BATEMO

UNDERSTANDING BATTERIES

CHARGE FAST BUT DON'T DESTROY

HOW VIRTUAL LI-ION BATTERIES CAN SOLVE THE DILEMMA

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Motivation

ULTRA-FAST

15 MIN.

150 KW

350 KW

Agenda

I THE IDEA

II THE MODEL

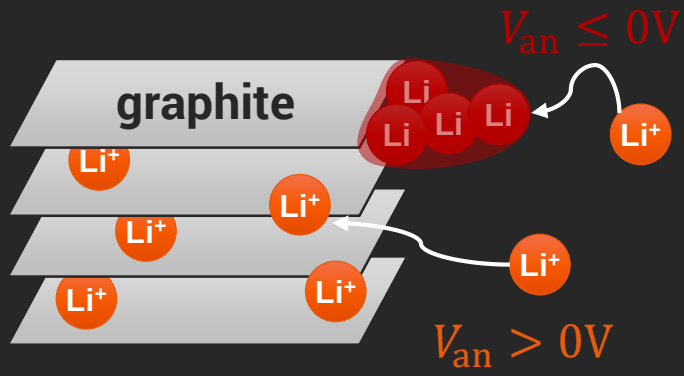
III THE STRATEGY

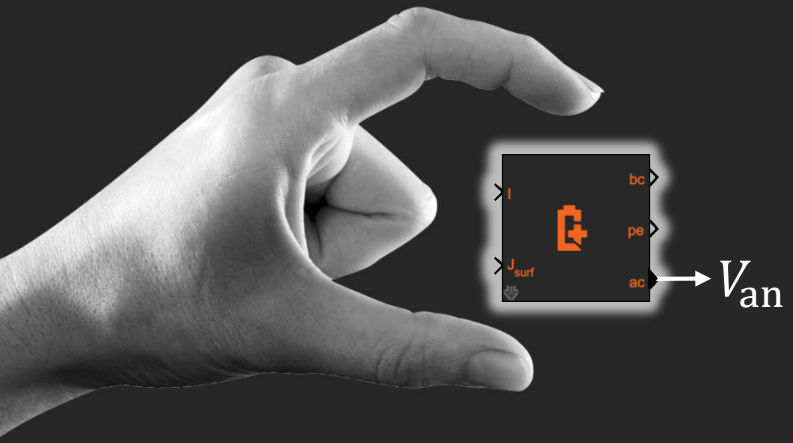
IV CONCLUSION

I The Idea

LITHIUM-PLATING is the problem …

… and triggered by an **ANODE POTENTIAL** below zero.





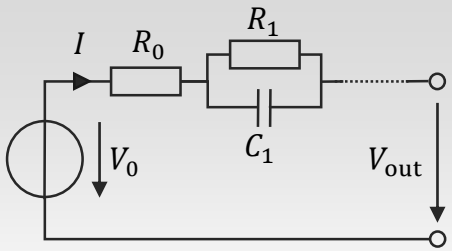
If you have a **VALID MODEL** to simulate the anode potential …

… you can calculate an optimal **CHARGING STRATEGY!**

II The Model

physicality & precision

ECM-Models



- parameterization in several weeks
- simulation in a couple of seconds
- simple handling

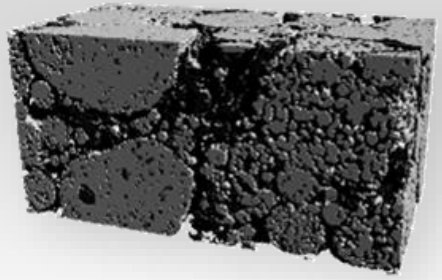
Development
unprecise and **no aging**

BATEMO CELL

- physical model
- parameterization for any cell
- global validity always demonstrated

Ideal Solution
precise, **fast** and **easy-to-use**

FEM-Models



- parameterization in several months
- simulation in several hours
- battery expert needed

