Towards Rare-Earth-Free Permanent Magnets: Fe-(CuMn) Nanocomposites

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To alleviate pressure on strategic element supply, the present investigation focuses on basic research into rare-earth-free permanent magnetic materials through development of a Mn-based nanocomposite, utilizing antiferromagnet/ferromagnet exchange interactions to enhance coercivity [1-2]. To this end, $Cu_{30}Mn_{70}$ ribbons are synthesized via melt-spinning to access metastable phases and nanostructures that may foster exchange coupling. X-ray diffraction reveals two face-centered cubic γ-phases (a_1 =3.750 Å, a_2 = 3.744 Å). Magnetic measurements indicate blocking behavior below 123 K, and a giant exchange anisotropy of ~10 kOe at 10 K. We hypothesize that the exchange anisotropy arises from interactions between nanoscale antiferromagnetic Mn-rich regions of γ_1 and ferromagnetic Mn-poor regions of γ_2.

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[1] Kouvel, J.S., "Exchange anisotropy in Cu-Mn and Ag-Mn alloys," *J. Appl. Phys.* **S31** (1961), no. 5, pp. S142-147.

[2] Kouvel, J.S., "A ferromagnetic-antiferromagnetic model for copper-manganese and related alloys," *J. Phys. Chem. Sol.* **24** (1963) pp. 795-822.