

# Labex MATISSE

## Axe 4

« Thermal hysteresis suppression in magnetic thin film exhibiting giant magnetocaloric effect at room temperature »

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Figure 1: Six-axes goniometer compatible with ultra-high vacuum with heating and cooling capabilities for investigations on collisions

### Hosting laboratories, teams and thesis supervisors names:

Institut de Nanosciences de Paris :

- «Clusters and Surfaces under Intense Excitations», Martino Trassinelli and Dominique Vernhet
- «Growth and properties of hybrid thin film systems», Mahmoud Eddrief and Massimiliano Marangolo

### Research project

Magnetic materials present usually a magnetocaloric effect, i. e. their temperature increases when they are placed in a magnetic field and decreases when they are removed. Some materials are characterized by a magnetic phase transition correlated to a giant magnetocaloric effect at room temperature, making them potentially interesting for application in magnetic refrigeration. However the magnetic transition is commonly coupled to a structural transition (a first order phase transition), which is responsible of a large thermal hysteresis (for example 6 K for MnAs). Recently, the research teams involved in this project demonstrated that impact of slow highly-charged ions on MnAs thin films allows to suppress the hysteresis. Nevertheless the mechanisms involved are by far not understood and this project aims at providing clues on the fundamental processes occurring on different magnetic materials under well controlled ion bombardment.

Reference: M. Trassinelli et.al, Suppression of the thermal hysteresis in magnetocaloric MnAs thin film by highly charged ion bombardment. Applied Physics Letters, **104** :081906, 2014.

### Summarize your scientific results & impacts

Influence of the incident ion energy on the thermal hysteresis suppression and on the threshold fluence (number of ions/cm<sup>2</sup>) for which this phenomenon occurs are under study. These investigations are extended to other magnetocaloric materials (for instance FeRh) to understand the origin of this hysteresis suppression. Furthermore, a program analysis has been developed to map and control accurately the incident fluence on the sample (Fluence

### Main key facts

Poster presentation:

- M. Trassinelli et.al, *Properties' modifications of giant magnetocaloric thin films with highly charged ions*, 9<sup>th</sup> International Symposium on Swift Heavy Ions in Matter (SHIM-2015), 18-21 May 2015, Darmstadt, Germany, accepted
- S. Cervera et.al, *Towards the understanding of mechanisms responsible of the thermal hysteresis suppression by highly charged ions collisions in thin films*, 21<sup>th</sup> International Workshop on Inelastic Ion-Surface Collisions (IISC2015), 18-23 October 2015, Donostia-San Sebastián, Spain, submitted

Selected Oral presentation:

- S. Cervera et.al, *Impacts of highly charged ions as seeds in a magneto-structural phase transition of magnetocaloric thin films*, 29<sup>th</sup> International Conference on Photonic, Electronic and atomic Collisions (ICPEAC 2015), 22-28 July 2015, Toledo, Spain, accepted