Abstract Laura Lewis:

Towards New FeNi-Based Permanent Magnets of High Energy Destiny

Motivation persists to diversify the supply of rare-earth-based supermagnets in response to ever-growing demand in energy, defense, transportation and consumer product sectors. In contrast to many rare earth elements that are currently utilized in ultra-strong permanent magnets, the elements Fe and Ni are among the most abundant, most readily processed and most studied magnetic elements in the Earth's crust. An intriguing proposition is to develop the equiatomic FeNi compound with the tetragonal L10 structure, a meteoritic mineral known as tetrataenite, into a magnet. Tetrataenite exhibits confirmed impressive permanent magnetic properties that are derived from, in part, its lower-symmetry tetragonal crystal structure (1). This tetragonal anisotropy leads to a large magnetic remanence which significantly amplifies the amount of magnetic energy that may stored in this compound.

While tetrataenite has been confirmed to exhibit excellent permanent magnetic properties, it is only found naturally and in appreciable volumes in selected meteorites subjected to extraordinarily slow cooling rates, as low as 0.3 K per million years. In this presentation new results concerning recent progress towards laboratory-based synthesis of tetrataenite will be presented, with the goal to foster discussion of its potential as a rare-earth-free permanent magnetic material. In particular, effects on phase formation accelerated by severe plastic deformation and post-processing treatments that allow access to kinetically hindered but thermodynamically accessible states will be described. In this manner tailored synthesis and processing protocols for the realization of a new type of magnetic material are identified and advanced, with high relevance for the creation of next-generation permanent magnets comprised entirely of easily accessible, earth-abundant elements that may be utilized for energy-relevant applications and beyond.

1. Lewis, L. H., et al. "Inspired by nature: investigating tetrataenite for permanent magnet applications." Journal of Physics: Condensed Matter 26.6 (2014): 064213.