A Reduced Order Model Of Lithium Ion Batteries Derived From The Cahn-Hilliard Equation

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Abstract

Emerging battery technologies are addressing applications of renewable and fossil fuel energy sources since they can store and release energy on demand. In recent years significant strides have been made in lithium battery technology. Lithium batteries are the primary sources of power in modern-day applications, such as portable consumer electronics, electric and hybrid electric vehicles (EV and HEV), implantable electronic medical devices and space vehicles. Vehicle applications require battery monitoring system (BMS) to not only protect Li-ion batteries from overheating and overcharging and over-discharging, but the BMS is also vital for formulating power management strategies that account for battery electrical and thermal performance limitations while minimizing fuel consumption and emissions. A disadvantage common to dimensional physics-based Li-ion battery models are the long simulation time due to a large number of nonlinear equations, so these models become computationally inefficient for simulating conditions in real-time. Thus, a large body of research has ensued towards developing reduced-order models (ROM) for Li-ion batteries. Our ROM was developed from data generated from the COMSOL© Multiphysics solution of the Cahn-Hilliard equation for Lithium iron phosphate (LiFePO4) cathodes. Principle component regression of the COMSOL® generate data was then used to develop the lowest rank model capable of reproducing the batteries SOC profiles for ambient temperatures ranging from 253 to 298 K.

Reference

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