The influence of mean field interactions reflected by the FORC diagram

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I. Introduction

The strong interest in the study of magnetic nanostructures like the Bit Patterned Media (BPM) [1] is evidently related to their technological application in recording. The magnetic characterization is an important step in the understanding of the structure behavior during the recording process. This is also giving valuable insight for the recording stability in time and the noise related problems.

In recent years it has been shown that the FORC diagram method is a valuable instrument which provides the experimentalist with important information about the magnetic system [2, 3, 4]. Experimental FORC studies made on patterned media [5] and subsequent theoretical studies [6], have repeatedly produced a quite complex FORC diagram – in the shape of a wishbone - for a magnetic system with a very simple structure.

II. Model and results

This paper is dedicated to the study of very simple magnetic structures within the framework of two models: the Preisach model and the Ising model. The Preisach model is the model that offers the most direct link between the distribution of the magnetic entities within a sample as a function of coercivity and interactions and the FORC diagram revealed in experiments [4]. The Preisach model fundamental brick is the rectangular hysteron which is also the constitutive element in an Ising system of magnetic entities with intrinsic anisotropy, similar to the BPM described previously. The Ising model based on Preisach hysterons can include more physical information about the real system than the Preisach model but the Preisach model can provide essential understanding of the typical features observed in various cases.

As an example we show the results given by the Preisach moving model [7] for a singular Preisach distribution (constant distribution of coercivity between two given limits and zero dispersion of interactions). The FORCs and the FORC diagrams are presented in Fig. 1 for negative mean field interactions. The geometrical characteristics of the FORC diagrams are essentially linear.

In the case of negative (demagnetizing) mean field interaction, the constant distribution of coercivities is giving a positive FORC distribution along two lines (which are at the origin of the wishbone shape of the FORC diagram for the BPM). The slopes of the two lines are related to the intensity of the mean field parameter and on width of the coercivity distribution.

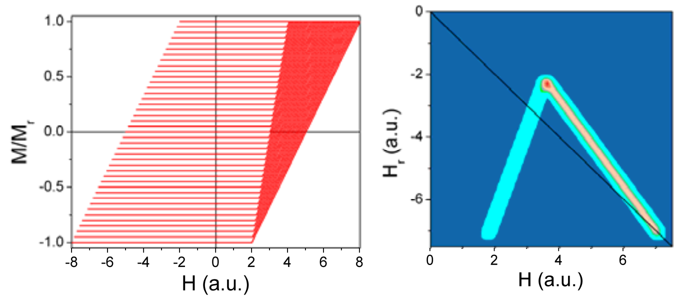

Fig.1. FORCs and FORC diagram for a Moving Preisach model with negative mean field interactions.

When the mean field interactions have magnetizing effects the FORC distribution show also two linear distribution, but this time one is negative and the other positive. The presence of the negative component in the FORC distribution was repeatedly observed in magnetic systems with magnetizing mean field interactions. This result confirms the relation between the negative region on the FORC diagram and the magnetizing mean field interactions.

The study was extended on many other simple systems which are models for longitudinal or perpendicular magnetic structures (patterned media, nanowire systems, etc.).

In the full paper the results obtained with the Preisach model are compared with the ones provided by the Ising model with rectangular Preisach-type hysterons.

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