Lithium-Ion Battery Single Particle Model Tutorial

Lithium-Ion Battery Single Particle Model is the code to simulate the lithium-ion battery cell model.

The code contains various models.

1. Finite Difference Method Model without Degradation. (FDM Model)
2. Finite Difference Method Model with Linearized Degradation. (FDM LM Model)
3. Finite Difference Method Model with Nonlinear Degradation. (FDM NM Model)
4. Pade Approximation Model without Degradation (Pade Model)
5. Pade Approximation Model with Degradation (Pade-D Model)
6. Optimization-Based Model (O-B Model)
7. Diagram

   Description automatically generatedSimulink (Open “battery\_cell\_model.slx”)

Capacity Loss

Side reaction current density

Positive

Surface Concentration

Negative

Surface Concentration

Voltage

O-B Model

Pade-D Model

Pade Model

FDM NM Model

FDM LM Model

FDM Model

Diagram

Description automatically generatedBattery Cell

Output Voltage

Capacity Loss

Positive Electrode

Negative Electrode

Negative Electrode

Side reaction current density

Diagram

Description automatically generated

Output equation of the state space model.

Calculate the surface concentration

State equation

Diagram

Description automatically generatedPositive Electrode

Output equation of the state space model.

Calculate the surface concentration

State equation

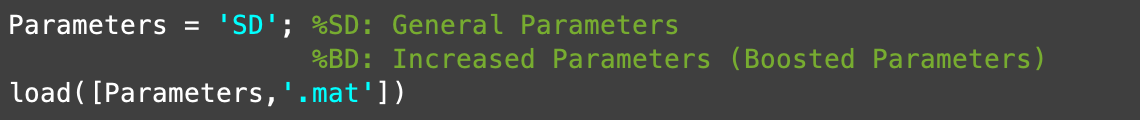
1. MATLAB File

To run the code, open the file “RUN\_ROM\_battery\_cell.m”

Following steps are the setup to run the battery cell model.

1. Text, chat or text message

   Description automatically generatedYou have to choose what model you are going to run. (FDM Model, FDM\_LM Model, FDM\_NM Model etc.)
2. After you choose the battery cell model, you have to select what parameters you are going to use. Skip this part if you select the model that does not contain a degradation model

In this code, we have two options. First is ‘SD’ (General Parameters). Second is ‘BD’ (Increased Parameters)

1. Select the model’s order

Text, application

Description automatically generated with medium confidenceFDM Model & FDM LM Model

Text

Description automatically generatedFDM NM Model

In FDM NM Model, we have to load the nonlinear map to calculate the negative surface concentration. There are two nonlinear maps. 'degradation\_map\_SD.mat' is for ‘SD’. 'degradation\_map\_BD.mat' is for ‘BD’.

Text, chat or text message

Description automatically generatedPade Model & Pade-D Model

Graphical user interface, text, application

Description automatically generatedO-B Model

1. Setup the input current

Graphical user interface, text, application

Description automatically generated

Text

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Description automatically generated

If you want to use the 1-D look up table block you have to setup the ‘t’ and ‘u’ variables.

A picture containing text

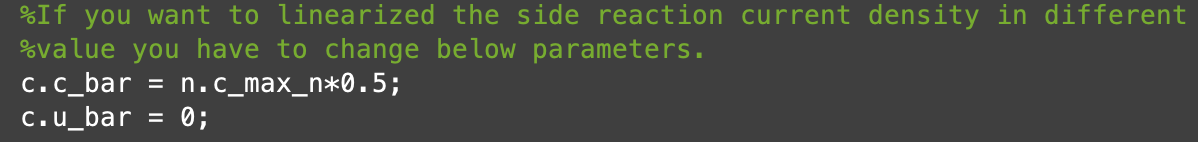
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Or you can setup the various input current using Simulink block as shown above. (Sinusoid wave, square wave etc.)

1. Initial Condition

In initial condition part, the only thing you have to change is “line 137”.

1. Linearized side reaction current density coefficients (minor step)



Remind below equation.

Line 174 – Line 197 is the code to calculate the .

1. Text

   Description automatically generatedSetup the time range.