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A coupled chemo-mechanical model to study the effects of adhesive strength on the electrochemical performance of silicon electrodes for advanced lithium ion batteries

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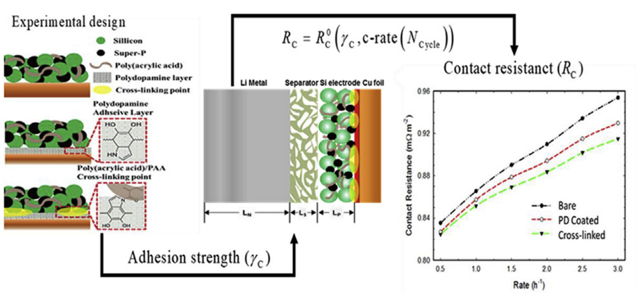
HIGHLIGHTS

- A coupled chemo-mechanical model for Si-based secondary batteries.
- Model parameterization and model validation.
- Contact resistance and adhesive strength between Si composite electrode and Cu current.
- Optimal electrode design for specific capacities.

GRAPHICAL ABSTRACT



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ABSTRACT

A coupled chemo-mechanical model which considers the contact resistance as well as the influence of the attractive forces inside the contact area between the electrode and current collector was developed to evaluate the effects of the adhesive strength of a binding material on the electrochemical performance of silicon-based lithium-ion batteries. The increase in contact resistance between the electrode and current collector was introduced as a factor that reduces the electrochemical performance of the cell. The model predictions were validated with experimental data from coin-type half-cells composed of Li metal, Si electrodes, and Cu current collectors coated with binding materials with different adhesive strengths. The contact resistance increased with an increasing number of cyclic current rate. The adhesive strength decreased with cyclic current rate. The proposed model was used to investigate the effects of adhesive strength and various cell design parameters on the specific capacity of the Si-based Li-ion cells.

1. Introduction

Lithium-ion batteries (LIBs) have been extensively used as the primary power sources of portable electronic devices such as laptops, mobile phones, and microelectronic devices owing to their high energy density and long cycle life [1–6]. However, there remain numerous

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