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Self-supported $Li_4Ti_5O_{12}$ nanosheet arrays for lithium ion batteries with excellent rate capability and ultralong cycle life

Shuai Chen, Yuelong Xin, Yiyang Zhou, Yurong Ma, Henghui Zhou* and Limin Qi*

Beijing National Laboratory for Molecular Sciences, State Key Laboratory for Structural Chemistry of Unstable and Stable Species, College of Chemistry, Peking University, Beijing 100871, China.

Electronic supplementary information

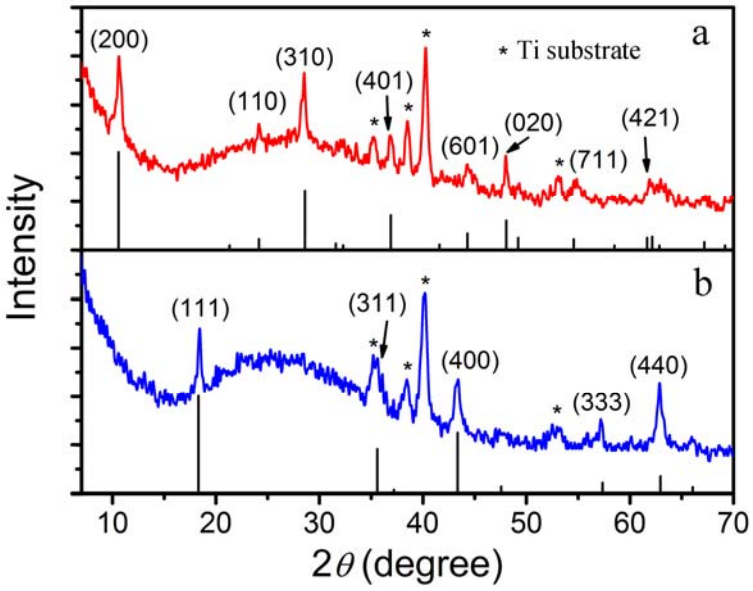

Fig. S1 XRD patterns of the powders scratched from (a) as-prepared H-LTO nanosheet arrays and (b) LTO nanosheet arrays after calcination at 550 °C. The standard XRD pattern of H-LTO ($Li_{1.81}H_{0.19}Ti_2O_5 \cdot xH_2O$, JCPDS No. 47-0123) and LTO ($Li_4Ti_5O_{12}$, JCPDS No. 49-0207) are also presented in (a) and (b), respectively. "*****" denotes the diffraction peaks arising from the Ti powders scraped off from the substrate.

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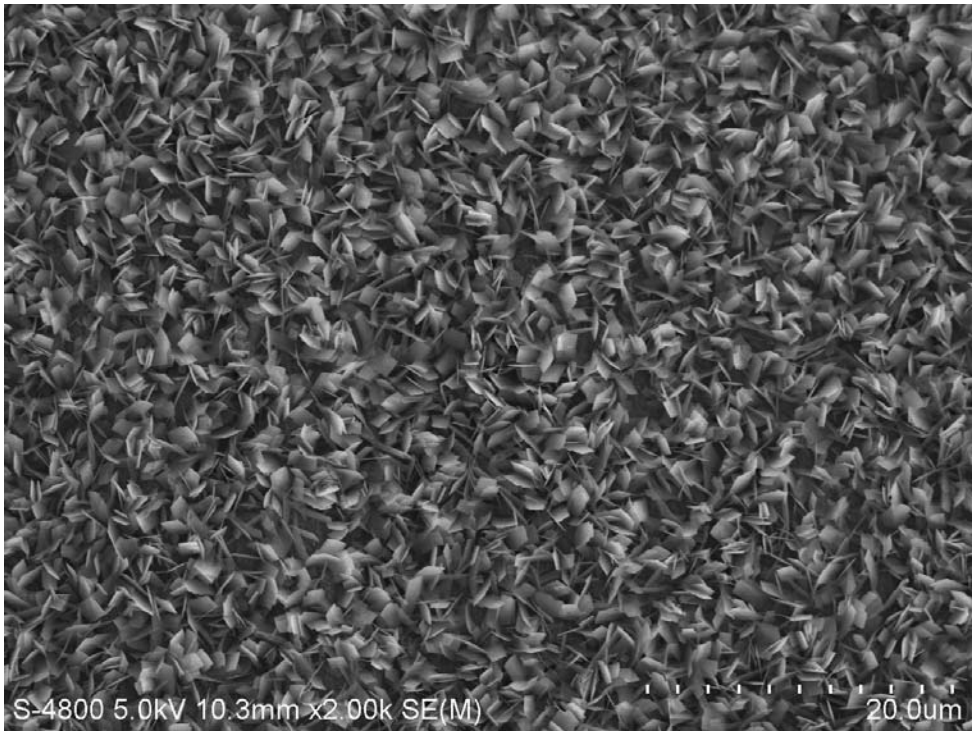

