Multifunctional ferromagnetic shape memory alloys for solid state refrigeration

Franka Albertini
Institute of Materials for Electronics and Magnetism (IMEM) - National Research Council (CNR), Magnetic Materials, Italy
franca.albertini@imem.cnr.it

Ferromagnetic shape memory alloys are multi-functional materials suitable for a variety of energy-related applications thanks to their extraordinary phenomenology (e.g giant magnetoelastic, magnetocaloric, barocaloric effects) arising from the coupling between magnetic and structural degrees of freedom. They undergo a martensitic transformation between magnetically ordered phases that can be driven by temperature, pressure, stress and magnetic field [1].

The most representative materials are Ni_2MnX full Heusler compounds, X being a group IIIA-VA element. Among them, one of the most studied systems is Ni–Mn–Ga, which shows magnetic field induced strains up to 12% due to twin variants reorientation and considerable values of direct magnetocaloric effect. On the other hand In- and Sn-based alloys (the so called “metamagnetic Heuslers”) are very promising for the possibility to easily induce the transformation from a low moment martensite to a high moment austenite by applying external fields (magnetic field, pressure, stress). This phase change triggers magnetic superelasticity, magnetothermal conductivity, magnetocaloric and barocaloric effect.

We have recently shown that for Mn-rich Ni-Mn-Ga alloys, Co substitutions produce important changes in magnetism and structure, originating a peculiar phase diagram of the magnetic interactions and phase instabilities, giving rise to a metamagnetic behaviour, enhanced magnetization and volume discontinuities at the transformation, and allowing to tune the magnetocaloric effect from direct to inverse [2]. In this talk we will present a thorough study of main basic and functional properties of these alloys, including high field (up to 30 T) and high pressure (up to 1GPa) measurements and discuss their tailoring potential for improving their multifunctional exploitation in solid state refrigeration.

References [1] M. Acet et al. in Handbook of Magnetic Materials vol. 19, K.H.J. Buschow, Eds. (Elsevier, Amsterdam, 2011), pp-231-289.

[2] S. Fabbrici et al. Special Issue Entropy in Shape Memory Alloys, Entropy 2014, 16, pp. 2204-2222.