Reduction of Microscale Li-Ion Battery Models

Mario Ohlberger* and Stephan Rave†

* Institute for Computational and Applied Mathematics & Center for Nonlinear Science
University of Münster
Einsteinstr. 62, 48149 Münster, Germany
Email: mario.ohlberger@uni-muenster.de - Web page: http://www.uni-muenster.de/math/u/ohlberger

† Institute for Computational and Applied Mathematics
University of Münster
Einsteinstr. 62, 48149 Münster, Germany
Email: stephan.rave@uni-muenster.de - Web page: http://www.stephanrave.de

ABSTRACT

A major cause for performance degradation and failure of rechargeable Li-ion batteries is the disposition of a metallic Li-phase at the positive electrode of the battery cell (Li-plating). The processes leading to the formation of this additional phase, however, are still poorly understood. It is the aim of the MULTIBAT project to gain new insights into the causes of this phenomenon through mathematical modeling and numerical simulation of Li-ion cells at the micrometer scale, resolving the porous geometry of the electrodes [1].

A problem with this approach is that such microscale models lead to large-dimensional, highly non-linear discretizations which, due to their complexity, cannot be solved directly at the cell level on current hardware. Even for smaller sections of a cell, parameter studies of the cell's behavior can easily become prohibitively expensive.

The reduced basis method ([2] and references therein) is a generic approach to the reduction of parametrized discrete problems based on the idea of projecting the original high-dimensional equations onto a problem-adapted low-dimensional reduced space spanned by solution snapshots of the high-dimensional problem for certain well-chosen parameters. Unlike classical multiscale discretizations, this allows an efficient reduction of the computational complexity while retaining the characteristic microscale features of the solution, which need to be preserved in order to understand Li-plating.

In this talk we give a brief introduction to the main ingredients of reduced basis schemes and show by the example of microscale battery models how this approach can be applied to complex nonlinear problems.

REFERENCES

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