Fig. S2 Large-area SEM image of LTO nanosheet arrays.

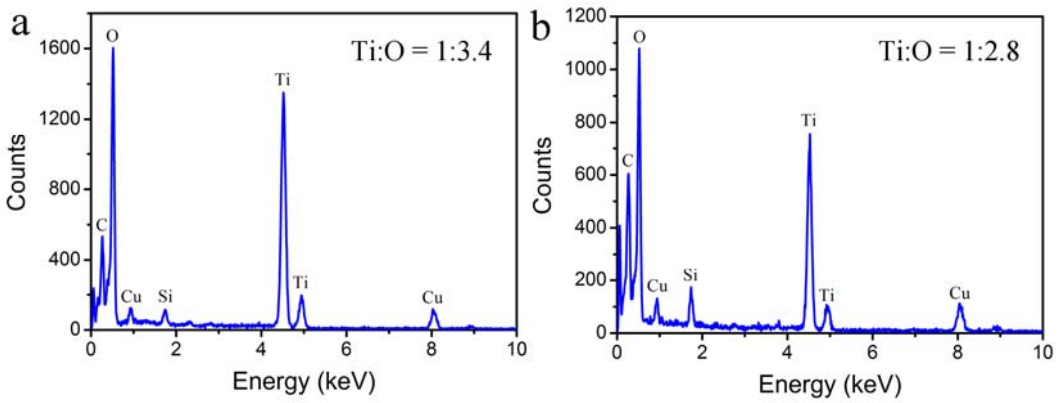

Fig. S3 EDS spectra of (a) H-LTO and (b) LTO nanosheets scraped off from the Ti substrate. The existence of C, Cu and Si can be attributed to the copper grid-supported ultrathin carbon film (Beijing Zhongjingkeyi Technology Co. Ltd.) used as the substrate in HRTEM.

