Soft Magnetic Materials for Electrical Machines

Names and Affiliation of the Lecturers:

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Scope and Benefits:

Electrical machines are used in the fields of energy generation and distribution, industrial applications, household appliances or in the transportation sector. Electromobility is a broad application field for speed variable traction drives. In order to increase the power density and efficiency, rotational motor speeds are generally increasing with which new challenges arise. The measures to improve the efficiency of electrical machines by constructive measures and design choices are generally exhausted. A bare potential still lies in the magnetic circuit materials which enable the fundamental energy conversion. The correct way of modeling and implementation in FE machine simulations is as important as the consideration of structural material characteristics in order to utilize this material potential. This tutorial will illustrate the most important aspects of soft magnetic materials for electrical machines with a focus on the application of electrical steel in traction drives.

Contents:

Starting from the challenges and main problem with usual approaches to select a specific material, the fundamental relations between the magnetic properties and structural material parameters are explained. Advanced strategies to select the best possible material with respect to the application requirements are presented and, in this context, the modeling and implementation in simulation chains up to the evaluation of results for different drive cycles is discussed. The first part of the tutorial ends with an outlook on the modeling of the cut-edge effect to highlight the importance to increase model accuracy by accounting for relevant physical effects. In the second part of the tutorial, a thorough review on the magneto-mechanical coupling sets the framework to discuss effects of mechanical stress in electrical machines, either induced by processing, manufacturing or during the operation of electrical machines. From this on, innovative approaches to utilize the deeper understanding of electrical steel in the design process of electrical machines are presented.

From flux bridge design to segmented machines, an overview on current research trends ends the second part of the tutorial which is concluded with a short summary.

Schedule:

Friday, 9 September 2022 - 2nd Tutorial Day - Morning

09:30 - 11:00	Introduction - Part 1
11:00 - 11:30	Coffee break
11.30 - 13:00	Part 2 - Conclusions
13:00 - 14:00	Lunch break (Optional – if ordered)

Who should attend:

The tutorial will present the state-of-the-art material selection approaches, explain the importance of advanced modeling and will present innovative trends for electrical machines in a straightforward manner. Prior knowledge on the deeper fundamentals of electrical steel is required. The target audience comprises interested researchers, machine designers or PhD students.

- Researchers who are working with electric traction drives and want to learn all about the material-machine interactions and challenges
- Industry affiliates who are interested in the challenges and improved modeling approaches for electric traction drives

Technical Level:

Technical Level: Beginners, advanced, experienced

About the Lecturers:

Nora Leuning received the M.Sc. degree in materials engineering from the RWTH Aachen University in July 2015 and the Dr.-Ing. degree from the Faculty of Electrical Engineering and Information Technology from the RWTH in July 2020. Since 2015 she is a research associate at the Institute of Electrical Machines (RWTH), where she is team leader of the group "Analysis and Modeling". Her main research interests include the experimental analysis, material modeling and subsequent evaluation of production processing and design interdependencies of soft magnetic materials in electrical machines.

Benedikt Schauerte received the M.Sc. degree in electrical engineering in May 2017. Since July 2017 he is working as a research assistant at the Institute of Electrical Machines (IEM) of the RWTH Aachen. He works in the fields of magnetic measurements, magneto-mechanical coupling and its consideration in the FEA of rotating electrical machines as in the development of novel sensor topologies for the vectorial characterization of two-dimensional stress distributions under magnetizations in arbitrary directions.