Additive Manufacturing of NdFeB Permanent Magnets from Recycled Raw Materials

Summary

The global demand for permanent magnet materials is increasing. NdFeB neodymium magnets are essential for the realization of the targeted e-mobility and green energy milestones by enabling the construction of the most compact and powerful electrical machines. The project will combine recycled NdFeB raw materials with the production freedom of additive manufacturing (AM) technologies to realize innovative topology optimized rotating electrical machines. The overall goal of the project is to develop a methodological expertise in 3D-printing permanent magnets and includes both theoretical and practical work. The project focuses on the optimization of the pre-printing, printing and post-printing processing parameters when working with two distinct AM technologies: laser powder bed fusion (L-PBF) and extrusion (FDM) based methods with the goal of maximizing the AM NdFeB magnet power density. The utilized raw materials will include both commercial and in-house produced NdFeB powder from recycled sources

Research field:	Electrical power engineering and mechatronics
Supervisor:	Dr. Hans Tiismus
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

Within this thesis, the PhD candidate will learn in depth about hard magnetic materials and obtain practical skills, which include: operating two different AM manufacturing systems (L-PBF and FDM), numerical modelling skills in the electromagnetic domain (with COMSOL Multiphysics), and laboratory work in material and electrotechnical science domains. The candidate is responsible for the development and implementation of permanent magnet material optimization procedures, with the goal of maximizing the printed material's anisotropic structure and remanence magnetization. At the end of the thesis, a prototype demonstrator motor will be built, which will utilize additively manufactured NdFeB permanent magnets. The candidate will present his/her work at international conferences and publish journal papers required to complete the thesis within the PhD studies.

Responsibilities and tasks

- Study of additive manufacturing of permanent magnet materials
  - Determination of the state of the art, possibilities and limitations of AM NdFeB magnets
  - Identification of the best practices for the 3D printing of permanent magnets
- Optimizing process with L-PBF printing
  - Learning to operate the SLM-280 printing system.
  - Optimizing the printing and post processing of recycled NdFeB powder
  - Measuring the material properties and determining the design rules for prototyping
- Optimizing the process with FDM printing
  - Learning to operate the Flashforge creator 2 pro printing system.
  - Optimizing the preparation, printing and post processing of recycled NdFeB powder
  - Measuring the material properties and determining the design rules for prototyping
- Prototyping
  - In cooperation with the Electrical Machine Research group team, designing an electrical machine prototype, with the goal of maximizing the impact of integrated 3D printed magnets
  - Numeric validation of the design in COMSOL Multiphysics.
  - The 3D printed magnets will be tested through exhaustive measurements of the prototype machine.

Applicants should fulfil the following requirements:

- a master’s degree in physics, electrical engineering, or material engineering
- a clear interest in the topic of the position
- excellent command of English
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to help in organizational tasks relevant to the project

The following experience is beneficial:

- Theoretical and experimental basics of electrical machines and metallurgical processes
- Knowledge of electromagnetic phenomena and hard magnetic materials
- Programming in C++/ MATLAB
- Prior experience with FEM software, such as COMSOL Multiphysics.
- prior experience with 3D-printing

We offer:

- 4-year PhD position in the leading electrical machines research group in Estonia with a large portfolio of dedicated research, industrial and study-oriented projects
- The chance to do high-level research in one of the most dynamic Universities and research groups in the region
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of electrical machines and material sciences.

About the department

The Department of Electrical Power Engineering and Mechatronics of Tallinn University of Technology is an interdisciplinary research center that focuses on socially relevant and future-oriented research and teaching issues related to power engineering and mechatronics. The mission of the Department is to be a leader in electrical engineering and technical studies and development projects in Estonia, known and valued in society, and a respected partner in both national and international cooperation networks and organizations.

TalTech’s electrical machines research group (EMG) deals with calculations, modeling, control, testing and development of electrical machines (motors, generators, transformers). In addition, the group conducts expertise, consultations and trainings.

FOCUS FIELDS:

- Electrical machines calculations, modelling and testing
- Determination of electric and loading parameters
- Thermal analyses in calorimetric chamber and wind tunnel
- 3D printed electrical machines
- Modelling and experimental detection of electrical machine faults
- Digital twins for electrical machine control and diagnostics
- Artificial intelligence (AI) in electrical machine design and diagnostics

Additional information

For further information, please contact Dr. Hans Tiismus hans.tiismus@taltech.ee or visit https://taltech.ee/en/electrical-machine-group

To get more information or to apply online, visit https://taltech.glowbase.com/positions/770 or scan the the code on the left with your smartphone.