Modeling Cycle Life of A Rechargeable Li-ion Battery:Theory

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Introduction

A charge-discharge model to simulate the cycle life behavior of rechargeable Li-ion batteries has been developed. The model is based on loss of the active lithium ions due to an electrochemical parasitic reaction. The effect of parameters such as depth of discharge (DOD), end of charge voltage (EOCV) and overvoltage of the parasitic reaction on the cycle life behavior of a battery will be presented.

Model Development

The model is based on porous electrode theory, concentrated solution theory, Ohm's law, intercalation/deintercalation kinetics and transport in the solid phase and the electrolyte phase.[1-8] To determine the influence of a specific cycling process on the cycle life behavior of a Li-ion battery, the CV charge step is taken into account, in addition to the CC charge process. The discharge process in the simulations determines the starting point of the next charge process.

It is assumed in this study that the solvent, ethylene carbonate (EC), undergoes two-electron reduction at the anode/electrolyte interface during the charge process, thus precipitating an insoluble film (a newly formed SEI layer) on the surface of the anode particles.

Fig. 1 presents the simulations of the first four charge-discharge cycles. EOCV of 4.0 V, DOD of 0.4, charge rate of 1C and discharge rate of 0.5 C were used for the simulations.

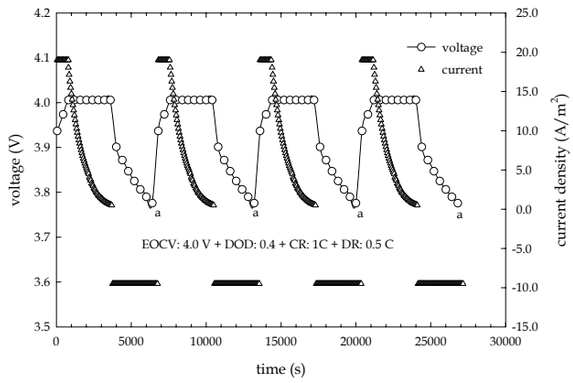

Figure 1. Simulations of cycling process. (EOCV: 4.0 V; DOD: 0.4; CR: 1C; DR: 0.5 C)

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References

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