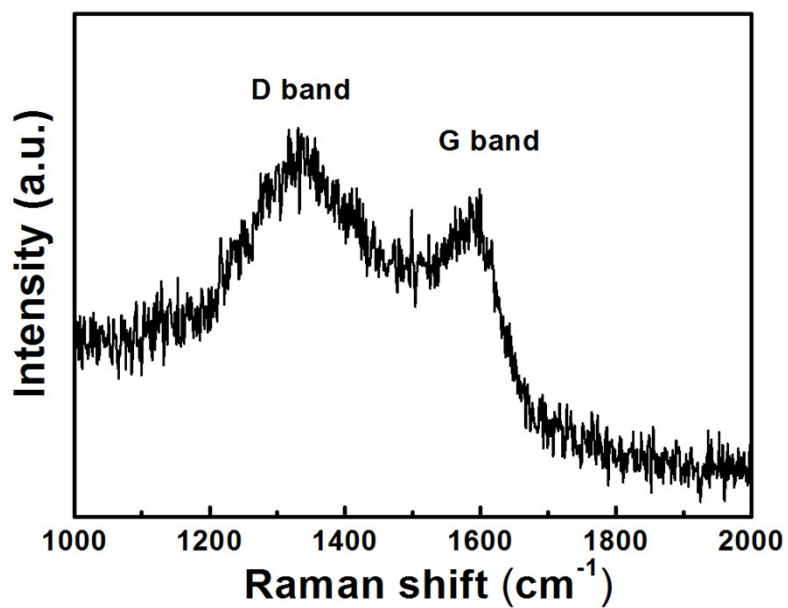


Figure S7. Raman spectrum of the as-prepared LTO-TO@MoO₂/C composite.

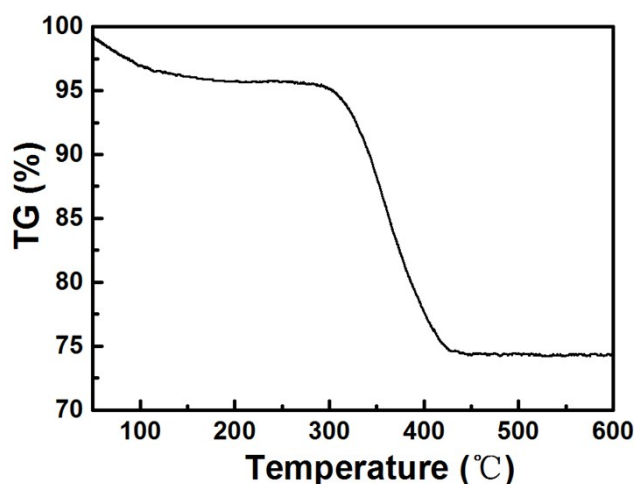


Figure S8. TG curve of the LTO-TO@MoO₂/C composite from 100 to 600 °C under air gas flow with a temperature ramp of 10 °C min⁻¹. The final weight loss of TiO₂@MoO₂/C was caused by carbon decomposition in air ($C + O_2 \rightarrow CO_2$) and the oxidation of MoO₂ ($MoO_2 + O_2 \rightarrow MoO_3$).

