Electronic Supplementary Information

Excellent long-term cycling stability of La–doped $Li_4Ti_5O_{12}$ anode material at high current rates

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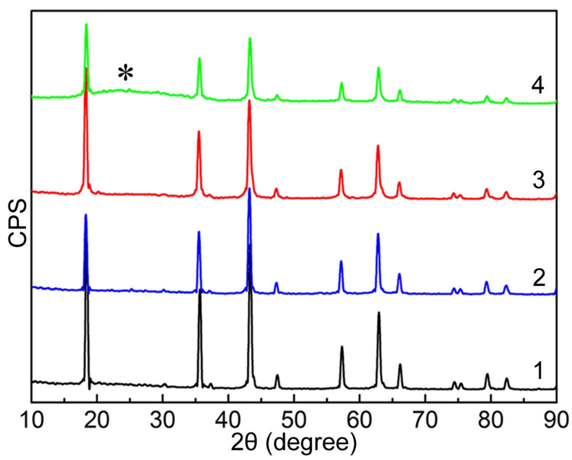

Fig. S1. XRD patterns of $La_xLi_{4-x}Ti_5O_{12}$ for x = 0 (1), 0.02 (2), 0.06 (3) and 0.1 (4).

The XRD patterns of $La_xLi_{4-x}Ti_5O_{12}$ (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 $La_{0.1}Li_{3.9}Ti_5O_{12}$ suggest the severe lattice distorsion and a slight structural change owing to the higher La–doping content of 0.1.

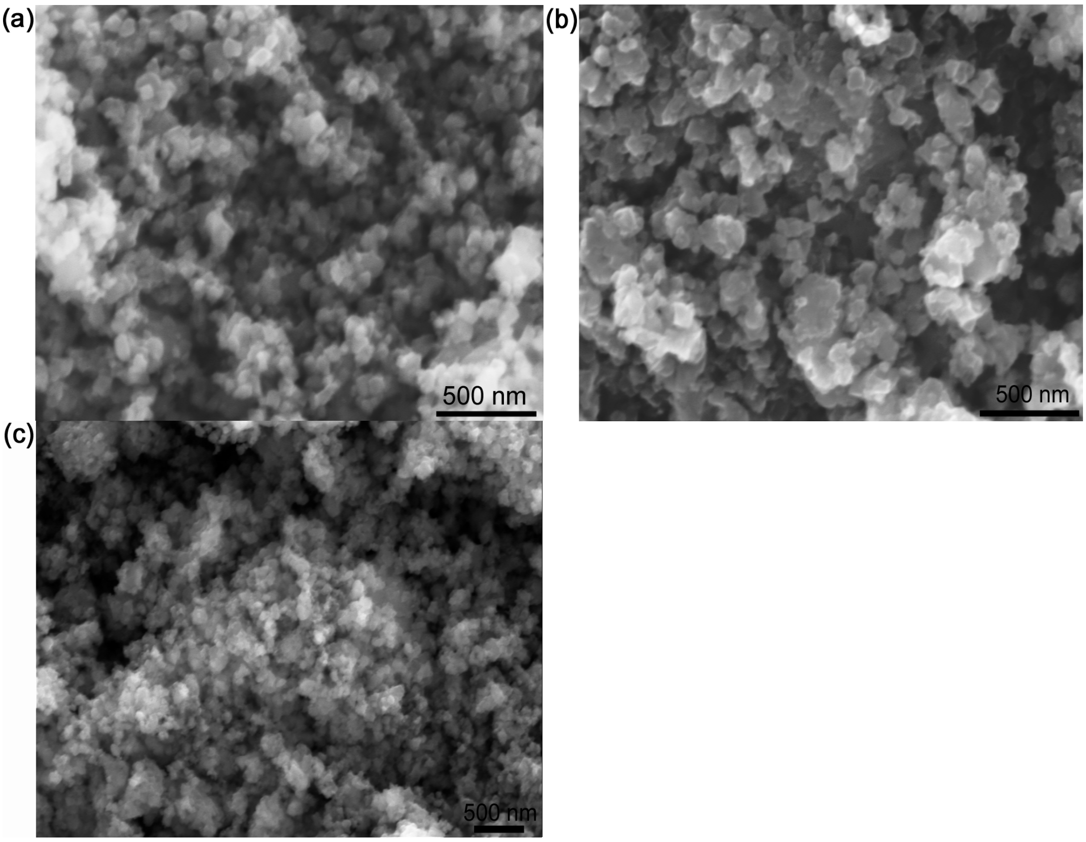

Fig. S2. FESEM images of (a) $Li_4Ti_5O_{12}$, (b) $La_{0.02}Li_{3.98}Ti_5O_{12}$ and (c) $La_{0.1}Li_{3.9}Ti_5O_{12}$.

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.

