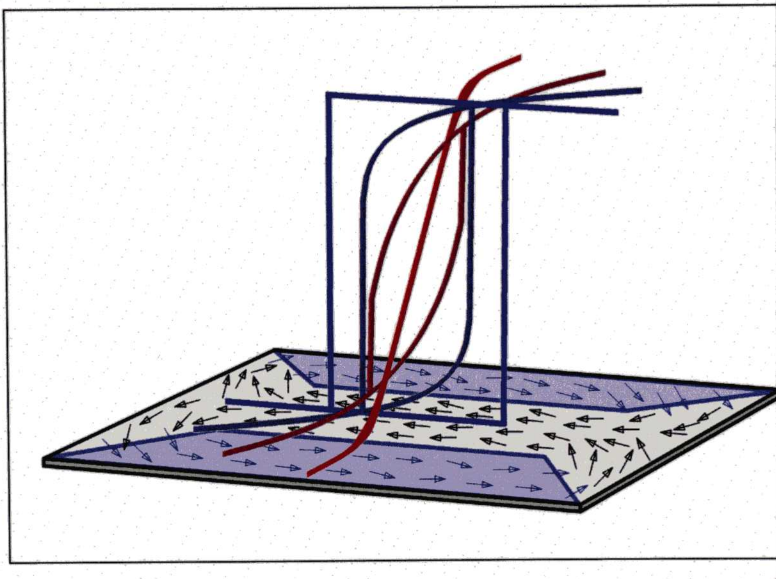
Generalized Energetic Model for Characterizing the Magnetic Hysteresis of Anisotropic Thin Films



Peter Haumer

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DISSERTATION

Generalized Energetic Model for Characterizing the Magnetic Hysteresis of Anisotropic Thin Films

ausgeführt zum Zwecke der Erlangung des akademischen Grades eines Doktors der technischen Wissenschaften von

Peter Haumer

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About the Author

Peter Haumer was born in St. Pölten, Austria in 1975. Having finished Master studies in Electrical Engineering (2001) and Business Informatics (2003), he started PhD studies in Technical Science at Vienna University of Technology. The PhD thesis about magnetic hysteresis modeling for thin film material has been supervised by Prof. Hans Hauser until his death in 2007, and afterwards by Prof. Johann Nicolics. During his research, the author has presented his results at international conferences and published several articles on magnetic hysteresis modeling in international journals.

Besides his scientific work, Peter Haumer is currently employed as control systems engineer in the field of electric traction systems for rail vehicles.

About this Book

In this book, a generalized two-dimensional energetic hysteresis model for characterizing the magnetization process of thin ferromagnetic films is presented. Based on the "Energetic Model of Ferromagnetic Hysteresis" (EM), which has been introduced by H. Hauser in 1994, so called statistical domain classes adapted from the magnetic easy directions of the material sample are distinguished. As a first generalization, the orientation of the elementary magnetic dipoles within a statistical domain class is no longer restricted to the specified easy direction, but is represented by a stochastic circular distribution function that is characterized by a mean orientation and a certain variance. So local misalignments of magnetic moments due to imperfections within the material can be modeled on the one hand, and the temperature dependence of the spontaneous magnetization can be described from the first principles on the other hand. The second key extension is the fully two-dimensional formulation of the EM comprising all the energy contributions of the model.

On the example of Permalloy thin films for AMR sensors, it is demonstrated how variations in the technological parameters of the underlying sputter process influence the microstructural misalignment of the magnetic dipole moments, which becomes manifest in the macroscopic magnetization curves. As shown within this work, the generalized EM is able to quantify the homogeneity of the film as well as these misalignments in terms of anisotropy dispersion.

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