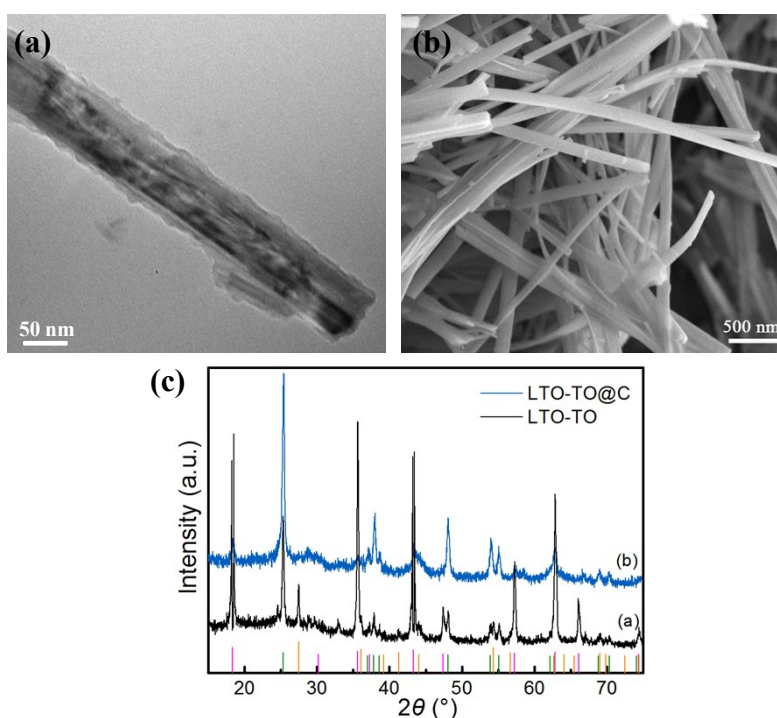


Figure S9. (a) TEM image of as-prepared LTO-TO@C composites. (b) SEM image of LTO-TO composites. (c) XRD patterns of LTO-TO@C and LTO-TO. Compared with the peak intensity of LTO-TO@C and LTO-TO, the relative intensity of Li₄Ti₅O₁₂ to TiO₂ in LTO-TO@MoO₂/C composite is minimum. The possible reason for the variable Li/Ti ratio was attributed to the consumption of Li₄Ti₅O₁₂ during the fabrication of Li_{1.81}H_{0.19}Ti₂O₅·H₂O@Mo-PDA due to the weak alkaline environment.

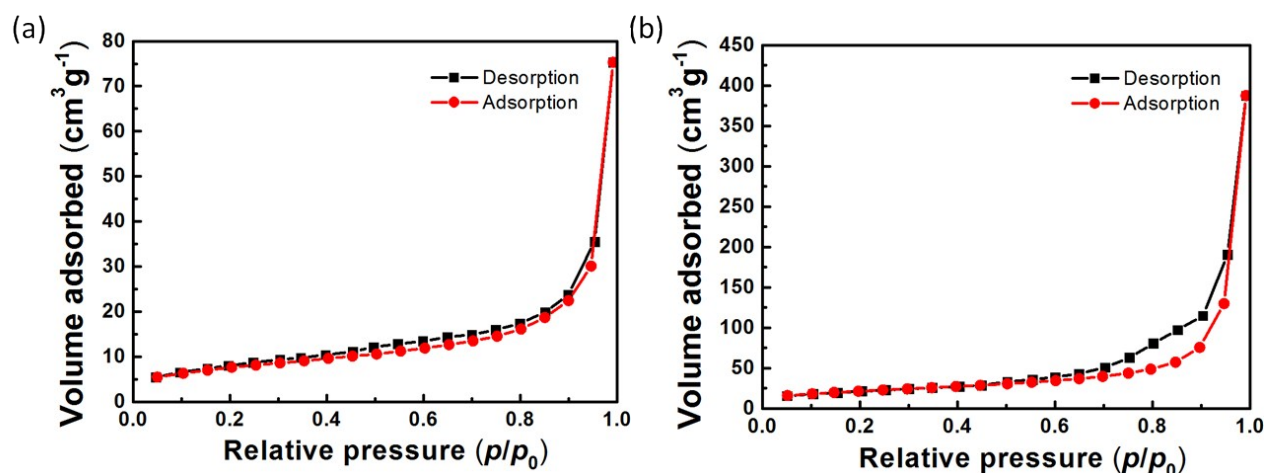


Figure S10. N₂ adsorption/desorption isotherms of (a) LTO-TO@C and (b) LTO-TO.

