Charge-discharge behaviors of graphene like graphite for the anode of lithium ion battery

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Recently, electric vehicles, drones, etc have attracted much interest as state-of-the-art technologies. For the widespread use of these technologies, lithiun ion batteries with not only high energy density but also fast charging capability, long cycle life, and low cost are required. For the anode of such batteries, various types of materials including silicon, transition metal oxides, nano carbons and so on have been considered, however, none of them have provided sufficient electrochemical properties.

In this context, we have recently proposed a graphene like graphite (hereafter GLG) which is prepared from the thermal reduction of graphite oxide (abbreviated as GO) for the anode of lihtium ion battery.[1] The morphology and interlayer spacing are similar to those of graphite, however, it shows higher capactiy and rate performance like graphene, and improved coulombic efficiency. In this study, the effect of oxygen in GLG on the capacity of it was investigated in detail.

The oxygen contet of GLG was controlled by changing the reduction temperature of GO, heat treatment of it under oxygen or hydrogen gases, the oxidation degree of GO. Fig.1 shows the 1st charge-dicharge curves of GLG samples prepared at various temperatures. The cell voltage steeply decreased during charge and the charge capacity became lower for GLG samples prepared at higher temperatures, accordingly with lower oxygen contents. That during discharge increased linearly except for the sample obtained at 1000°C and then at certain cell voltages it increased more steeply. The voltages where the slope changes became lower as the increase in the thermal reduction temperature. Moreover, the capacities above 2 V which is not available in the real battery were much smaller than those observed for graphene based materials. It is also rather interesting that smaller discharge capacities were observed for GLGs with larger interlayer spacing and smaller crystalline sizes. The discharge capacity reached 677 $mAhg^{-1}$ for GLG700. Fig.2 shows the relationship between O/C ratio and capacity with an upper limit cell voltage of 2 V of GLG samples. The capacity increased with the increase in the oxygen content in GLG, which strongly indicates that oxygen content is one of the most important parameter to determine the discharge capacity of GLG.

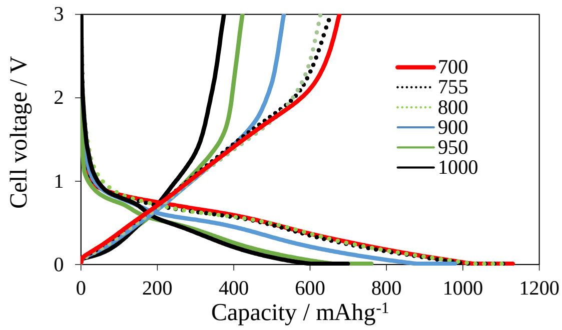

Fig.1 1st charge–discharge curves of GLG prepared at 700, 755, 800, 900, 950 and 1000°C.

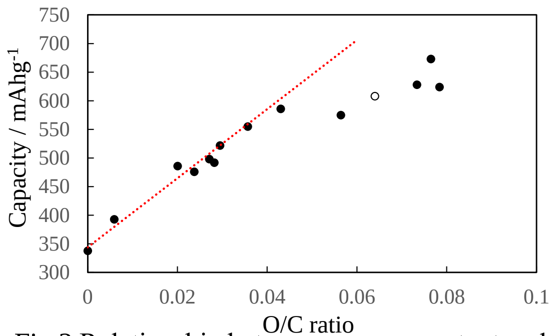

Fig.2 Relationship between oxygen content and 1st discharge capacity of GLG samples. Open circle indicates the datum reported in Ref.1.

References:

[1] Q. Cheng, Y. Okamoto, N. Tamura, M. Tsuji, S. Maruyama and Y. Matsuo, Sci. Rep., 7 (2017) 14782.