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

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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} ($Li_{3.75}Si$ 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 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