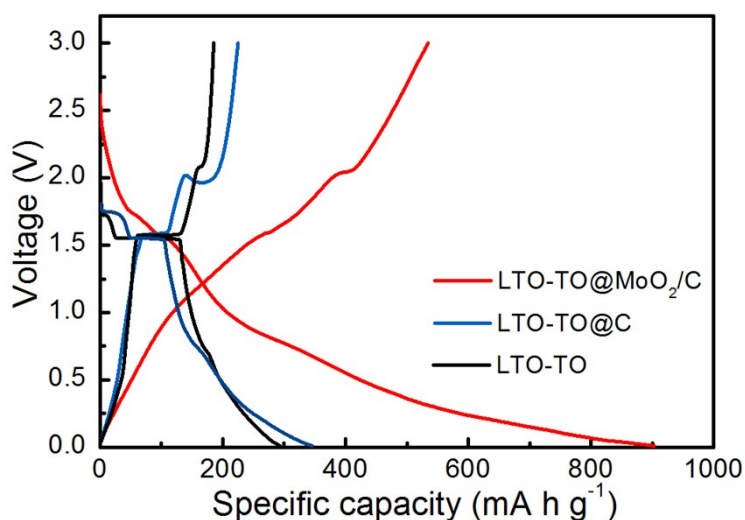


Figure S11. The first charge–discharge profiles of the LTO-TO@MoO₂/C, LTO-TO@C and LTO-TO at 100 mA g⁻¹. The charge and discharge capacities for LTO-TO@MoO₂/C are 534.5 and 903.3 mAh g⁻¹, respectively, with a Coulombic efficiency of 60 %. The charge and discharge capacities for LTO-TO@C are 224.8 and 345.4 mAh g⁻¹, respectively, with a Coulombic efficiency of 65 %. The charge and discharge capacities for LTO-TO are 185.2 and 293.2 mAh g⁻¹, respectively, with a Coulombic efficiency of 63 %.

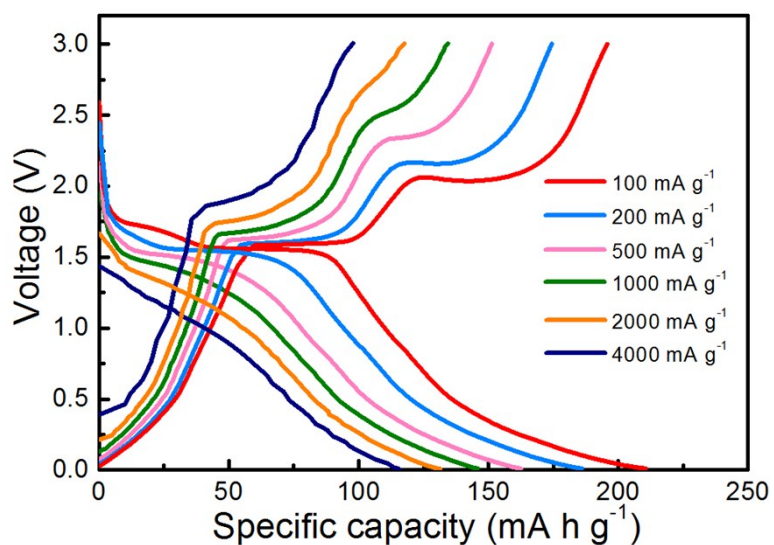


Figure S12. Galvanostatic charge–discharge profiles of the LTO-TO@C electrode at different current densities.

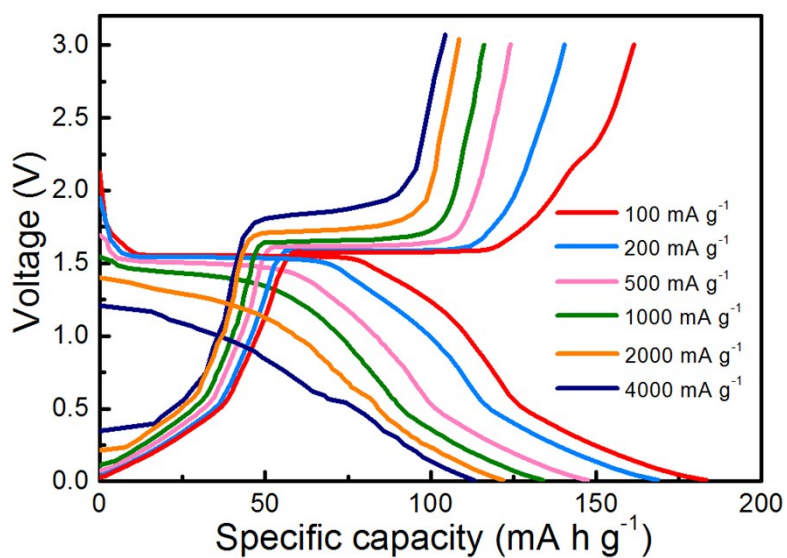


Figure S13. Galvanostatic charge–discharge profiles of the LTO-TO electrode at different current densities.