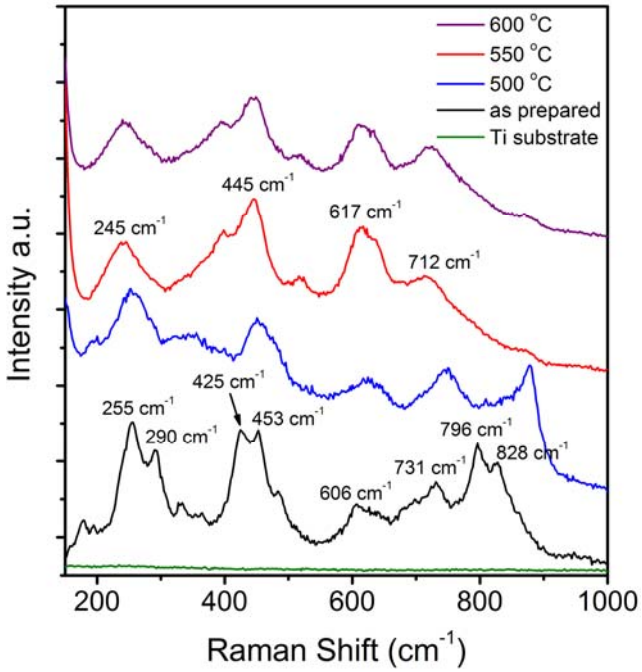

Fig. S4 Raman Spectra of Ti foil, as-prepared H-LTO nanosheet arrays, and nanosheets arrays after calcined at different temperatures. The 445 cm^{-1} Raman lines was assigned to the stretching vibrations of the Li-O bonds in LiO_4 polyhedra, whereas the 245 nm^{-1} Raman bands were attributed to the bending vibrations of O-Ti-O bonds. Both bands suggest the existence of $Li_4Ti_5O_{12}$ (R. Baddour-Hadjean, J.-P. Pereira-Ramos, *Chem. Rev.* **2010**, *110*, 1278).

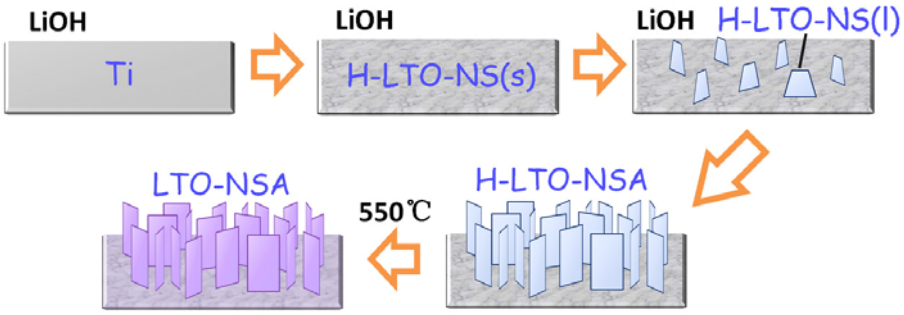

Fig. S5 Schematic illustration of the formation of $Li_4Ti_5O_{12}$ nanosheet arrays on Ti foil. The reaction between Ti foil and LiOH led to the growth of a dense layer of small H-LTO nanosheets (H-LTO-NS (s)). Then, the growth of some small H-LTO nanosheets into large H-LTO nanosheets (H-LTO-NS (l)) occurred, which was followed by the evolution of densely aligned, large rectangular H-LTO nanosheet arrays (H-LTO-NSA). Finally, the H-LTO nanosheet arrays were converted into LTO nanosheet arrays (LTO-NSA) with the morphology preserved via thermal decomposition.

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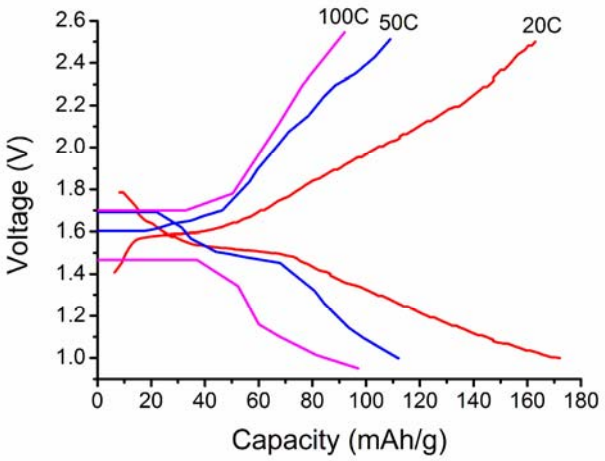

Fig. S6 Galvanostatic discharge/charge profiles of LTO nanosheet arrays cycled at different rates. Note that the data of 200 C were not obtained because of the too short charge/discharge time.

