Vector mixed Preisach-LLG model. Implementation and comparisons.

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I. INTRODUCTION

The study of the magnetic processes taking place in applications - like the processes involved in magnetic information recording or the magnetic behavior of electric machines - cannot neglect the vector character of both physical quantities involved, the magnetic field H and the magnetic moment M. This is the main reason why in recent years one can observe a strong interest in the development of more efficient vector hysteresis models ([1], [2]).

The intense studies concentrated on scalar hysteresis models have provided a number of models with reliable identification techniques which can explain a wide range of typical scalar measurements specific to most measuring devices commonly available in the laboratories.

Despite the relative great success of the phenomenological models in the scalar hysteresis modeling, the development of vector models was not as successful, either due to the difficult implementation of the different variants or, due to the lack of clear and tractable identification techniques. This is one of the reasons why the most successful approach in the modeling of the vector magnetic behavior was the micromagnetic (physical) approach. The main disadvantage of applying a micromagnetic model to a large system is that it requires great computing resources so, in this context, phenomenological vector models represent a very useful category of models which are aiming to obtain the precision achieved by the micromagnetic models in describing the vector properties of a sample as well as the rapidity and the simplicity of phenomenological models.

II. IMPLEMENTATION

One of the main strategies used for designing phenomenological vector models is to upgrade scalar models by adding the angle of the external applied field and the easy axis orientation distribution of the medium as input parameters. For example, in the case of the Preisach-type models, a usual step towards the generalization to vector models is the addition of an angular dependence to the existing scalar Preisach function.

We have used a slightly different strategy to develop a new vector model with a remarkable numerical efficiency that can be easily implemented on parallel computer environments [3]. Our model, referred to as the Preisach-LLG model, uses the concept of vector pseudoparticle for which the equilibrium state in a given applied field is calculated with the well known Landau-Lifshitz-Gilbert equation. The main difference between our model and a classical micromagnetic model is that the value of the interaction field acting on each pseudoparticle is fixed, like in the Preisach-type models. A statistically stable vector distribution of interaction fields is taken into account leading to the de-coupling of the differential equations describing the behavior of each pseudo-particle.

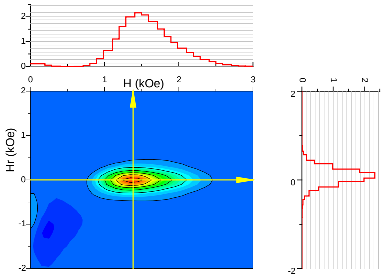

Fig.1. Using FORC diagram to identify coercive field distribution (up) and interaction field distribution (right).

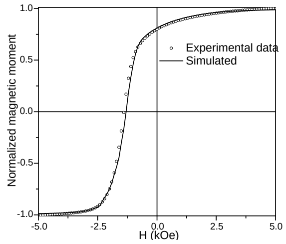

Fig.2. Results of identification procedure.

The identification algorithm is based on easy axis distribution identification and on scalar measurements - like first-order reversal curves (FORC) diagrams (Fig. 1).

III. RESULTS AND COMPARISONS

The results of the identification procedure applied to experimental data measured on an oriented magnetic medium are displayed in fig. 2.

The full paper will also include different comparisons with other vector models.

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