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Kui Liang, Hailin Yang, Wenxun Guo, Jianlong Du, Lingyun Tian, Xiaofeng Wen



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Facile preparation of nanoscale silicon as an anode material for lithium ion batteries by a mild temperature metathesis route

Kui Liang*, Hailin Yang, Wenxun Guo, Jianlong Du, Lingyun Tian, Xiaofeng Wen

College of Materials Science and Engineering, Hunan University, Changsha 410082, China.

* Corresponding author. Tel./fax: 073188821611

E-mail address: liangkui363@163.com

Abstract

Silicon has been regarded as a promising alternative anode material for next-generation lithium ion batteries (LIBs) due to its high theoretical specific capacity of 3590 mAh g^{-1} ($\text{Li}_{3.75}\text{Si}$ formed at room temperature). In this work, nanoscale silicon has been synthesized via a simple and effective metathesis reaction in which SiCl_4 is the silicon source and Zn is the reductant and solvent, at a mild temperature of 500°C . The preparation process is very simple, facile and low-cost. The as-prepared silicon particles are spherical with a diameter of 150-200 nm, and the delithiation capacity of the nanoscale silicon can reach $1747.7 \text{ mAh g}^{-1}$ at a current density of 0.2 A g^{-1} .

Keywords: Nanoscale silicon; Mild temperature; Metathesis reaction; Lithium ion batteries; Electrode materials

1. Introduction

Lithium ion batteries (LIBs) are required for electric devices, photovoltaic devices and electric vehicles. Due to the rapid development of such applications, there is a growing demand for the development of LIBs that have a high energy density and a long cycle life. Graphite, as one of the most widely used anode materials in LIBs, has a theoretical specific capacity of approximately 372 mAh g^{-1} and limits the specific energy of LIBs [1]. Silicon has been determined to be one of the most promising

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