



EPE'22 ECCE Europe – Tutorial Announcement

## Understanding Lithium-Ion Batteries as a partner of Power Electronics

### Name(s) and Affiliation(s) of the Lecturer(s):

Prof. Dr. Dirk Uwe SAUER  
RWTH Aachen University  
Germany

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### Scope and Benefits:

The objective of tutorial is to present:

- How lithium-ion batteries work,
- What the state of the art is and what new developments can be expected in the coming years,
- What performance you can expect from different products and chemistry,
- How to assess the safety of lithium-ion batteries,
- What the dominant ageing processes in lithium-ion batteries are and how they are related to the operating conditions, and
- What dynamic properties lithium-ion batteries have and how these can be modelled with impedance-based models and measured with impedance spectroscopy.

### Contents:

Schedule is as follows:

**Monday, 5 September 2022 – 1<sup>st</sup> Tutorial Day – Full Day**

**09:30 - 11:00                      Tutorials Part 1**

**Introduction: (Estimated time: 30 minutes)**

- Introduction of speaker, their background and activities of the host institution
- Introduction of the participants to understand their background and their expectations on the tutorial
- Introduction to the seminar program and, it of interest, discussion of additional focus topics

**Introduction of Lithium-Ion Battery Technology (Estimated time: 60 minutes)**

- General classification of lithium-based batteries



- General design, thermodynamics, and kinetics of lithium-ion batteries
- Various commercially available variants of lithium-based batteries and general overview on their specific properties and performance characteristics
- Availability of raw materials, development of markets and market players

**11:00 - 11:30                      Coffee break**

**11.30 - 13:00                    Tutorials Part 2**

**Performance, Safety, and Lifetime of Lithium-ion Battery Technology (Estimated time: 90 minutes)**

- Safety issues of lithium-ion batteries: what can happen in a lithium-ion battery, what is the role of the battery management system and what can be done on battery pack level to make the battery more safe
- Charging and discharging performance of lithium-ion batteries: what limits the power rating, what is lithium plating during charging, what is the impact of temperature and ageing on the performance
- Lifetime and reliability of lithium-ion batteries: how does the size of the cells and the parallel and series connection of the cells affects the reliability, what are the main ageing processes in lithium-ion batteries, how does the operating conditions affect the lifetime

**13:00 - 14:00                    Lunch break**

**14:00 - 15:30                    Tutorials Part 3**

**Impedance Spectroscopy for characterization and modeling of the dynamic behavior of lithium ion batteries (Estimated time: 90 minutes)**

- Fundamentals of experimental and theoretical aspects of impedance spectroscopy on lithium-ion batteries
- Basic concepts for impedance-based modelling and diagnostics of lithium-ion batteries incl. parameterization
- What can we learn about the dynamics of lithium-ion batteries from impedance measurements
- Hardware aspects of impedance measurements on batteries in the lab and on commercial battery systems
- Applications of impedance spectroscopy in quality control and safety monitoring

**15:30 - 16:00                    Coffee break**

**16:00 - 17:30                    Tutorials Part 4**

**System integration of batteries and power electronics (Estimated time: 90 minutes)**

- What is the best voltage level of a battery system, how does the voltage level affects the battery system design and the battery system reliability
- What is the effect of ripple currents on lithium-ion batteries depending on frequency and amplitude applied by power electronics on the batteries
- How could a joint design of battery pack and power electronics improve the quality of the package
- What is the function of charge balancing systems and what are balancing topologies



- Typical designs of battery management systems
- Final discussion of all aspects of the tutorial and discussion of special questions or applications of the participants

### **Who should attend:**

The target audience of the tutorial is anyone for whom batteries play a role in system development and applications. In particular, it aims to provide the knowledge necessary for developers of power electronics used together with batteries to understand the battery.

The tutorial will benefit anyone who,

- develop power electronics for battery systems,
- develop products and applications with battery systems,
- need to assess and evaluate the technological possibilities and market development in the battery field, and
- fundamentally want to better understand how batteries work and what performance and characteristics are achieved today.

### **Technical Level:**

- Advanced in Electrical Engineering
- Beginners in Battery Technology.

### **About the Lecturers:**



**Dirk Uwe Sauer** is professor for Electrochemical Energy Conversion and Storage Systems at the Institute of Power Electronics and Electrical Drives (ISEA) at RWTH Aachen University since 19 years. He is a specialist for all aspects on system integration of batteries incl. testing, characterization, ageing, modeling, diagnostics, lifetime prediction and field integration into any type of mobile or stationary applications. His chair has about 75 full time employees and more than 60 students as student assistance, or in bachelor or master thesis. He is a member of the National Academy of Science and Engineering (acatech) and the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW). He is also the co-founder of 4 spin-off companies.



**Alexander Blömeke** is an electrical engineer by training from RWTH Aachen University. He is working in the field of battery characterization, battery diagnostics and battery modelling with a special focus on impedance-based methods. Currently he is the chief engineer of the department “Battery System Design and Vehicle Integration” with about 25 scientists from different disciplines at the “Chair for Electrochemical Energy Conversion and Storage Systems” at the Institute of Power Electronics and Electrical Drives (ISEA) at RWTH Aachen University.