NATURAL CRYSTALLITE GRAPHITE USED AS ANODE MATERIAL IN SECONDARY LITHIUM ION BATTERY

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Introduction

Previous work in our laboratory shows that the shape of the ideal graphite anode material of lithium ion battery should be granular and the particle should be composed of some crystallites in different orientation. That's why the artificial graphite is used as anode material. For natural flaky graphite, its particles are generally composed of one single crystal. In order to reduce the cost of anode material, we intend to use one kind of natural graphite to replace the artificial one. The XRD (Figure 1) and TEM show that the so-called "amorphous graphite " produced in China is composed of micro-crystals, and SEM (Figure 2) shows that its shape is granular. The size of the micro-crystals is generally smaller than 100nm. Therefore, we would call the "amorphous graphite" as "natural crystallite graphite". The present work studies the application of natural crystallite graphite for anode material of lithium ion battery.

Experimental

Charge-discharge cycling tests for the crystallite graphite were carried out using a 2-electrode Li/C cell. The manufacturing process is quite similar as the report in reference [1]. Galvanostatic cycling is performed at a constant current density of $0.2mA/cm^2$ under the potential range between 0 and 2.5V vs. Li/Li^+. The natural crystallite graphite and flaky graphite samples are made in China. X-ray diffraction studies were carried out using a RIGAKU D/max II (Cu-K α radiation) to figure out the size of crystallite in the C-axis direction. A CSM-950 scanning electronic microscopy was used to obtain the morphology of the particles.

Results and Discussion

Figure 2 shows that the shape of particle is granular, and the average diameter is about 20 μ m.

Figure 3 shows the potential changes with time for Li/natural crystallite graphite cell. Its granular shape makes its irreversible capacity to be only 15% of the first discharge capacity. The second discharge capacity is 330 mAh/g. From Figure 4, the coulombic efficiency was calculated to be above 90% after 600 cycles. For Li/natural flaky graphite cell, Figure 5 shows that the degradation occurred after about one hundred cycles.

Natural crystallite graphite has excellent cycle stability because of its structure difference from flaky graphite's. When Li^+ intercalates into graphite, the crystallite graphite can expand in all directions, thus its total expansion is low. For flaky graphite, it only can expand in c-axis which causes its expansion concentrated on one direction, therefore the particles will break out from the anode film easily.

Conclusion

Natural crystallite graphite has excellent cycle stability with 330mAh/g reversible capacity. It could be an ideal anode material for secondary lithium ion battery.

Reference

1.A.Naji , J.Ghanbaja.,et al.. Electroreducion of graphite in $LiClO_4$-erhylene carbonate eletrolyte. Characterization of the passivating layer by TEM and Fourier-transform infrared spectroscopy. Journal of Power Source 1996;63:33-39

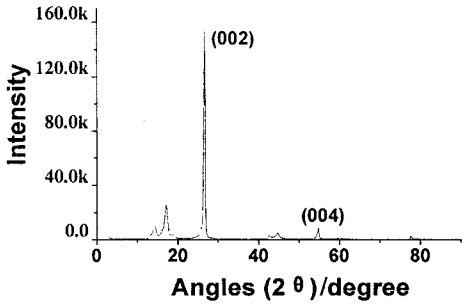

Figure 1.X-ray diffraction pattern for natural crystallite graphite.

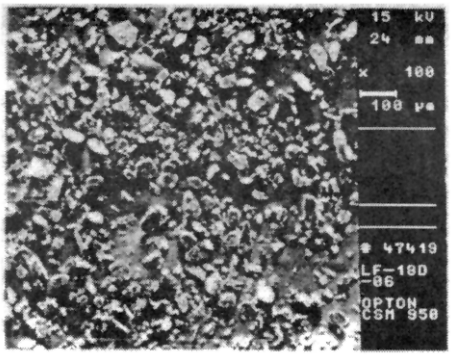

Figure 2 SEM photograph of natural crystallite graphite

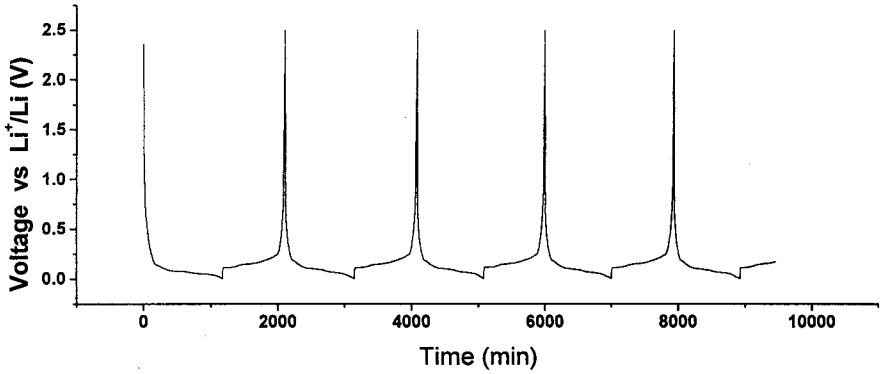

Figure 3.The charge–discharge curve of Li/natural crystallite graphite cell.

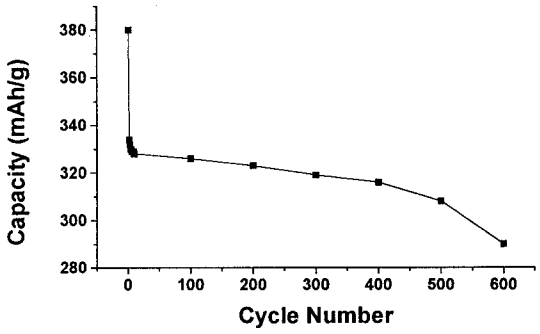

Figure 4.The correlation between capacity and cycle number for Li/natural crystallite graphite cell.

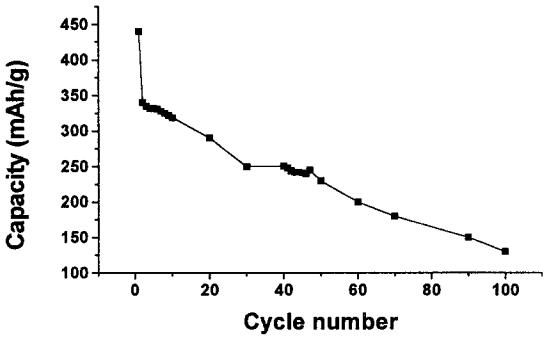

Figure 5 The correlation between capacity and cycle number for Li/natural flaky graphite cell