Advanced recycled NdFeB permanent magnets for new energy and mobility applications

Summary

The global demand for permanent magnet materials is increasing fast. Neodymium-iron-boron (NdFeB) 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 develop recycled NdFeB raw materials and characterize them with new and competing products on the market. The overall goal of the project is to develop a methodological expertise in recycling permanent magnets and includes both theoretical and experimental work. The project focuses on optimization in terms of magnetic parameters by both bulk (magnetometry, VSM) and microscopic (NMR-NQR) magnetism-based methods with the goal of maximizing the recycled NdFeB magnet power density. The project is a close collaboration of labs at KBFI/NICPB, TalTech, and Tartu University with practical guidance of the new Narva magnet factory by Neo Performance Materials Inc (NEO) utilizing both commercial and in-house produced NdFeB samples.

Research field:	Applied physics and mathematics
Supervisors:	Kerli Liivand Raivo Stern
Availability:	This position is available.
Offered by:	School of Science National Institute Of Chemical Physics And Biophysics
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: numerical modelling skills in the electromagnetic domain (with Python, MATLAB, COMSOL Multiphysics etc.), and laboratory work in material and electrotechnical science domains (QD MPMS or PPMS, XRD, NMR-NQR, AFM/MFM). The candidate is responsible for the development and implementation of permanent magnet material optimization procedures, with the goal of maximizing the resulting material's anisotropic structure and remanence magnetization. At the end of the thesis, set of recipes to produce most powerful NdFeB permanent magnets from the recycled ones will be formulated and presented. 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 decomposing strategies of permanent NdFeB magnet materials
  - Determination of the state of the art, possibilities and limitations of NdFeB magnets
  - Identification of the best practices for the chemical/physical decomposition of permanent magnets
- Optimizing process with HDDR and other decomposing techniques
  - Learning to operate the electro-chemical decomposing systems
  - Measuring the material properties and determining the design rules for prototyping
- Optimizing the process with field/pressure compacting
  - Learning to operate the commercial field/pressure compacting systems
  - Optimizing the preparation, printing and post processing of recycled NdFeB powder
  - Measuring the material properties to determine the design rules for prototyping
- Prototyping
  - In cooperation with the TalTech 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.
  - Characterization of Tartu ALD NdFeB (thin) films

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 magnetic materials and metallurgical processes
- Knowledge of electromagnetic phenomena and hard magnetic materials
- Programming in Python/ MATLAB/LabView/MultiVu etc.
- Prior experience with FEM software, such as COMSOL Multiphysics
- prior experience with experimental equipment (QD MPMS or PPMS, XRD, NMR-NQR, AFM/MFM)

We offer:

- 4-year PhD position in the leading electrical materials 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 National Lab, partnering 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 high magnetic fields and material sciences.

About the department

Proposed PhD topic builds on experimental capacity of the magnetism group at NICPB and suggests to explore the new methods for recycling of used Nd-Fe-B magnets as well as materials of various multi-ferroic materials and their potential applications in a comprehensive way. We employ the powerful options of the Quantum Design's PPMS (physical property measurement system) not only for basic characterisation of the new materials but also as a tuneable sample space for much more involved:

1. AFM-MFM scanning probe from Nanoscan to study surface physics in up to 14T and in temperature interval of 1.8-400 K;
2. Home-made (MagRes, Dr Arneil Reyes, NHMFL/FSU, Tallahassee) NMR-NQR spectrometer to investigate the short-range interactions and spin dynamics.

FOCUS FIELDS:

- Magnetic materials calculations, modelling and testing
- Determination of structural and magnetic parameters
- Thermal analyses in He-cooled magnetometer and other options of the QD PPMS
- NMR-NQR techniques and data analysis

Additional information

For further information, please contact Prof. Raivo Stern raivo.stern@kbfi.ee or visit https://kbfi.ee

To get more information or to apply online, visit https://taltech.glowbase.com/positions/800 or scan the the code on the left with your smartphone.