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TECHNISCHE UNIVERSITÄT DARMSTADT

FUNKTIONALE MATERIALIEN

Advanced Research Lab / Master Thesis

Utilize the full rare-earth basket to produce gap magnet

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. To address this, **in this project we will develop a "gap magnet"** with good thermal stability to fill the gap between ferrite and Nd-Fe-B, targeting intermediate energy application ($100 \leq (BH)_{max} \leq 200$ kJ/m³)).

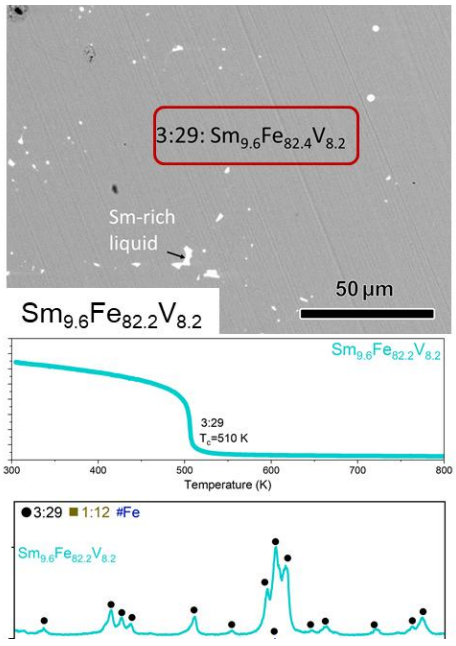

Fig. 1 . Typical microstructure, MT curve and XRD pattern for the sample with 3:29 phase.

Project Highlights

Goal: Develop a resource-efficient gap magnet free from highly scarce heavy rare earths, while ensuring full utilization of the rare-earth element basket.

Focus Material: $Sm_3Fe_{29-x}M_x$ (M = V) compounds

Key Tasks You'll Tackle:

- Prepare and characterize single-phase $Sm_3Fe_{26.7}V_{2.3}$ ingot
- Measure intrinsic magnetic properties (M_s, H_a, T_c) and analyze microstructure.
- Perform composition design to synthesize variants such as $Sm_3Fe_{27}V_2$, $Sm_3Fe_{27.3}V_{1.7}$, $Sm_3Fe_{27.4}V_{1.4}$ exploring phase stability. If the single phase won't obtain in V-lean region Sm will be substitute with Zr and Y. Selected sample will be subjected to grain size refinement.

Why Join

- Hands-on experience with advanced magnetic materials and state-of-the-art characterization.
  - Sample preparation → **arc melting, induction melting**
  - Structural analysis → **X-ray powder diffraction**
  - Microstructure analysis → **Scanning electron microscopy (SEM)**
  - Magnetic characterization → **PPMS magnetometer**
- Opportunity to publish results and build a strong research portfolio. Collaborate with different research group in the frame of CRC Hommage (more details: https://www.tu-darmstadt.de/sfb270/about_crc/index.en.jsp)
- Work in a dynamic, international materials science environment.

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