The study of lithium intercalation and deintercalation properties in TiO$_2$ nanoparticles

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The demand for high capacity of lithium rechargeable batteries has stimulated the search for use in high power mobile electronic devices. The Lithium ion battery has been developed with LiCoO$_2$, LiMn$_2$O$_4$, and V$_2$O$_5$ as cathode materials and graphite as an anode material. In the anode materials, to avoid graphite drawbacks, transition metal oxides (SnO$_2$, WO$_3$, TiO$_2$ etc.) have been studied. Titanium oxide (TiO$_2$) represents one of promising anode materials for use in lithium rechargeable batteries, instead of graphite. The TiO$_2$ has a higher volumetric capacity (1307 mAh/cm$^3$) than that of graphite (837 mAh/cm$^3$).1, 2

Our research focused on the synthesis and characterization of intercalation oxide such as TiO$_2$.3 The object of the present study is to investigate the electrochemical behavior of TiO$_2$ nanoparticles with three different nanoparticles, 7 nm, 14 nm and 30 nm sized TiO$_2$ nanoparticles were synthesized by a hydrolysis method and were analyzed using X-ray diffraction(XRD), transmission electron microscopy, X-ray photoelectron and Raman spectroscopy. The cells were fabricated with TiO$_2$ electrode, metallic Li anodes, and polypropylene separators in a glovebox filled with Ar gas. An 1 M LiPF$_6$ in EC:DEC(1:1) was used as the electrolyte. The electrochemical behavior of the TiO$_2$ with three different nanoparticle sizes was investigated by cyclic voltammetry, cycler, and a.c. impedance spectroscopy. The intercalation and deintercalation properties were compared with three different TiO$_2$ (7 nm, 14 nm and 30 nm) samples. Different mechanisms were appeared for the three types of the samples, indicating that particle size had a significant influence on the intercalation/deintercalation properties.

Typical XRD of synthesized three different TiO$_2$ nanoparticles by the hydrolysis method is given in Figure 1. Mechanism of three different TiO$_2$ nanoparticles will be discussed in detail.

References

Figure 1. XRD Patterns of three different TiO$_2$ nanoparticles