Poster | Material, processing, and characterization

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[P2] Sm-based Magnets & Nitrides

Session Chair: Mr. Johann Fischbacher (University for Continuing Education Krems, Austria), Dr. Yusuke Hirayama (AIST, Japan)

[P2-43] Maximizing the extrinsic magnetic properties of SmCoB-based compounds

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SmCo4B exhibits the highest anisotropy field (mu0HA approx 90 T at 300K) among the RE-TM compounds resulting in an ultrahigh coercivity of mu0Hc = 4.4 T [1,2]. However, its low remanence (mu0Mr = 0.3 T) limits both its maximum energy product and overall performance. The low magnetization of SmCo4B can be enhanced through composition tuning. Specifically, the mu0Ms of SmCo4B, initially 0.35 T, increases to 0.48 T for SmCo3.8Fe0.2B and further to 0.55 T for Sm0.7Nd0.3Co3.8Fe0.2B [3]. It should be noted that these values were measured under an applied field of 14 T where the sample was not saturated.In this work, we investigated the effect of composition and process parameters tuning on the extrinsic magnetic properties and phase development. To achieve this, SmCo4B, SmCo3.8Fe0.2B and Sm0.7Nd0.3Co3.8Fe0.2B were synthesized by melt spinning at wheel speeds of 10, 30, and 50 m/s, followed by thermal treatment at 800 C for 30 min. Our findings indicate that the type of substituent element significantly influences the coercivity trend, as summarized in Fig. 1. Furthermore, both wheel speed and heat treatment significantly influence phase formation, thereby affecting the shape of the hysteresis loop.For example, as-spun SmCo4B ribbons with single phase display a kink-free hysteresis loop with mu0Hc = 1.57 T and a remanence mu0Mr = 0.2 T. Annealing at 800 C introduces a kink in the loop, reducing mu0Hc to 0.82 T while slightly increasing mu0Mr to 0.23 T due to the formation of a small amount of a secondary phase. Further annealing at 900 C produces a square loop with mu0Hc = 2.6 T and mu0Mr = 0.29 T.In contrast, Fe- and Nd-substituted ribbons exhibit an improved, kink-free hysteresis curve upon annealing. The best magnetic properties (mu0Hc = 4.3 T and mu0Mr = 0.25 T) are achieved in SmCo3.8Fe0.2B ribbons produced at 30 m/s and annealed at 800 C. In this study, we will discuss in detail the role of microstructure and phase formation in determining extrinsic magnetic properties and explore strategies for their enhancement.

Fig. 1 The coercivity trends for both as-spun and annealed SmCo4B and SmCo3.8Fe0.2B samples, produced by melt spinning at wheel speeds of 10, 30, and 50 m/s.

References:

[1] X. Jiang et al., J. Alloys Compd. 617 (2014) 479-484. [2] H. Ido et al., J. Appl. Phys. 73,

6269 (1993). [3] P. Tozman, et al., IEEE International Magnetic Conference-Short papers (2024).
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