Capacity-fading analyses of Silicon Oxide Negative Electrode in Li-ion Batteries

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As is known to all [1, 2], the high-capacity silicon is a promising anode material for high energy (≥300Wh/kg) Li-ion batteries. Compared to the severe volume change of silicon, silicon oxide (SiO_x) electrodes exhibited relatively stable cycling performance, owing to an inactive buffer to accommodate volume expansion.

In this study, fading analyses of NCA/SiO_x battery was carried out using a back-to-back full coin cell instead of a traditional coin cell. This cell system can simulate the real work environment of batteries. Furthermore, it can provide a sufficient lithium source inside the full cell and an effective way of monitoring the electrode potentials during cycles. The back-to-back full coin cell was realized through combining the Li side of NCA coin cell and the Li side of SiO_x coin cell back to back into a new full cell. It was found that the impedance of the cell was not increased in this full cell system, that is, the contact resistance between Li sides could be ignored. The cycling performance of back-to-back full cell and traditional full cell were shown in Fig.1(a). During the initial 25 cycles, two kinds of cells presented rapid capacity degradation. However, it was apparent that back-to-back full cell exhibited much more stable cycle performance after 25 cycles than that of traditional coin cell. Meanwhile, the observation of positive and negative potentials and the differential capacity analysis of discharge curves were depicted in Fig.1(b). All results show that the capacity fading during the initial stage was ascribed to the structural change of SiO_x and the loss of active lithium in the NCA/SiO_x battery, while the main reason for the subsequent cycle fading was the loss of active lithium. This phenomenon can confirm that the cycle performance of Si-based batteries can be effectively improved by prelithiation.

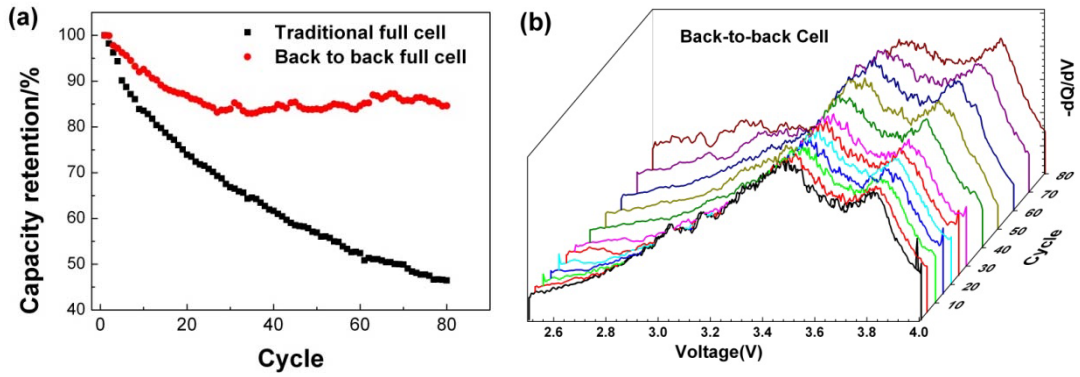

Figure 1. (a) Cycle performance of two kinds of cells; (b) discharge differential capacity curves of the back-to-back full cell.

This work was supported by the National Natural Science Foundation of China (U163720101).

References:

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[2] I. Choi, M.J. Lee, S.M. Oh, Electrochimica Acta 85(2012) 369-376.