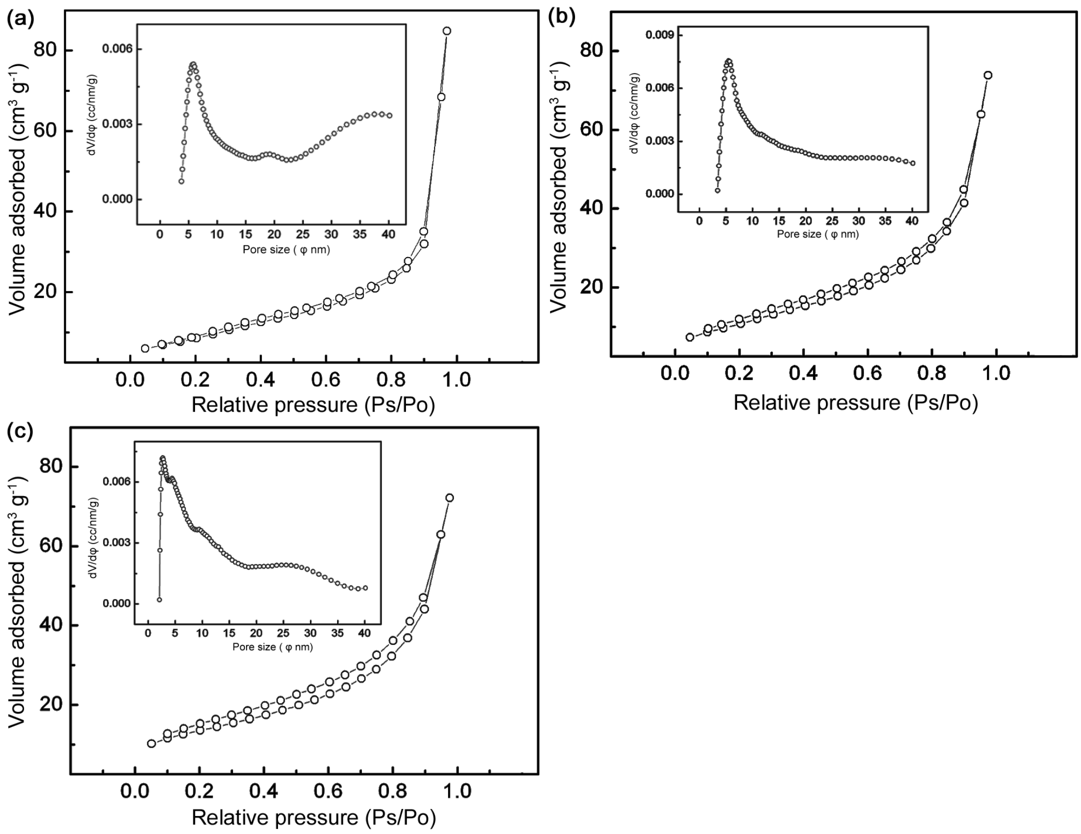

Fig. S3. Nitrogen adsorption/desorption isotherms of (a) $Li_4T_5O_{12}$, (b) $La_{0.02}Li_{3.98}T_5O_{12}$, (c) $La_{0.1}Li_{3.9}T_5O_{12}$. The insets dispaly the corresponding DFT pore size distribution.

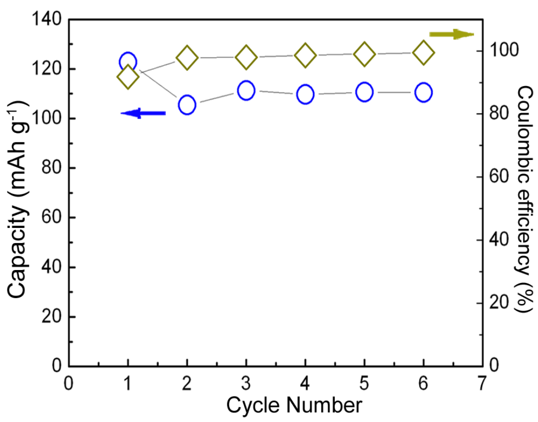

Fig.S4. Cycling performance of another $La_{0.06}Li_{3.94}Ti_5O_{12}$ cell measured at –40 °C at 0.1 C.

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 °C further demonstrates the outstanding performance at low temperatures, as well as the good reproducibility of the performance for various LLTO cells.

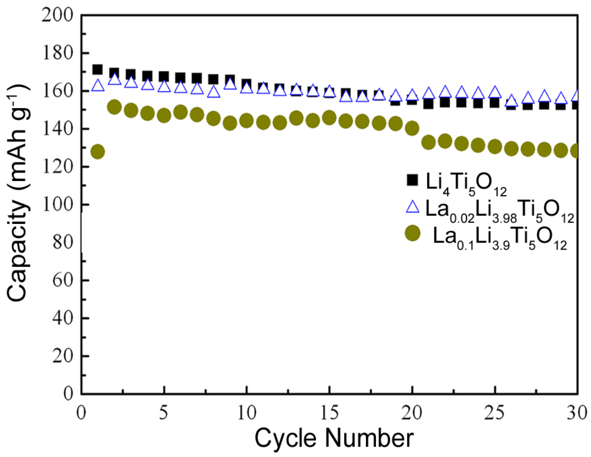

Fig.S5. Cycling performance of $Li_4Ti_5O_{12}$, $La_{0.02}Li_{3.98}Ti_5O_{12}$ and $La_{0.1}Li_{3.9}Ti_5O_{12}$ measured at 0.1 C at 25 °C.

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 $La_xLi_{4-x}Ti_5O_{12}$, respectively. The capacity fading of $La_{0.1}Li_{3.9}Ti_5O_{12}$ 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 (σ = 3.84×10^{-9} S cm^{-1}) and Li–ion diffusion coefficient (D_σ = 3.47×10^{-10} cm^2 s^{-1}) as compared to those of $La_{0.06}Li_{3.94}Ti_5O_{12}$ (σ = 8.12×10^{-8} S cm^{-1}, and D_σ = 7.31×10^{-9} cm^2 s^{-1}) collected in Table 1.