Supporting Information

Two-dimension dysprosium-modified bamboo-slip like lithium titanate with high-rate capability, long cycle life for lithium-ion batteries

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In order to investigate the formation process of dysprosium modified bamboo-slip like $Li_4Ti_5O_{12}$ nanosheets, a series of experiments were carefully conducted to track the change of morphology and structure. Fig. S1 shows the XRD patterns and SEM images of the precursors of LTO2 obtained after hydrothermal treatment at different time. The XRD patterns of the precursors before and after hydrothermal treatment are present in Fig. S1 (a). Initially, aqueous solution of LiOH was slowly added dropwise to the solution of tetrabutyl titanate and kept stirring for

2 h without hydrothermal reaction. The XRD pattern shows that the as-prepared sample is amorphous phase. It is also reported that this amorphous phase was hydrous titanium oxide.[1] The amorphous $TiO_2{\bullet}nH_2O$ is crucial for preparing $Li_4Ti_5O_{12}$, which will significantly influence the structure, morphology and electrochemical performance.[2] From Fig. S1 (b), the hydrolysate of hydrous titania is composed of nanoparticle-like aggregates. When the reaction time is prolonged to 12 h, the sample presents some diamond-shaped and strip shape irregular nanosheets, with the sizes ranging from 50 to 100 nm, as display in Fig. S1 (c).

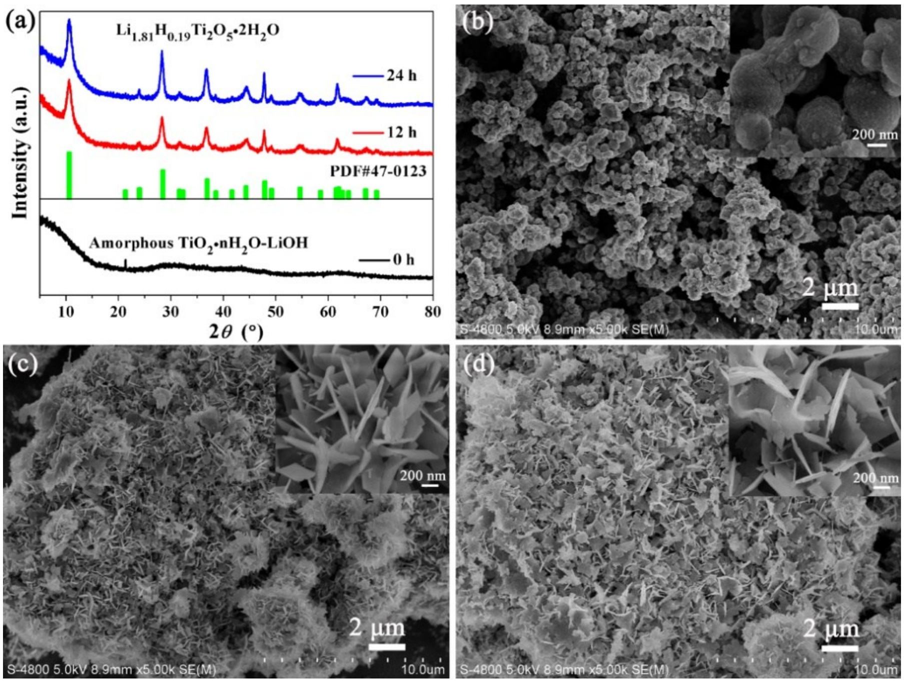

Fig. S1 The precursors of LTO2 obtained from hydrothermal treatment at different time: (a) XRD patterns, (b) SEM images for 0 h, (c) 12 h, and (d) 24 h, respectively.

Furthermore, no impurity is detected through the XRD pattern, which shows that the reactants have already completely transformed to the layered lithium titanium oxide hydrate $Li_{1.81}H_{0.19}Ti_2O_5{\bullet}2H_2O$ phase (JCPDS Card no. 47-0123). It is worth noting that the peak at 10.5º indicate this product has a layered titanate structure.[3] When the reaction time is further prolonged to 24 h, the sharp peaks in the XRD patterns illustrate the excellent crystallinity of the $Li_{1.81}H_{0.19}Ti_2O_5{\bullet}2H_2O$ phase. The corresponding SEM image in Fig. S1 (d) shows the graphene-like nanosheets are formed, only uniform graphene-like nanosheets with thicknesses of 30-50 nm and sizes of 300-900 nm are left. It is more interesting that the sizes of the nanosheets are much larger than before. A series of images indicate that the morphology evolve from nanoparticles to irregular nanosheets, then transform to the uniform graphene-like nanosheets through the Ostwald ripening process with extension of reaction time. [4]

