thermal conductivity in a magnetic field, Ill compare numerical data on the S=1 model obtained using exact diagonalization techniques to exact results using the BA method. For the ESR data, using a recently developed BA technique, I'll show that the extremely sharp line observed in experiments, is due to a singular excitation to a single excited state.

MA 14.7 Tue 11:15 H 0112

Multi-scale modelling of magnetization dynamics — •Andrea De Lucia, Mathias Kläui, and Bejnamin Krüger — Institut für Physik, Johannes Gutenberg Universität, Mainz

A Multi-scale Magnetization Dynamics Simulation scheme was developed and applied to systems with special spin structures and properties. The MicroMagnum simulator was used as starting point and expanded to include a Multi-scale approach. The software selectively simulates different regions of a ferromagnetic sample employing the most suitable discretization and model according to the properties of each region. Simulating magnetization dynamics in a Multi-scale environment allows one to rapidly evaluate the Landau-Lifshitz-Gilbert equation in a mesoscopic sample with nanoscopic accuracy where needed. Possible application of this software include Skyrmion Dynamics, Domain Wall motion and Spin Wave generation.

MA 14.8 Tue 11:30 H 0112

Effective models for exchange bias systems based on atomistic spin dynamics simulations — •Irina Stockem, Stefan Muschack, and Christian Schröder — Bielefeld Institute for Applied Materials Research, University of Applied Sciences Bielefeld, Wilhelm-Bertelsmann-Str. 10, 33602 Bielefeld, Germany

The exchange bias anisotropy was observed at stacked ferromagnetic and antiferromagnetic layers by Meiklejohn and Bean in the 1950^{th} [1]. The exchange bias leads to an asymmetric shift of the hysteresis loop, which is fixed during the fabrication process in conventional systems. In novel systems, like Co/Cr_2O_3, this shift can be switched [2]. Although the discovery of the exchange bias is more than half a century ago a comprehensive theoretical model is still missing. Many simplified and analytical solvable models exist but these are not applicable to real exchange biased structures. In order to obtain a better understanding of the dominating factors of exchange bias systems we have developed effective models and investigated these by spin dynamics simulations [3]. We compare our results to existing models and to atomistic spin dynamics simulations of a three dimensional Co/Cr_2O_3 model system.

[1] W. H. Meiklejohn and C. P. Bean, Phys. Rev. **105**, 904 (1957).
[2] Y. Shiratsuchi et al., Appl. