FORC analysis of Heusler-type magnetocaloric alloys: an effective temperature approach.

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Although the largest magnetocaloric response corresponds to materials with first order phase transitions (FOPT), this comes associated to hysteresis and rate dependent phenomena. Therefore, the optimal magnetocaloric materials would be those which present the large response of FOPT, but with the characteristics of second order phase transitions, i.e. lack of hysteresis and good performance under cyclic conditions. Consequently, it is of the utmost importance to be able to fully understand the hysteresis of the phase transition in FOPT alloys and compounds in order to be able to predict their behavior under cycling and optimize the usable magnetocaloric response of these samples.

In this talk we will show recent results on the application of FORC analysis to magnetocaloric materials. We will start showing that the thermal hysteresis of Heusler type alloys gives FORC distributions which are dependent on the intensive variables temperature and field [1]. This implies that it would be necessary to obtain FORCs for different temperatures and fields in order to accurately model the transition, which becomes a rather tedious task.

A detailed analysis of the martensitic transition of a Heusler alloy driven both by magnetic field (in isothermal conditions) and by temperature (at a constant magnetic field) allows us to show that the main characteristics of the FORCs are not affected by the measurement protocol and that there is a direct relationship between the hysteresis loops of both temperature- and field-driven transitions. Therefore, it is possible to develop an effective temperature approach so that the hysteresis loops caused by the different excitations can be described using a single intuitive magnitude [2], allowing us to propose a characterization procedure for the thermal hysteresis that is much more efficient in terms of time and resources.

[1] V. Franco, T. Gottschall, K.P. Skokov, O. Gutfleisch, IEEE Magnetics Letters 7 (2016) 6602904.

[2] J.S. Blázquez, V. Franco, A. Conde, T. Gottschall, K.P. Skokov, O. Gutfleisch, Applied Physics Letters 109 (2016). Accepted for publication.