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TECHNISCHE UNIVERSITÄT DARMSTADT

FUNKTIONALE MATERIALIEN

Advanced Research Lab / Master Thesis

Exploring Sm-Co-B phase diagram to facilitate the magnet development

$SmCo_4B$ exhibits the highest anisotropy, ≈90 T at 300K, field among RE-TM compounds which delivers an ultrahigh coercivity of 4.4 T [1]. However, they exhibit a low μ_0M_r of 0.3T which limits their maximum energy product as well as their performance. This project aims to overcome the low magnetization of $SmCo_4B$-based compounds while preserving their large μ_0H_c. For this purpose:

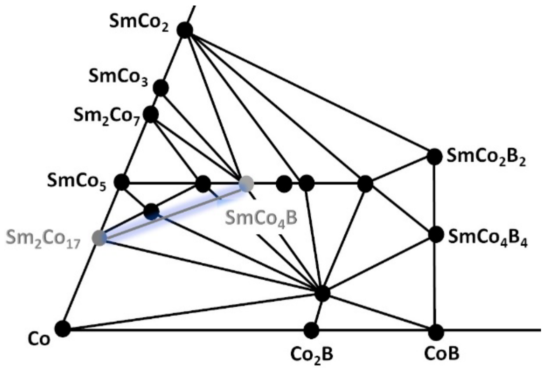

Fig. 1 Highlighted line will be investigated in phase diagram of Sm-Co-B at 700°C [2].

In Step 1, $SmCo_4B$ ingots will be prepared by arc melting followed by melt spinning to refine the grain size. The grain size refinement parameters (wheel speed, nozzle size, annealing temperature) will be optimized to achieve the highest μ_0M_r and μ_0H_c. (ARL)

In Step 2, the composition belonging to the highlighted regions will be prepared with the method optimized in Step 1. This region is expected to deliver a mixture of Sm_2Co_{17} and $SmCo_4B$. By optimizing the melt spinning and annealing condition, it will aim to obtain a core-shell structure where the Sm_2Co_{17} core will provide large M_s (μ_0M_s =1.25 T, μ_0H_a =8.5 T) and $SmCo_4B$ shell will provide large H_c (μ_0M_s =0.4 T, μ_0H_a = 90T). (ARL)

In Step 3, the ribbons that show superior magnetic properties will be used to develop an isotropic and anisotropic magnet. For this purpose, hot compaction, hot deformation, and liquid sintering procedures will be preferred. (Master thesis)

As a result, we will aim to produce a cost-effective version of $SmCo_5$-type magnets for sustainable magnet industry [3,4].

[1] X. Jiang et al., J. Alloys Compd. 617 (2014) 479-484.
[2] Y. Chen et al., J. Alloys Compd. 305 (2000) 216-218.
[3] M. Gjoka et al., Materials, 17 (2024) 808.
[4] X. Chi et al. J. Alloys Compd. 942 (2023) 169107.

Expertise to be gained:

- Learning about **the magnetic materials for aerospace and satellite communication applications and scientific literature search**
- Powder sample preparation → **arc melting, induction melting and melt spinning**
- Structural analysis → **X-ray powder diffraction**
- Microstructure analysis → **Scanning electron microscopy (SEM)**
- Magnetic characterization → **PPMS magnetometer**

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