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LiON – Silicon-Carbon Composites for Lithium-Ion Batteries in Vehicle Applications

Introduction

The transport sector is problematic due to the dependence on fossil fuels, a finite resource with well-known environmental issues. One of the promising alternatives is to use electric energy instead. However, electrification on a large scale of the vehicle fleet is today hindered by the cost and performance of the batteries. For electricity to be competitive to diesel or gasoline, we need better charge capacity and better cyclability without increasing the cost.

The lithium ion battery

The three main components of a battery are electrodes; anode and cathode, where the electrochemical reactions can take place, and we need an electrolyte providing the ionic transport between the electrodes. Additional components of a battery cell are spacers, current collectors and electrolyte additives. During discharge, electrons are released in the reaction on the anode and bound in the cathode reaction (see figure 1). During charging, the process is reversed, and the lithium ions are intercalated in the anode.

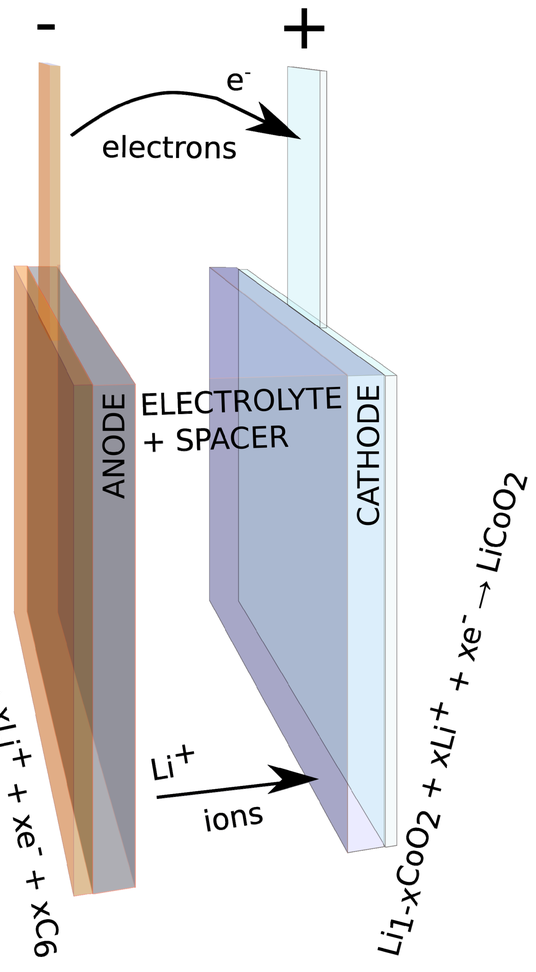
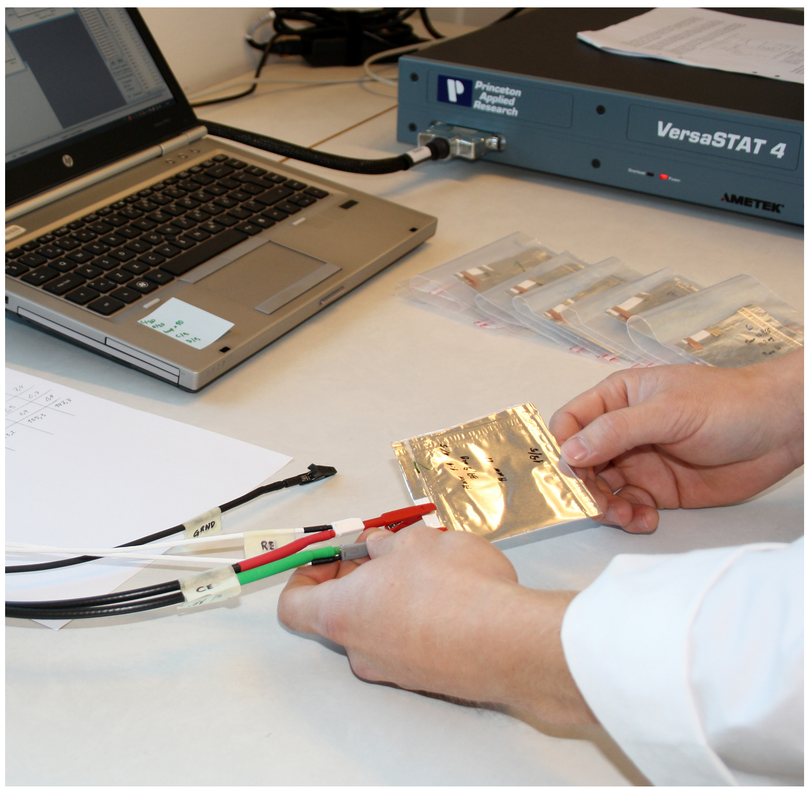


Figure 1: The principle behind a conventional lithium-ion cell during discharge.

Most lithium ion batteries today use graphite as anode material, because of its relative abundance and good cycle life. Graphite can intercalate one lithium per six carbons. What we are investigating is the use of silicon as lithium-intercalating material and graphite/graphene as current collecting matrix. Silicon is a superior material for lithium intercalation with the ability to intercalate four lithium for every silicon atom. The main issues that arise from the use of silicon are:

- Severe volume expansion during lithiation, that cause cracks to form and loss of connection.
- Poor electrical conductivity.

These issues can be minimized with a sufficiently small particle size and a supporting matrix with high conductivity that can withstand the volume expansion. See figure 2.



Aim and goal of project

The main goal of the project is to increase the capacity and cycle life of the anode. The means to achieve the goal is by:

- Optimizing particle size – with consideration to cycle life and simplicity of production.
- Develop methods that are easily scalable – So it may be scaled up to production by the end of the project.
- The materials used are in abundance and easily accessible.

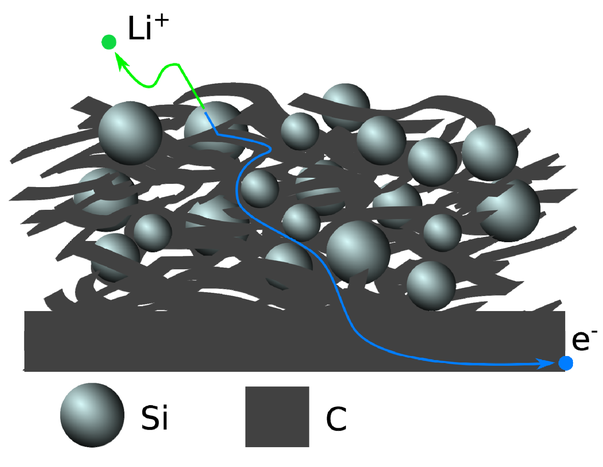


Figure 2: Carbon/silicon composite.

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