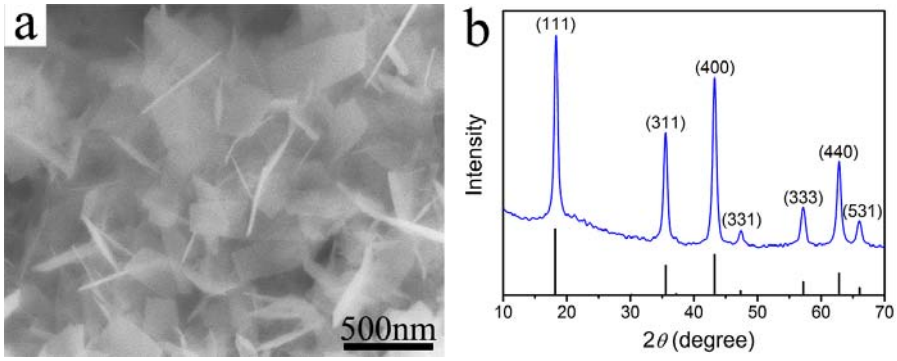

Fig. S7 SEM image (a) and XRD pattern (b) of randomly dispersed $Li_4Ti_5O_{12}$ nanosheets (LTO-NS). The nanosheets have an average length of 500 nm and width of 200nm. The standard XRD pattern of LTO ($Li_4Ti_5O_{12}$, JCPDS No. 49-0207) is also presented in (b).

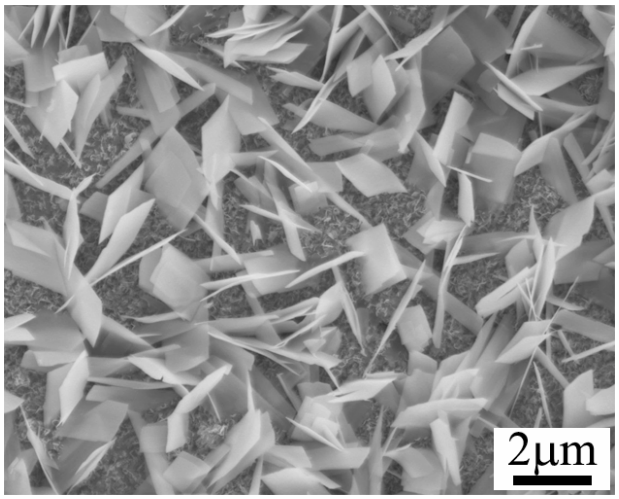

Fig. S8 SEM image of $Li_4Ti_5O_{12}$ nanosheet arrays on Ti foil after 3000 cycles at a charge/discharge rate of 50 C

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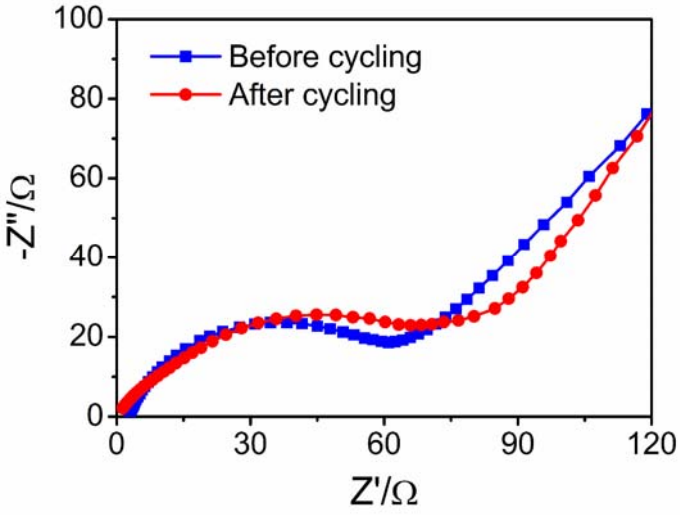

Fig. S9 Nyquist plots of LTO-NSA-1 before and after 100 cycles at 50 C.