Intermetallic Iron-based materials as possible Gap magnets

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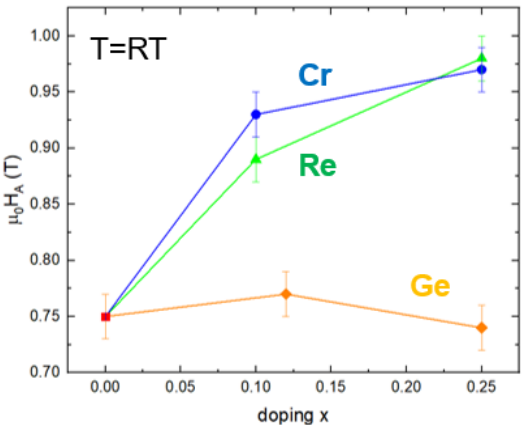
The permanent magnet market, at the current state, is essentially split into two types of materials. On one end we have cheap but low performing ferrite magnets, on the other end we have the more expensive and better performing rare earth (RE) magnets. RE magnets are of fundamental importance in the transition from fossil fuels towards renewable energy alternatives. However, in the last decade, more concerns have been risen regarding their supply risks, volatile prices and environmental impact. The development of a new class of non-critical magnets with intermediate properties, called “gap magnets” [1], could help in reducing the demand for such critical materials. Gap magnets could replace RE magnets in those applications that don’t require extreme efficiency and performances. Since iron is one of the most common magnetic elements, iron-based intermetallic materials such as Fe5SiB2, Fe2-xCoxPySi1-y and Fe2MnGa are desirable for this new class of magnets. In this work we synthesized and characterized the structural and magnetic properties of different intermetallic compounds as a function of temperature, such as Curie temperature, saturation magnetization and anisotropy field as measured by AC susceptometry, Vibrating Sample Magnetometry, Singular Point Detection and Nuclear Magnetic Resonance. Among these candidates, Fe5SiB2 shows a high magnetic saturation and Curie temperature. It has also been reported that its low anisotropy energy can be increased by chemical substitution [2.3]. We have replaced Fe and Si with different quantities of Re, Cr and Ge respectively, and we found that substitution of Re and Cr leads to a significant increase in anisotropy of about 30% (fig 1). The SPD measurements also present an anomalous behavior that suggests that this material doesn’t have an easy axis configuration as commonly reported in literature [4], but rather an easy plane or easy cone.



Anisotropy field as a function of Re, Cr and Ge content.

References

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