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Preparation of Macro-porous Si as a Anode Material for Li-ion Battery

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Extended Abstract

In lithium-ion batteries, lithium ions move between the battery's anode and cathode during charge and discharge. Carbon-based materials, like graphite and carbon micro-bead have used as anode materials for Li-ion battery. However, carbon-based anode materials have low coulombic efficiency and high irreversible capacity. In this reason, the alloys anode material mixed with the other material, such as Sn, Sb, Ge and Si etc., for enhancing the capacity of anode materials [2]. The silicon is used as a anode material for Li-ion battery to boosting the capacity of anode materials. The Silicon has the highest specific capacity (4212 mAh/g with formation of Alloy/de-alloy materials), high energy density and good safety [3]. Even though the silicon has high specific capacity, it often exhibits a swelling phenomenon during Li insertion and extraction. In this study, macro pores are existed in the silicon for prevention of the swelling phenomenon. The macro-porous silicon was synthesized from TMOS(Tetra methyl ortho silicate) and PMMA(Poly methyl methacrylate). The nano-sized PMMA beads used as a template for the formation of macro-pores was synthesized by the suspension polymerization method. The PMMA beads had 300nm size and it used a diffusing state in water. The TMOS was used as the precursor for the synthesis of macro-porous silica [1]. A mixture of TMOS and PMMA was thermal treated at 650 °C for 5 h under the air purging. Then, the macro-porous silica was mixed with aluminum powders. The aluminum powder was used for the conversion of macro-porous silica to silicon. The macro-porous silica and aluminum mixture slurry was thermal treated at 650 °C for 5 h under the argon purging. The macro-porous silica can be reduced to the macro-porous silicon with the reducing agents. Meanwhile, aluminum powder, used as reducing agent, is oxided for the reduction of silica. A metal oxide, like a Al_2O_3 in anode materials, can repress silicon. Therefore, the reduced macro-porous silicon sample was treated with HCl and H_3PO_4 in order to remove Al_2O_3. The macro pores of silicon were confirmed by SEM analysis. The reducing of silica was confirmed by XRD and XPS analysis.

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