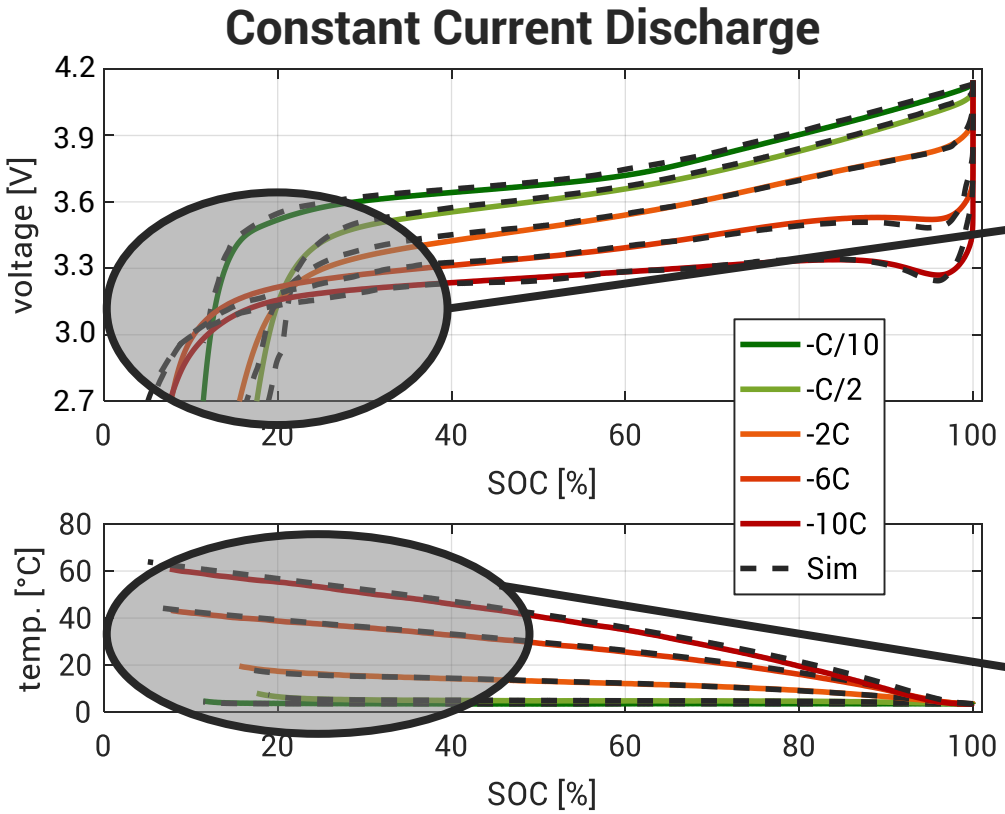
Research
complex and **slow**

speed & handling

Validation

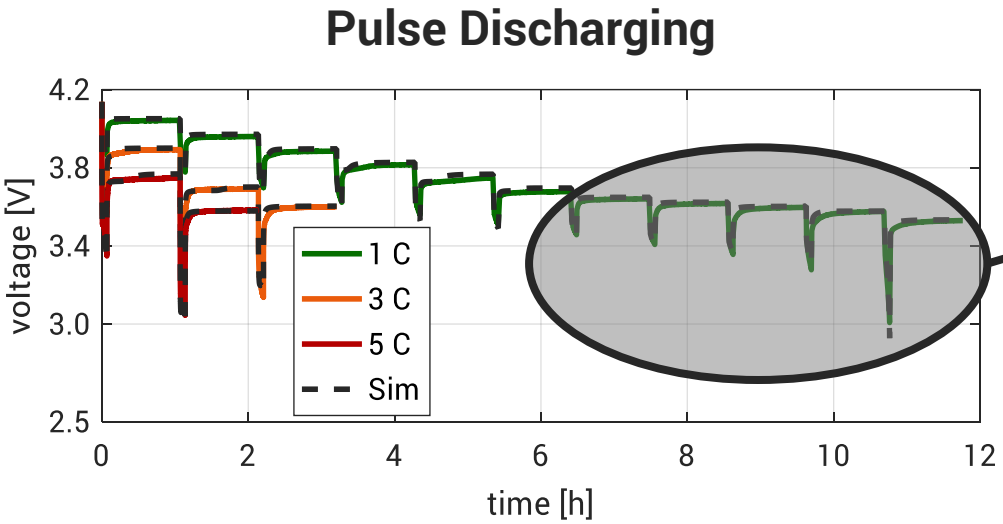
Model-based development of charging methods requires

