

Enhance the Capacity of Graphite for Lithium-ion Battery Anode by Ag Inlay and Carbon Coverage

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1. Introduction

Ag was recognized as an effective additive to improve the anode performance of carbon for Li-ion secondary batteries, and it has benefits of high theoretical capacity and suitable working potential [1]. The swelling problem of the lithium alloyable metal could be solved by composition of silver with graphite, which was investigated by a chemical deposition method [2], and reducing the size of Ag particles.

Mechanofusion as a composite process provides a convenience for dispersion of Ag on graphite, and when the constituents differ in size there is an increase tendency for segregation [3]. The carbon coverage offers further wrap of Ag/graphite composite to prevent Ag falling off from the graphite during charge and discharge.

2. Experimental

In mechanofusion process, 10g of the commercial Ag particle with diameter of 100-200 nm and 90g of the graphite with 22 μ m were applied to construct the composite. 90g of above composite was added into 200 ml of a 50 vol% alcohol aqueous solution with 10g of α -Resorcylic acid and 1g P₂O₅, then that became slurry. The slurry was followed by heat at 80°C for concentrate, which was then heated at 220°C for 1 h, 700°C for 2 h and 800°C for 4 h in a furnace. The heating process in the furnace was all under Ar flow to remove the side-product of polymerization and carbonization. The final product were ground and sieved through 200 mesh before being employed to fabricate electrodes for the coin cell test.

Electrochemical measurement was performed within coin cells, using lithium as counter electrode, and the Samsung electrolyte (EC/PC/EMC/DMC=3/1/4/2 by vol.).

3. Results and Discussion

The Ag, adhesive to the graphite after mechanofusion, of the composite, was covered with carbon came from α -Resorcylic acid, as shown in Fig. 1. The first galvanostatic discharge performance, which was shown in Fig. 2, of the composite electrode with carbon coverage was compared to that without carbon coverage and the graphite electrodes. Both the curves of composite electrodes, with and without carbon coverage, they exhibit obvious plateaus that can be ascribed to the formation of different Li-Ag alloys. In the discharge curve of the electrode of the composite with carbon coverage, there is a tile, could be assigned to the characteristic of the carbon, followed the plateau. The charge and discharge capacities of formation were collected in Table 1. On the basis result, more than 20% of capacity enhancement, in comparison with bare graphite, can be achieved by using the composite material with carbon coverage.

References

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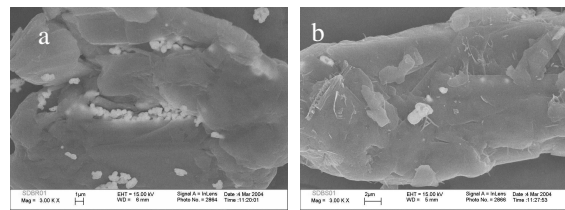


Fig. 1. (a) SEM micrograph of composite of graphite and Ag (b) the composite of with carbon coverage.

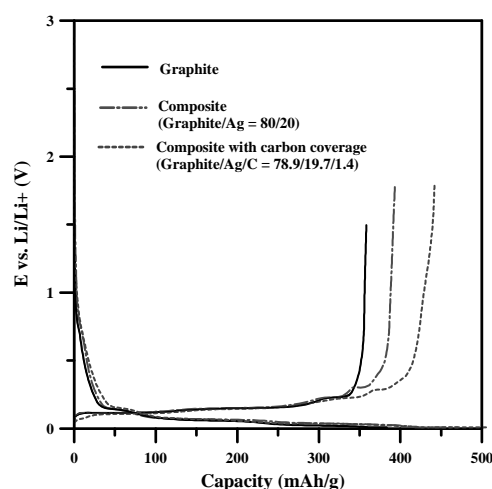


Fig. 2. The first galvanostatic performances of the graphite, the composite, and the composite with carbon coverage electrodes.

Ratio of Graphite/Ag/C	1 st Li- insertion (mAhg ⁻¹)	1 st Li- extraction (mAhg ⁻¹)	1 st cycle efficiency (%)	Irreversible capacity (mAhg ⁻¹)
100/0/0	401	360	89.8	41
80/20/0	470	393	83.6	77
78.9/19.7/1.4	511	443	86.7	68

Table 1 Comparison of capacities in the first cycle Li insertion and extraction reactions between 0 and 2V at 5 mA⁻¹.