

Advanced Research Lab / Master Thesis

Tailoring the microstructure in highly complex composition

Magnetic isolation of hard magnetic grains with an intergranular phase is a key factor in obtaining high coercivity, which has been established in the microstructure of Nd-Fe-B magnets owing to the phase equilibrium of hard magnetic $\text{Nd}_2\text{Fe}_{14}\text{B}$ with a low melting point phase [1,2]. SmFe_{12} -based compounds exhibit superior intrinsic magnetic properties at magnet operating temperature compared with $\text{Nd}_2\text{Fe}_{14}\text{B}$. However, the inability to achieve an optimal microstructure similar to Nd-Fe-B in SmFe_{12} -based magnets remains the main bottleneck for realizing large coercivity (H_c) and remanence. Our preliminary results in $(\text{Sm,Zr})(\text{Fe,V,Ag})_{12}$ bulk alloy shows that we can separate the 1:12 grains with Sm-Ag intergranular phase while keeping the phase stabilizer V minimum (Fig 1). In this project, we will apply grain refinement procedure (melt spinning and ball milling) on $(\text{Sm,Zr})(\text{Fe,V,Ag})_{12}$ bulk alloy to realize H_c .

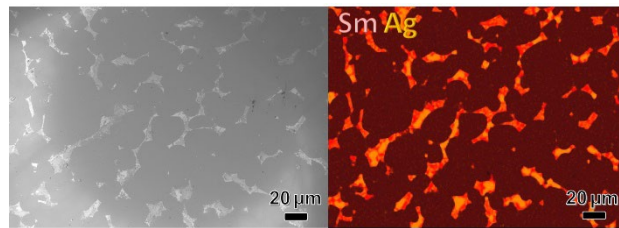


Fig. 1 The microstructure of $(\text{Sm,Zr})(\text{Fe,V,Ag})_{12}$ alloy where 1:12 grains are isolated with Sm-Ag intergranular phase

- (1) In the First step, the experimental condition will be optimized for $(\text{Sm,Zr})(\text{Fe,V,Ag})_{12}$ bulk to obtain the microstructure in Fig. 1.
- (2) In next step, melt spinning, excess of Sm, and annealing condition will be optimized for a particular composition of $(\text{Sm,Zr})(\text{Fe,V,Ag})_{12}$.
- (2) The microstructure, crystallographic and magnetic properties will be investigated.
- (3) Once high coercivity is established further composition tuning (tunning Ag, addition of Co) will be perform to improve further their magnetization.

[1] P. Tozman et al. Scr. Mater. 194 (2021) 113686.

[2] P. Tozman et al. Acta Mater. 258 (2023) 119197.

Expertise to be gained:

- Learning about **scientific literature search and writing**
- 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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