In Situ Synthesis of Reduced Graphite Oxide-$Li_2ZnTi_3O_8$ Composite As a High Rate Anode Material for Lithium-ion Batteries

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In the present commercial LIBs, the graphite is a common anode material due to its low cost and rapid charge-discharge capability. However, a fatal problem for using this material is the dendritic lithium growth on the surface of the electrode during the overcharging process [1]. As a result, it is urgent to develop novel anode materials, which not only meet the increasing safety demand but also exhibit high energy density and good cycling stability. Cubic spinel $Li_2ZnTi_3O_8$ (LZTO) with a space group of $P4_332$ has exhibited good high discharge capacity and good cycle stability [2]. This material has a high discharge voltage plateau around 0.5 V which can inhibit the dendritic lithium growth over charge to 0 V. On the other hand, LZTO is able to accommodate Li^+ reversibly with a theoretical capacity of 229 mA h g^{-1} which is much higher than that of zero-strain $Li_4Ti_5O_{12}$ [3]. However, LZTO also suffers low electronic conductivity and ion diffusion rate. The poor electronic conductivity of LZTO still limits its rate capability and long-term cycling life.

In this study, we synthesized pristine LZTO and reduced graphite oxide modified LZTO (LZTO@RGO) samples via in situ ball mill assisted solid state method for the first time. RGO/LZTO mass ratios were selected as 0.1: 1, 0.25:1 and 0.5:1, respectively. The effects of RGO content on the crystal lattice, particle morphology and electrochemical properties were investigated.

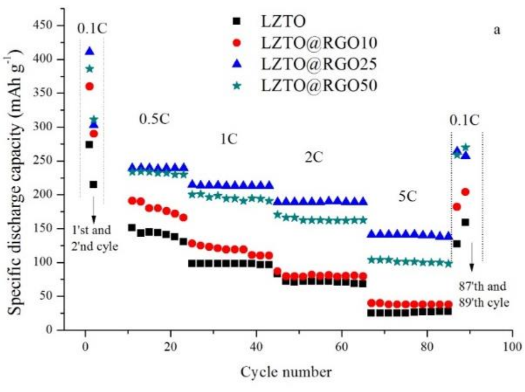

Figure 1. Rate capabilities of LZTO and LZTO@RGO anode materials

The specific capacity of LZTO@RGO anodes can be increased due to the fact that reduced graphite oxide layers can improve the lithium ion diffusion rate and the electronic conductivity. So, compared to pristine LZTO, RGO modified anodes have better electrochemical properties, such as specific capacity and high rate property.

The electrochemical performance of LZTO could be improved by adjusting the content of RGO. Among all the samples, LZTO@RGO25 exhibits excellent electrochemical performance in terms of high capacities (302, 250, 221, 194 and 154 mAh g^{-1} at current densities of 0.1, 0.5, 1, 2 and 5C, respectively).
As shown in Fig. 2, among all the samples, the LZTO@RGO25 anode has the highest discharge capacities at 0.1 C and 1 C rates, whereas the pristine LZTO anode has much less lithiation capacity under the same condition [4].

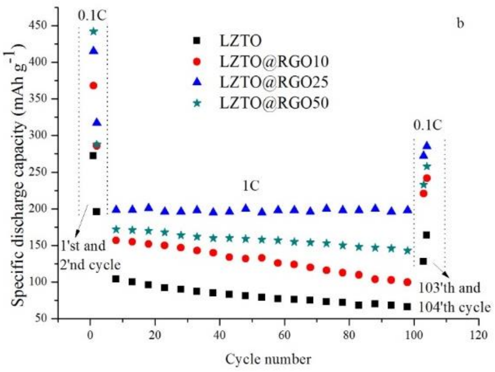

Figure 2. Cycling life performance of LZTO and LZTO@RGO anode materials at 1C current rate.

The enhanced electrochemical properties of the LZTO@RGO anodes may lead to potential applications for advanced lithium batteries.

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