ARC-DISCHARGE SYNTHESIS OF COMPOSITE CARBON-TIN NANOMATERIAL FOR LI-ION BATTERY ANODES

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Due to the growth of the portable electronic devices production, interest in Li-ion batteries is increasing. In modern commercial batteries, an anode is made of graphite, which theoretically gives a maximum capacity of 372 mAh/g. The use of tin makes it possible to achieve a greater capacity value: the theoretical maximum capacity is 994 mAh/g. However, the processes of intercalation of lithium ions into the tin material are accompanied by the volume expansion of the anode material, which leads to instability of the solid electrolyte interface layer and the destruction of the anode. An usage of nanoscale tin structures held by a stable matrix helps solve this problem. Moreover, in comparison with bulk tin, the nanoscale tin material has a more expanded surface and shorter diffusion paths for lithium ions, which significantly improves the characteristics of Li-ion batteries.

Arc-discharge synthesis is a promising method for producing composite carbon-metal nanomaterials [1]. This work presents the study results of the electric arc spruttering of composite graphite-tin electrodes, which leads to the formation of the nanomaterial consisting of spherical tin nanoparticles surrounded by a carbon matrix (Fig. 1(a)). The dimensional characteristics of tin nanoparticles, varying from 5 to 30 nm, and the structural characteristics of the carbon matrix, which can be either amorphous or graphene-like, depend on the conditions of electric arc synthesis.

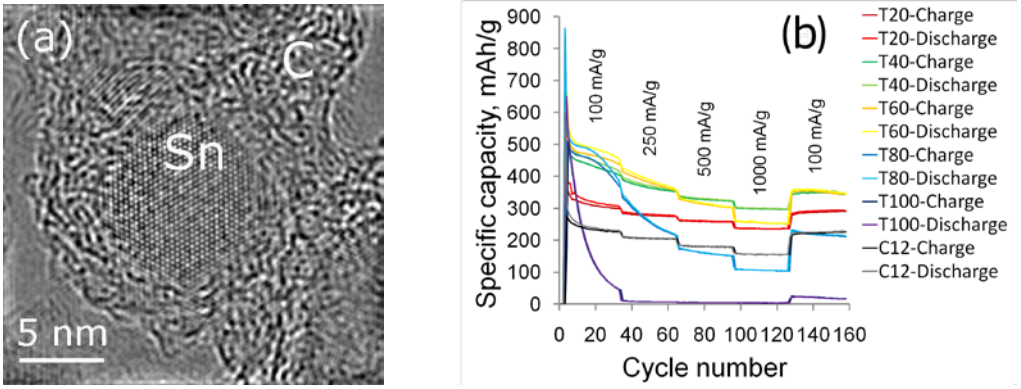

Fig.1. (a) HRTEM of Sn nanoparticle surrounded by carbon matrix, (b) Cycling characteristics of the synthesized C/Sn nanomaterials

The morphological and structural properties of C/Sn nanomaterials affect the capacitive characteristics of the anodes of Li-ion batteries (Fig. 1(b)). A tin content increase leads to an increase in specific capacity, but an tin nanoparticle size increase and an increase in the rigidity of the carbon matrix leads to a decrease in the stability of such materials. As a result, it was found that the optimal material is tin nanoparticles with an average size of 8 nm packed in an amorphous carbon matrix.

REFERENCES

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