Development of a new oxide material for the negative electrode of lithium-ion batteries

High capacity hydrogen titanium oxide prepared by soft chemical synthesis

We have developed a new high-capacity hydrogen titanium oxide material ($H_2Ti_{12}O_{25}$) for the negative electrodes of lithium ion secondary batteries in collaboration with Ishihara Sangyo Kaisha, Ltd. (ISK). The developed material exhibits the same voltage (approximately 1.55 V vs. Li/Li^+) as and a higher charge-discharge capacity per mass of oxide (225 mAh/g against 175 mAh/g) than lithium titanate ($Li_4Ti_5O_{12}$) presently used in negative electrodes. In addition, because the hydrogen atoms in the material form a skeletal structure due to hydrogen bonding, the structure of the material is stable, and is not affected by the lithium insertion and extraction reactions during charging and discharging. The new material displayed an excellent charge-discharge cyclic performance equivalent to that of the conventional lithium titanate, while it maintained a high capacity of over 200 mAh/g even after 50 cycles. Accordingly, the developed $H_2Ti_{12}O_{25}$ is expected to be one of the high-voltage oxide negative electrodes in advanced lithium-ion batteries.

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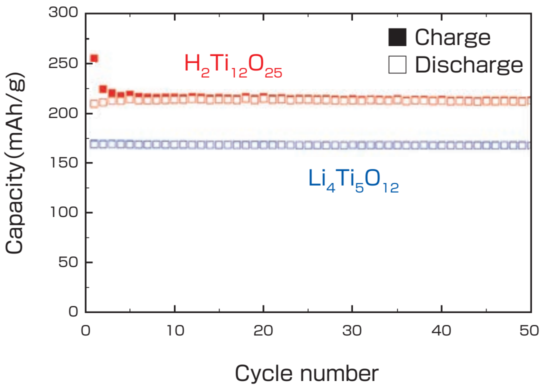

Charge-discharge cycle characteristics of new titanium oxide ($H_2Ti_{12}O_{25}$) and the conventional lithium titanate ($Li_4Ti_5O_{12}$: LT-017, manufactured by ISK) (counter electrode: metallic lithium; current density: 50 mA/g)

Fabrication method for submicrometer spherical particles

Utilizing instantaneous high temperature generated by laser irradiation

The fabrication of spherical particles has been of great their interest due to their interesting functionalities. Colloidal spheres of dielectric amorphous materials such as polystyrene and SiO_2 are commercially available. Solution-based self-assembly is also an important approach for the fabrication of spherical particles, although most of the particles are structurally unstable spheres composed of nanoparticle aggregates. Our group previously developed a method for reactive fabrication of B_4C submicrometer spheres by pulsed laser irradiation of boron nanoparticles in organic solvent using a focused laser beam with relatively low fluence. Inspired by this work, we have further developed a novel and versatile fabrication method for submicrometer spherical particles utilizing instantaneous high temperature generated by laser irradiation. Submicrometer spherical particles are obtained by unfocused pulsed laser irradiation onto raw CuO nanoparticles (Fig.).

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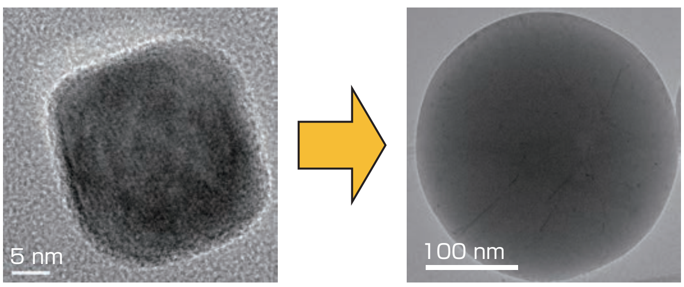

Morphological change induced by laser irradiation (copper oxide)