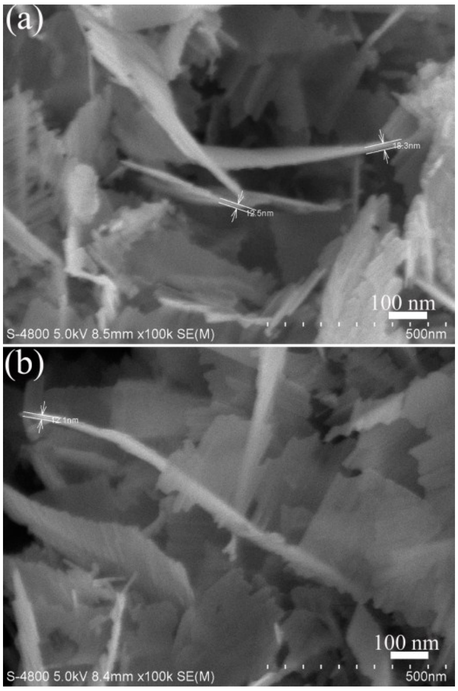

Fig. S2 SEM images of the as-prepared materials: (a) LTO1, and (b) LTO2.

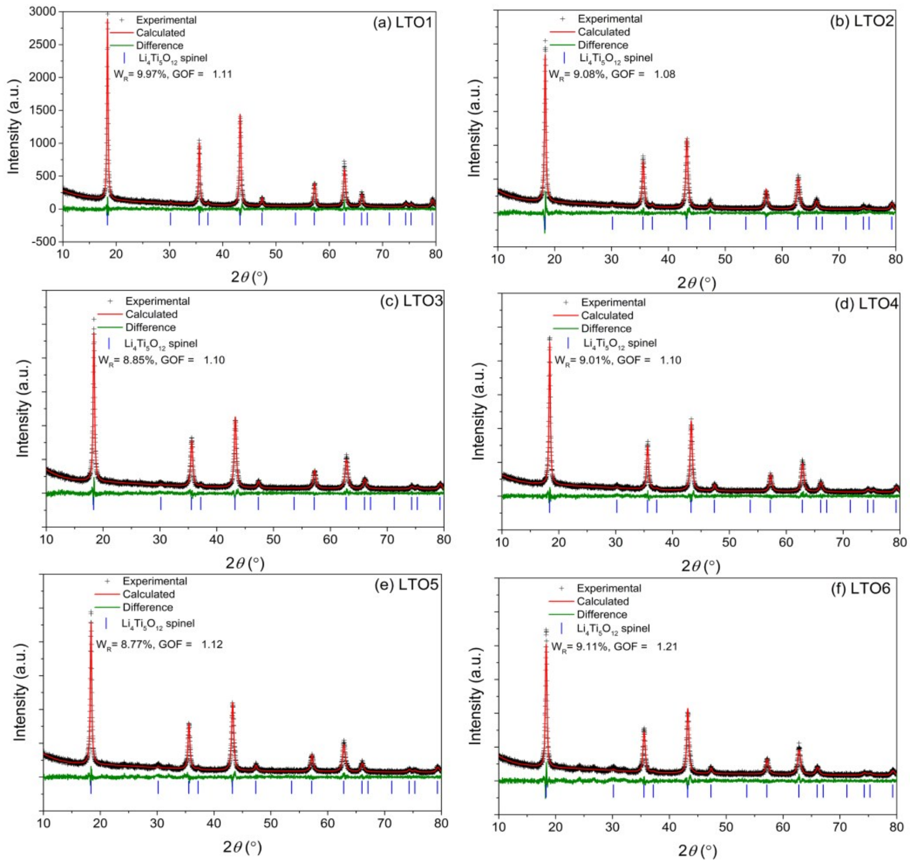

Fig. S3 Rietveld-refined fits using XRD data of (a) LTO1, (b) LTO2, (c) LTO3, (d) LTO4, (e) LTO5, and (f) LTO6.

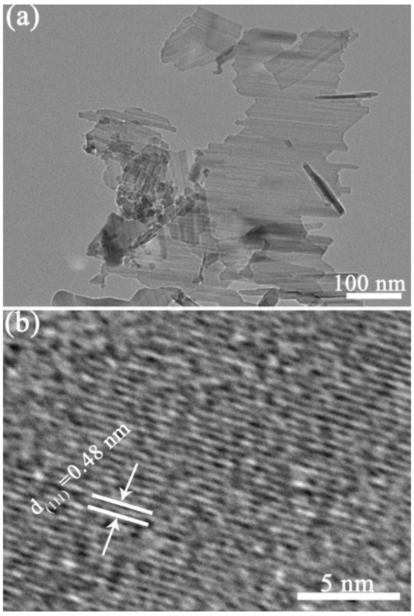

Fig. S4 (a) TEM image of LTO1, and (b) HRTEM image of LTO1.

Table S1 The charge-discharge plateau potential differences of LTO1 and LTO2.

Current	Potential values (mV)	
	LTO1-ΔE	LTO2-ΔE
5 C	110	92
10 C	137	110
20 C	203	165
30 C	257	240
40 C	318	290
50 C	364	340
60 C	406	384
80 C	480	466
100 C	565	492

Table S2 Fitted results of as-prepared materials by EIS.

Samples	R_s (Ω)	R_{ct} (Ω)
LTO1	3.15	108.70
LTO2	3.25	69.70

References

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