Example: 18650 cell @ 0°C



current dependant available capacity

thermal precision



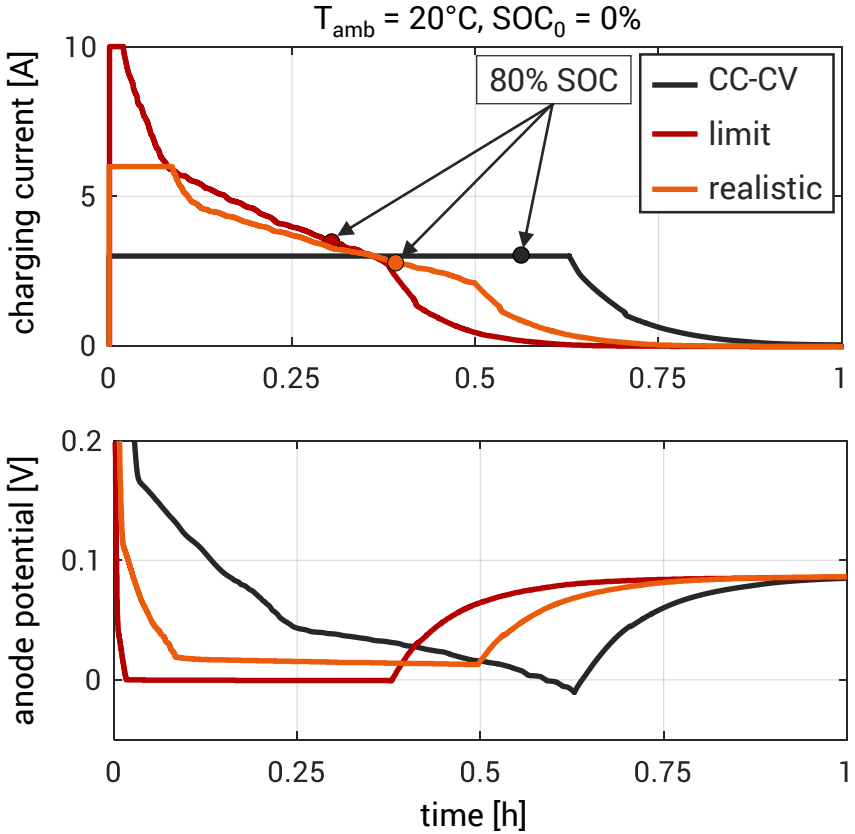
pulse and relaxation variation

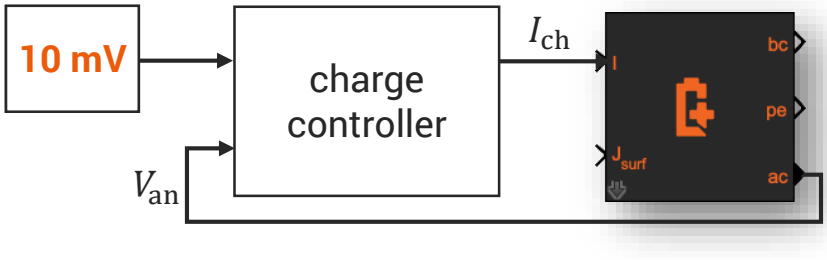
MODEL IS GLOBALLY VALID!

ANODE POTENTIAL IS GLOBALLY VALID.

OPTIMAL CHARGING STRATEGIES

III The Strategy





Fastest CC-CV: **34 Min.**

-47%

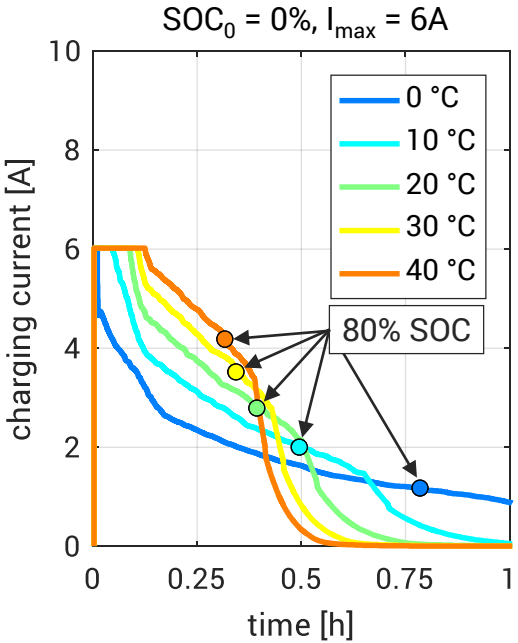
Physical Limit: **18 Min.**

-32%

Realistic: **23 Min.**

without additional aging

Example 1: Influence of temperature on charging time

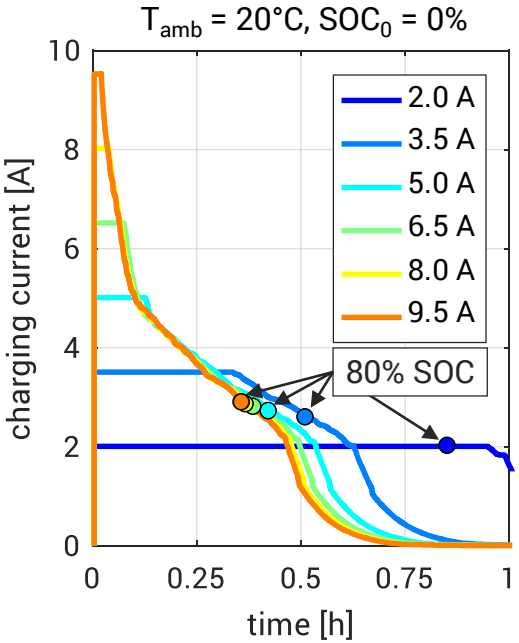


DESIGN OF THERMAL MANAGEMENT

A warm cell charges faster than a cold cell

But how much heating should you do exactly?

Example 2: Influence of max. current on charging time



DESIGN OF CHARGER

The more current a charger can deliver, the faster the charging

But for how much current exactly should you design your charger?

IV Conclusion

$V_{an} < 0$ triggers **lithium plating** → **predict V_{an}** with globally **valid model** → **control V_{an}** to charge at **physical limit**

functional safety

heating

aging

Charge fast but don't plate!

pack design

cooling

charger design

Model-based Development is the solution!

WANT TO DISCUSS?

Come to my poster!

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