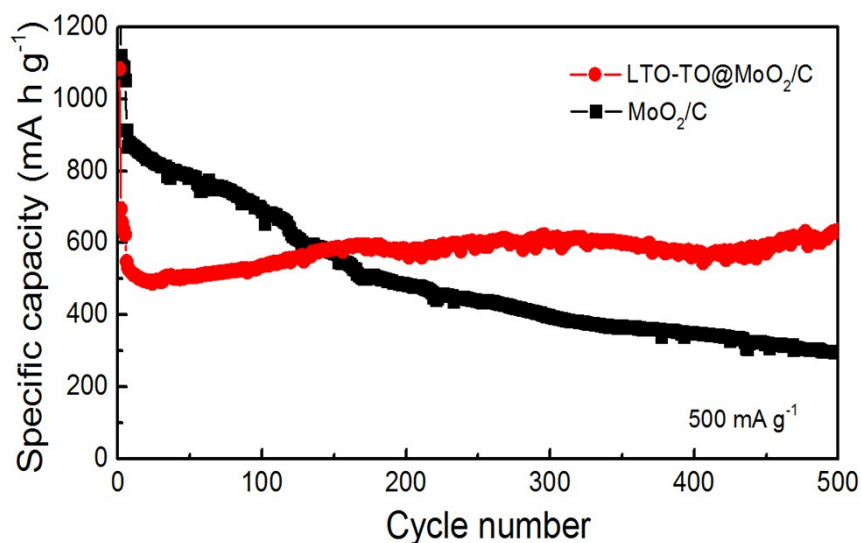


Figure S14 Cycling performances for LTO-TO@MoO₂/C and MoO₂/C at 500 mA g⁻¹.

In order to show the synthetic effect of composites, we also compared the electrochemical performance of the MoO₂/C composites (Fig. S14). The MoO₂/C nanospheres were synthesized via the same method without adding the LHTO-NWs and keeping the other heating experimental variables fixed (Fig. S5). It was found that the specific capacity of MoO₂/C drops rapidly during its whole cycle life, with the capacity retention of only 32% after 500 cycles. As a contrast the LTO-TO@MoO₂/C shows better stability than MoO₂/C. The specific capacity of LTO-TO@MoO₂/C even increases gradually up to 600 mAh g⁻¹ after 500 cycles, further demonstrating its high stability.

Table S1. Comparison of this work with previously reported Ti-based composites. Their electrode compositions are listed using the mass ratio of active materials: conductive carbon: binder.

Electrode materials	Electrode compositions	Loading density (mg cm ⁻²)	Capacity after cycles (mAh g ⁻¹)	Ref.
Li₄Ti₅O₁₂-TiO₂@MoO₂/C 3D heterostructures	80:10:10	~1.0	413, 500 cycles (1000 mA g⁻¹)	This work
Li ₄ Ti ₅ O ₁₂ /TiO ₂	75:15:10	N/A	139, 100 cycles (1000 mA g ⁻¹)	[1]
Li ₄ Ti ₅ O ₁₂ /MoS ₂	80:10:10	0.9-1.8	~160, 1000 cycles (10 C)	[2]
Li ₄ Ti ₅ O ₁₂ /TiO ₂ /C	80:10:10	2-3	101, 200 cycles (2000 mA g ⁻¹)	[3]
Li ₄ Ti ₅ O ₁₂ /NiO	80:10:10	N/A	176, 100 cycles (1C)	[4]
Li ₄ Ti ₅ O ₁₂ /rGO	80:10:10	N/A	187, 100 cycles (1C)	[5]
Li ₄ Ti ₅ O ₁₂ -TiO ₂ -Sn/C	80:10:10	~1.0	360, 600 cycles (1000 mA g ⁻¹)	[6]
Li ₄ Ti ₅ O ₁₂ /Sn	85:9:8	N/A	295, 30 cycles (0.02 C)	[7]
Li ₄ Ti ₅ O ₁₂ -Sn	80:10:10	N/A	224, 50 cycles (100 mA g ⁻¹)	[8]
Li ₄ Ti ₅ O ₁₂ /Sb/C	70:20:10	~2	236, 500 cycles (200 mA g ⁻¹)	[9]
Li ₄ Ti ₅ O ₁₂ /Co ₃ O ₄	80:10:10	N/A	~300, 50 cycles (160 mA g ⁻¹)	[10]
α-Fe ₂ O ₃ @Li ₄ Ti ₅ O ₁₂	80:10:10	N/A	249, 30 cycles (100 mA g ⁻¹)	[11]
SnO ₂ @Li ₄ Ti ₅ O ₁₂	80:10:10	N/A	457, 30 cycles (100 mA g ⁻¹)	[12]

References:

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