

A New High Capacity Graphite-Core/Silicon-Shell Composite Material for Lithium Ion Batteries

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Most state of the art lithium ion batteries use graphite or other carbonaceous materials for active mass in the negative electrode. The theoretical capacity ($372 \text{ mAh}\cdot\text{g}^{-1}$) of the LiC_6 -compound is in contrast to binary lithium alloys, for example $\text{Li}_{22}\text{Si}_5$ with a theoretical capacity of $4200 \text{ mAh}\cdot\text{g}^{-1}$, poor [1]. Unfortunately a large volume expansion occurs during the lithiation and delithiation of the silicone. This leads to mechanical stress and disintegration of the silicon particles which causes a high loss of capacity after a few cycles [2]. Numerous efforts have been made to overcome the dimensional problems.

In this work we investigated a new graphite-core silicon-shell composite material (figure 1) with an excellent cycling stability and coulometric efficiency (figure 2).

The advantage of such a composite material is the multiphase structure [3]. The graphite-core is able to buffer the large volume changes of the silicon shell. In addition to counter the capacity loss we chased to use CMC as binder, whose influence for the cycling stability for binary lithium alloys is published in literature [4, 5].

For the fabrication of our graphite-core/silicon-shell composite a gelatinous silicon compound was thermal decomposed under an argon flow on natural graphite. This decomposition leads to the silicon-shell on the graphite (figure 1, right).

Our electrodes are composed of the graphite-core/silicon-shell-particles as active material, *Super P* as conducting agent and CMC as binder (table 1). The electrode slurry was prepared via an optimized dispersing technique.

The characterization of the electrodes was done by physical and electrochemical measurements.

Table 1: electrode composition

	Graphite-core/silicon-shell material	Super P	CMC
w%	84	8	8

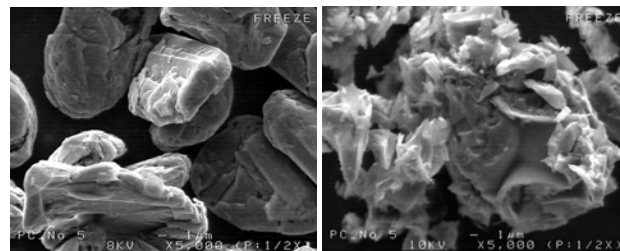


Figure 1: SEM image of natural graphite (left, magnification x5000) and of a graphite-core/silicon-shell composite material (right, magnification x5000)

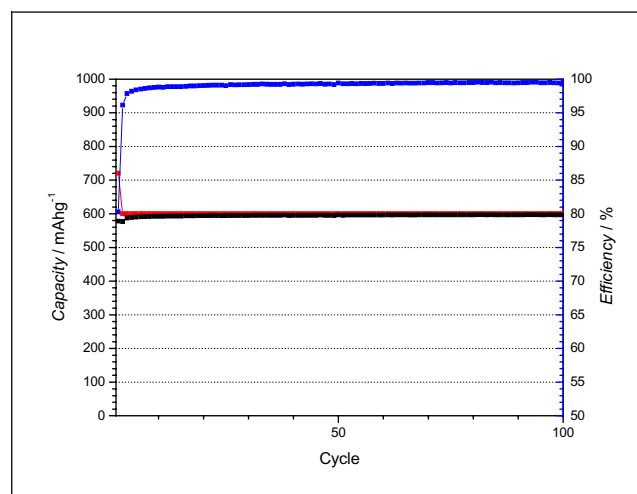


Figure 2: capacity limited cycling of a graphite-core/silicon-shell electrode with EC/DEC = 3:7 (v:v) + 2 w% VC, 1M LiPF₆

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