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Advanced Research Lab / Student Assistant (HiWi)

Investigation of microstructural features of hard magnetic Mn-Al materials

Material criticality and sustainability are becoming increasingly important in the development of advanced functional materials. With the growing demand for rare and critical elements in high performance applications, such as Nd-Fe-B and Sm-Co magnets, there is an urgent need to explore alternatives based on more abundant and less critical resources. MnAl alloys offer a promising solution in this regard. Manganese and aluminum are widely available and environmentally benign, making MnAl-based materials not only cost effective but also more sustainable.

This work will investigate the microstructural and magnetic characteristics of the Mn-Al system, focusing on the effects of different alloying elements, such as Ti and Ni, together with different synthesis routes. Using different synthesis techniques such as arc melting and rapid solidification, the material properties will be investigated to see how these methods and substitutions affect phase formation, grain structure and overall magnetic properties. This hands-on laboratory experience provides an opportunity to understand the critical role of microstructural features in tailoring the magnetic and mechanical properties of MnAl alloys for potential applications in high performance magnetic systems.

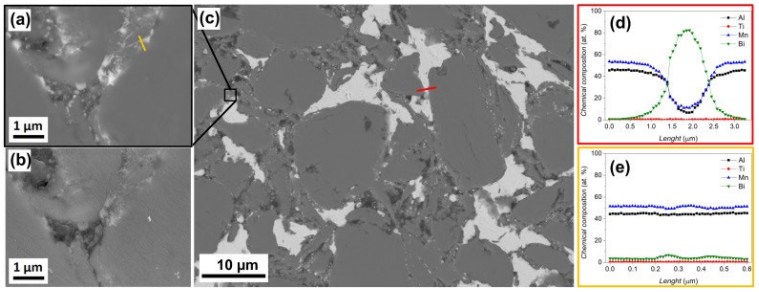

Figure - (a) BSE and (b) SE images of the hot compacted $Mn_{52.8}Al_{45}C_{1.7}Ti_{0.5}$ + 20 wt.% Bi sample together with (c) the overall low magnification BSE image. Two EDX line scan profiles are shown in (d) and (e) for red and yellow lines indicated in the BSE images.

Experience to be gained:

- Experience on industrially relevant preparation routes → arc melting / suction casting and melt spinning
- powder x-ray diffraction (XRD)→ structural properties, phase identification
- Scanning Electron Microscopy (SEM) and energy dispersive x-ray (EDX) analysis→ Microstructure analysis and chemical composition determination.
- Vibrating Sample Magnetometer (VSM)→ magnetic property determination

[1] J.S. Trujillo Hernández, S. Ener *et al.*, JMMM 610 (2024) 172573.
[2] A. Amato, S. Ener *et al.* ACS Sustainable Chemistry & Engineering 11 (2023) 36.
[3] F.Maccari, S. Ener et al., Journal of Materials Science 57 (2022) 6056.

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