The effect of carbon-coating on SnO$_2$-SiO$_2$ anode material for Lithium-ion Battery

Byung-Ki Na, Sang-Baek Kim

Deaprtment of Chemical Engineering, Chungbuk National University, Chungdae-ro 1, Seowon-ku, Cheongju, Chungbuk 362-763, Korea
nabk@chungbuk.ac.kr

Abstract

Tin-based lithium storage compounds are most noted for their reasonably low potentials for Li$^+$ insertion and high storage capacities. Such material deficiency is due to the large specific volume changes during Li$^+$ insertion and extraction reactions, which causes electrode disintegration. Crystalline SnO$_2$ and amorphous SiO$_2$ were reported to work as high capacity anode material. Amorphous SiO$_2$ works to promote the amorphitization of SnO$_2$.

Starting materials were Tin(II) chloride dihydrate (SnCl$_2$·2H$_2$O, 97%), tetra ethyl ortho silicate (TEOS, (C$_2$H$_5$O)$_4$Si, 99.9%), ethanol (C$_2$H$_5$OH, 99.9%), and Distillated water. SnCl$_2$·2H$_2$O and EtOH were mixed for 30 minutes. Then, TEOS and water were added into solution. Sol was changed to gel within 3~5 minutes.

The surface electrical conductivity of the composite is improved significantly due to carbon coating. It’s enhanced electrochemical performance and exhibited higher capacity and power and cycle performance.

Fig. 1 shows the charge-discharge curves of SnO$_2$-SiO$_2$. As the cycle time increases, the discharge capacity decreases. Fig. 2 shows the XRD patterns of SnO$_2$-SiO$_2$ composite after heat treatment. Sn peaks appear with the carbon coating. Fig. 3 shows the SEM images of SnO$_2$-SiO$_2$ composite at 300°C heat treatment. After carbon coating, the edge of the particle looks round-shaped. Fig. 4 shows the cycle performance of SnO$_2$-SiO$_2$ composite. After the carbon coating, the cycle performance is improved.

SnO$_2$-SiO$_2$ composite was quickly made by sol-gel process with TEOS and SnCl$_2$·2H$_2$O. We can find the existence of SnO$_2$ by x-ray diffraction data and its crystallinity was increased by increment of heat treatment temperature. Every cells show irreversible capacity after first discharge. And we confirmed that SiO$_2$ matrix helps to disperse SnO$_2$ particles. Carbon-coated SnO$_2$-SiO$_2$ showed improved discharge capacity and cycle performance.

References


Figures

![Fig. 1. Charge-discharge curves of SnO$_2$-SiO$_2$ composite heatreated at 300°C, (a) without carbon coating, (b) with carbon coating.](image)
Fig. 2. XRD patterns of SnO$_2$-SiO$_2$ composite after heat treatment, (a) without carbon coating, (b) with carbon coating.

Fig. 3. SEM images of SnO$_2$-SiO$_2$ composite at 300°C heat treatment, (a) without carbon coating and (b) with carbon coating.

Fig. 4. Cycle performance of SnO$_2$-SiO$_2$ composite, (a) without carbon coating, (b) with carbon coating.