



Contents lists available at ScienceDirect

Journal of Power Sources

journal homepage: www.elsevier.com/locate/jpowsour

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

Williams Agyei Appiah^a, Joonam Park^a, Seungwoo Byun^a, Inseong Cho^b, Attila Mozer^b, Myung-Hyun Ryou^{c,*}, Yong Min Lee^{a,*}

^a Department of Energy Science and Engineering, Daegu Gyeongbuk Institute of Science and Technology (DGIST), 333 Techno Jungang-daero, Hyeonpung-myeon, Dalseong-gun, Daegu 42988, Republic of Korea

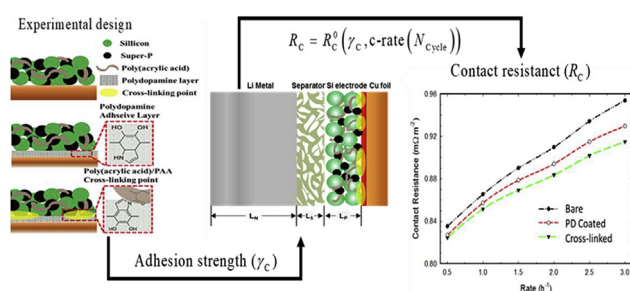
^b Intelligent Polymer Research Institute, ARC Centre of Excellence for Electromaterials Science, AIIIM Facility, Innovation Campus, University of Wollongong, Wollongong, NSW 2522, Australia

^c Department of Chemical and Biological Engineering, Hanbat National University, 125 Dongseo-daero, Yuseong-gu, Daejeon 34158, Republic of Korea

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



ARTICLE INFO

Keywords:

Lithium ion batteries
Adhesion property
Silicon
Contact resistance
Chemo-mechanical model
Simulation

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

* Corresponding author.

** Corresponding author.

E-mail addresses: mhyou@hanbat.ac.kr (M.-H. Ryou), yongmin.lee@dgist.ac.kr (Y.M. Lee).