Nano Si cluster-SiO_2-C Composite Material as High Capacity Anode Material for Lithium Batteries

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Silicon is attractive as a high capacity anode material for lithium battery, because lithium silicide can contain much more amount of lithium compared with Li-C compounds. However, the cycle ability of Li-Si alloying system is poor. Various attempts have been made in order to apply silicon as an anode material in lithium battery. It is important to prevent the pulverlizing of the silicon particle caused by the volume change during lithium insertion and extraction.

In the present study, silica-carbon composites including 5-10nm sized silicon particles were prepared using the disproportionation of silicon mono oxide ($2SiO \rightarrow Si+SiO_2$) and polymerization of furfuryl alchohol. X-ray diffraction measurement (XRD), observation by a transmission electron microscope (TEM) and electrochemical studies were carried out.

SiO powder and graphite powder were broken and mixed by a planetary ball mill. The milled composites were dispersed in solvent consisting of furfuryl alchohol, ethanol and water. Then dilute hydrochloric acid was added to the slurry and furfuryl alchohol was polymerized. The dried solid was heated at 1000ºC for 3h in Ar flow. The synthesized material was ground and applied to structural analysis and electorochemical experiments.

Fig.1 shows XRD pattern of the sample. The pattern contains the peak corresponding to graphite structure and silicon crystal. Fig.2 shows TEM image and electron beam diffraction figure of sample. TEM image shows that nano size cluster regarded as silicon crystal distributed throughout the sample. Therefore the synthesized material considered as SiO_2-C composite material dispersing nano Si clusters.

Fig.3 shows the charge discharge curves of Si-SiO_2-C composite (SiO:graphite:FA=1:1:1 at preparation) between 0.01 and 1.5V vs. Li/Li^+ at first cycle. The reversible capacity of sample was approximately 700mAh/g, which is almost twice as large as graphite materials. Fig.4 shows cycle performance. Si-SiO_2-C composite material shows good cycling life in 200 cycling.

We consider that the higher capacity and enhanced cycle life could be achieved by dispersing nonocrystalline Si in the SiO_2-C composite because SiO_2 is capable of bonding firmly to Si clusters and fixing them during charge-discharge cycles.

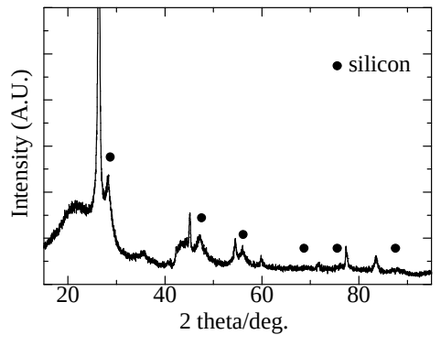

Fig.1 XRD pattern of synthesized Si-SiO_2-C composite material.

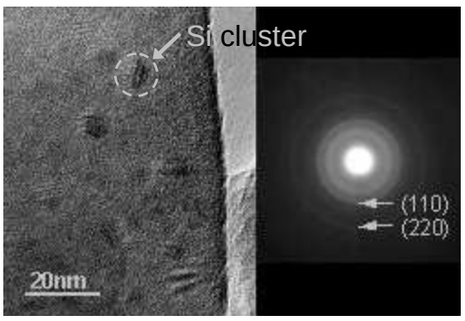

Fig.2 TEM image and ED figure of synthesized Si-SiO_2-C composite material**.**

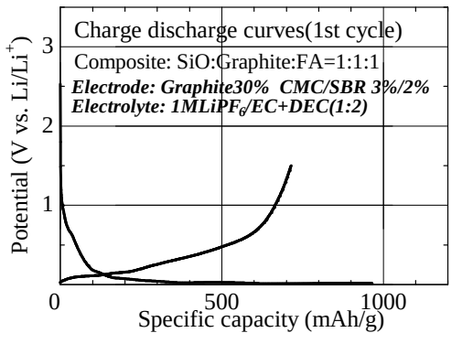

Fig.3 Charge-discharge curves of composite anode containing Si-SiO_2-C composite at 1st cycle.

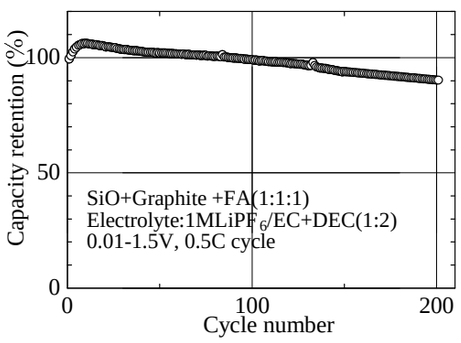

Fig.4 Cycling performancce of Si-SiO_2-C composite. (counter and reference electrodes were lithium film).