MAGNETOCALORIC EFFECT IN NANOGRANULAR GLASS COATED MICROWIRES

M. I. Ilyn [1], V. Zhukova[2], J.D. Santos[3], M.L. Sánchez[3], V.M. Prida[3], B. Hernando[3], V. Larin[4], J. González[2], A. M. Tishin[1] and A. Zhukov[2]

[1]Department of Physics, M. V. Lomonosov Moscow State University, 119992 Leninskye Gory, Moscow, Russia
[2]Department Materials Physics, Faculty of Chemistry, UPV/EHU, Paseo Manuel de Lardizabal 3, 20018 San Sebastián, Spain
[3]Department of Physics, Faculty of Physics, 33007 Oviedo, Spain
[4]TAMAG Iberica, Parque Tecnológico de Miramón, Paseo Mikeletegi 56, 20009 San Sebastián, Spain

The magnetocaloric effect (MCE) in magnetic materials has been widely used for attaining very low temperatures by applying a magnetic field isothermally and removing it adiabatically. As it is well known, in general an isothermal application of a magnetic field decreases the configurational entropy of the spin structure. A subsequent adiabatic demagnetization allows the spins to become disordered again, by means of the thermal energy provided by the phonon bath of the isolated sample. This causes cooling. To note that this effect has been, recently, exploited for room-temperature refrigeration by using giant MCE materials.

Magnetic room-temperature refrigerators are considered as an innovative, energy saving and environmentally friendly technology. The working body of the system is a solid magnetic substance. It leads to higher amount of heat absorption/extraction per volume than in the conventional gas based systems. However it takes a large heat transfer area to provide high heat exchange efficiency. Number of working prototypes utilized gadolinium in the form of small spheres to resolve this technical issue. Meanwhile extension of the surface promotes chemical reactions of solid refrigerant with liquid coolant used to transfer heat inside the system.

On the other hand, ferromagnetic glass-coated microwires have a number of attractive features that make them strong candidates for use as a sensing element in high performance magnetic field or stress sensors, magnetic labels, and micro machines. Although the research on magnetic microwires is well established, it was only very recently proposed to utilise them within artificially structured materials. As a new example we propose in this work the use of magnetic glass-coated microwires as magnetocaloric material to engineer magnetic functionality of advanced materials, for example, for exhibiting significant magnetic entropy changes around the Curie temperature (T_C) associated to MCE due to magnetic wire actuating performance. Therefore, a type of a smart material is proposed exhibiting MCE and coated with chemically inactive layer.

Glass-coated microwires of nominal composition Fe_3P have been investigated. Adiabatic temperature change, related with the MCE have been measured directly on special set-up created in Department of Physics of MSU using thermo-couple at room temperature in applied field of 10 kOe. The temporal change of the dT showed maximum value of about 0.02 K at room temperature. In according to our knowledge, this effect is firstly observed by us in these glass-coated microwires.