The Dep. of Functional Materials headed by Prof. O. Gutfleisch at the Institute of Material Science at TU Darmstadt is offering a

Doctoral Researcher (PhD) Position Composition and Process Engineering using Abundant Elements for Novel Gap Permanent Magnets

75 % with a fixed-term contract of 3 years

The permanent magnet market is dominated by ferrite magnets (31% of the market, $(BH)_{max}$=35 kJ/m³) for low-performance and sintered Nd-Fe-B magnets (59%, $(BH)_{max}$=474 kJ/m³) for high-performance applications. Only bonded Nd-Fe-B magnets are available for medium-performance applications, limited to room temperature applications, and representing 5% of the market share. Moreover, no sintered magnets are available for the medium-performance range that covers a wide operating temperature range. This project aims to address this to develop a “gap magnet” with good thermal stability to fill the gap between ferrite and Nd-Fe-B, targeting intermediate energy application (100 kJ/m^3 ≤ (BH)max ≤ 200 kJ/m^3). Optimal compositions will be identified using a machine learning-driven design process to enhance intrinsic magnetic properties such as saturation magnetization (M_s), anisotropy field (H_a), and Curie temperature (T_c), while stabilizing the metastable Sm_3Fe_{29} phase with minimal phase stabilizer M. By screening all available experimental data, the aim is to identify compositions with $\mu_0 H_a > 5$ T, $\mu_0 M_s > 0.8$ T, and $T_c > 550$ K, and to translate these intrinsic properties into extrinsic ones through an optimized microstructure, ultimately enabling the development of a prototype isotropic magnet with $\mu_0 M_r$ = 0.8–1.0 T, $\mu_0 H_c \approx 1.2$ T, and $(BH)_{max}$ in the range of 100–200 kJ/m³.

The position is hosted by the internationally renowned Functional Materials Group, which focuses on the development of resource-efficient functional materials.Our research contributes to the development of novel magnets from fundamental mechanisms to applications. Additional research topics include magnetocaloric materials for hydrogen liquefaction, magnetic materials for biomedical and catalytic applications, with a focus on synthesis, additive manufacturing, characterization, and modeling of magnetic, thermal, and microstructural properties.In particular, this project is a part of CRC 270 HoMMAge (https://www.tu-darmstadt.de/sfb270/about_crc/index.en.jsp), which is a consortium with Technische Universität Darmstadt, Universität Duisburg-Essen, Bergische Universität Wuppertal, Max Planck Institute for Sustainable Materials, and Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C) at Forschungszentrum Jülich, as well as industry. Their common goal is to develop new magnetic materials for efficient energy technologies by gaining a detailed understanding of the structural, magnetic, and electronic interactions within the material to adjust the local and global properties by new processing techniques to be developed, like additive manufacturing and severe plastic deformation methods.

Your tasks will be to evaluate $Sm_3Fe_{29-x}M_x$ (M = Cr, V, Mo, Ti) as a resource-efficient gap magnet, free from highly scarce heavy rare earths, while ensuring full utilization of the rare-earth element basket. The main focus will be on experimental material synthesis and characterization. Sample preparation will be carried out using induction melting, arc melting, melt spinning, and additive manufacturing, with the latter particularly employed to synthesize bulk materials with compositional gradients. Characterization will involve X-ray diffraction, scanning electron microscopy, and magnetometry. The candidate is expected to conduct thorough literature research and to present research results at national and international conferences, in peer-reviewed scientific journals, and during regular project meetings.

Your profile: Requirements include an excellent scientific degree (master's or equivalent) in Materials Science, Physics, Chemistry. Ideally, you have prior experience in the synthesis and characterization of metallic or magnetic materials (bulk, powders, or ribbons). Knowledge of programming is considered

an advantage. You must have very good English skills (fluent in both spoken and written) and strong communication competencies. We expect you to integrate into our interdisciplinary team, actively contributing to the overall progress of the project's objectives while pursuing your thesis with high motivation and independence. You should be highly motivated to publish your results, present them at international project meetings and conferences, and enjoy working in interdisciplinary and international teams.

We offer: The opportunity to work towards a PhD degree on a cutting-edge research topic in the field of functional materials for energy conversion and excellent working conditions in an international team with integration into a scientific network of well-renowned experts of the magnetic materials community. The Technical University of Darmstadt offers a varied, diverse working environment, independent work, demand-oriented training opportunities and individual personnel development. Flexible working hours, company health management, and the compatibility of family and career are a matter of course. In addition, you will receive free travel authorization for local and regional transport in the area of the state of Hesse (LandesTicket Hessen) according to the applicable regulations. All university employees can use the offer of deferred compensation in favor of a "Job Rad" leasing model.

The Technische Universität Darmstadt intends to increase the number of female employees and encourages female candidates to apply. In case of equal qualifications applicants with a degree of disability of at least 50 or equal will be given preference. Wages and salaries are according to the collective agreements on salary scales, which apply to the Technische Universität Darmstadt (TV-TU Darmstadt). Part-time employment is generally possible. Applications (all in a single PDF-file) should be sent including all usual documents, stating the above identification number, in the form of a pdf by e-mail to info@fm.tu-darmstadt.de. If you have any questions, please contact Dr. Pelin Tozman (pelin.tozman@tu-darmstadt.de) or Prof. Oliver Gutfleisch (oliver.gutfleisch@tu-darmstadt.de). For the website of the FM group, see www.mawi.tu-darmstadt.de/fm.