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Nanoscale strategies towards development of advanced Mn-based permanent magnets

Felix Jimenez-Villacorta

CSIC-Materials Science Institute of Madrid, Spain

The so-called “rare-earth crisis” in the 2010’s re-ignited investigation in the search for new concepts in permanent magnetic materials design. The key factor that determines this new joint global effort is that advanced fabrication and analysis methods with precision down to the nanoscale that combine composition and crystal structure control and optimization of the microstructure to manipulate the intrinsic magnetic properties of magnets (magnetization, exchange and magnetocrystalline anisotropy) or to enhance extrinsic magnetic features (remanence and coercivity) are now accessible. In this presentation, different strategies will be described in which nanostructuring and control of crystal structure and composition to the nanoscale through metallurgical non-equilibrium processing techniques convey optimization of the magnetic properties or advantageous modification of the fabrication process of new magnets. Two examples will be introduced. On one hand, a proof-of-concept of an exchange-biased magnet is presented, reproducing the special microstructure of anisotropic Alnico magnets in phase separated Fe-Co-Mn nanostructured alloys, as an alternative pathway for realization of novel rare-earth-free exchange-coupled magnets. Also, processing methods for nanostructured MnAl alloys are envisioned to promote formation of the intermetallic L10-type MnAl phase from a precursor γ -MnAl phase (exhibiting micromagnetic character) with lowered phase transformation temperatures, providing an attractive low energy route for the fabrication of permanent magnets.

Biography

Felix Jimenez-Villacorta is a Researcher at the Materials Science Institute of Madrid (ICMM-CSIC). After completion of his PhD in 2007, he worked for 3 years at the European Synchrotron Radiation Facility (ESRF), in the characterization of magnetic nanostructured materials by X-ray absorption spectroscopy techniques. After that, he made a Post-doctoral stay at Northeastern University, conducting research on the development of rare-earth-free nanostructured permanent magnetic materials. He has published 64 papers (+3 under review) in reputed journals, including a review article, and 2 book chapters.

fjv2003@gmail.com**Notes:**