Silicon/Carbon Yolk-Shell with Internal Void Space for Lithium Ion Battery Anodes

M. TOKUR, H. ALGUL, T. CETINKAYA, M. UYSAL, H. AKBULUT
Sakarya University Engineering Faculty, Department of Metallurgical & Materials Engineering, Esentepe Campus, 54187, Sakarya, Turkey
E-mail : mtokur@sakarya.edu.tr

Abstract:

Lithium ion batteries are good choice for portable electronic devices such as laptops, mobile phones and hybrid electric vehicles. Because, lithium ion batteries have high energy density, long cycle life, high safety and low cost. Carbon materials such as graphite are widely used as anodes in lithium ion battery applications. However, the theoretical specific capacity of negative electrode material of graphite is (372 mAh/g) the limiting factor for using portable devices. Silicon is one of the most promising alternative material due to its low working potential and highest specific capacity of 4200 mAh/g. However, silicon cannot be used singly, because of its lower conductivity and poor cycling stability during the electrochemical process. Carbon coated silicon is a practical strategy to improve the electrochemical performance of silicon based anodes. The carbon coatings can enhance the electrochemical conductivity as well as buffer the large volume changes of silicon particles to keep the electrode integrity.

In this study, Si-C composites were synthesized a new gradient sol–gel process. Then, the obtained Si-C composites were immersed in 10 wt.% HF aqueous solution at room temperature for 3-6-12 hours to obtain different Yolk-Shell structures. The surface morphology of the produced electrodes was characterized using Field-emission scanning electron microscopy (FESEM), Transmission electron microscopy (TEM) and Energy dispersive spectroscopy (EDS) in order to understand the elemental surface composition of composites. The structures of the composites were characterized using X-ray diffraction (XRD) patterns and Raman spectroscopy. The electrochemical performance of the produced Si-C electrodes was investigated by charge/discharge and cyclic voltammetry tests from 0.05V to 1.5V in CR2016 test cells. The resistances of the cells were investigated using ac impedance technique (EIS). This study proved that Si-C nanocomposites remarkably increase the discharge capacity of the Li-Ion Batteries.

*This work is supported by the Scientific and Technological Research Council of Turkey (TUBITAK) under the contract number 214M125. The authors thank the TUBITAK MAG workers for their financial support.

Contribution: Oral