Electronic Supplementary Information

Excellent long-term cycling stability of La–doped Li$_4$Ti$_5$O$_{12}$ anode material at high current rates

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Fig. S1. XRD patterns of La$_x$Li$_{4-x}$Ti$_5$O$_{12}$ for $x = 0$ (1), 0.02 (2), 0.06 (3) and 0.1 (4).

The XRD patterns of La$_x$Li$_{4-x}$Ti$_5$O$_{12}$ ($x = 0$, 0.02, 0.06 and 0.1) are shown in Fig. S1. The similarity of the patterns indicates that the as–obtained LLTO possesses the same spinel structure (JCPDS 49–0207). The occurrence of a small amount of amorphous phase (marked
with *) and the waved diffraction peak (curve 4) of $\text{La}_{0.1}\text{Li}_{3.9}\text{Ti}_5\text{O}_{12}$ suggest the severe lattice distorsion and a slight structural change owing to the higher La–doping content of 0.1.

**Fig. S2.** FESEM images of (a) Li$_4$Ti$_5$O$_{12}$, (b) La$_{0.02}$Li$_{3.98}$Ti$_5$O$_{12}$ and (c) La$_{0.1}$Li$_{3.9}$Ti$_5$O$_{12}$.

The morphology of the LLTO with the La-doping content of $x = 0, 0.02$ and 0.1 was also observed by FESEM, as revealed in Fig. S2. In comparison the images in Fig. S2 with those in Figs. 2-3, no significant difference could be distinguished from the morphology.
Fig. S3. Nitrogen adsorption/desorption isotherms of (a) Li$_4$Ti$_3$O$_{12}$, (b) La$_{0.02}$Li$_{3.98}$Ti$_5$O$_{12}$, (c) La$_{0.1}$Li$_{3.9}$Ti$_5$O$_{12}$. The insets display the corresponding DFT pore size distribution.

Fig. S4. Cycling performance of another La$_{0.06}$Li$_{3.94}$Ti$_5$O$_{12}$ cell measured at $-40 \, ^\circ\text{C}$ at 0.1 C.

The low temperature performance was also measured in other cells, as shown in Fig. S4. The reversible capacity of 110.3 mAh g$^{-1}$ at $-40 \, ^\circ\text{C}$ further demonstrates the outstanding
performance at low temperatures, as well as the good reproducibility of the performance for various LLTO cells.

![Cycling performance of LLTO](image)

**Fig. S5.** Cycling performance of Li$_4$Ti$_5$O$_{12}$, La$_{0.02}$Li$_{3.98}$Ti$_5$O$_{12}$ and La$_{0.1}$Li$_{3.9}$Ti$_5$O$_{12}$ measured at 0.1 C at 25 °C.

The cycling performance of the LLTO with other La-doping content was also tested, as exhibited in Fig. S5. After cycling 30 times at 0.1 C, the reversible capacities are 152.6, 156.6 and 128.8 mAh g$^{-1}$ for $x = 0, 0.02$ and 0.1 of La$_x$Li$_{4-x}$Ti$_5$O$_{12}$, respectively. The capacity fading of La$_{0.1}$Li$_{3.9}$Ti$_5$O$_{12}$ might be associated with the large lattice distortion induced by the La–doping content of 0.1 (Figs. 1, 4 and S1), which could be supported by the reduced electronic conductivity ($\sigma = 3.84 \times 10^{-9}$ S cm$^{-1}$) and Li–ion diffusion coefficient ($D_\sigma = 3.47 \times 10^{-10}$ cm$^2$ s$^{-1}$) as compared to those of La$_{0.06}$Li$_{3.94}$Ti$_5$O$_{12}$ ($\sigma = 8.12 \times 10^{-8}$ S cm$^{-1}$, and $D_\sigma = 7.31 \times 10^{-9}$ cm$^2$ s$^{-1}$) collected in Table 1.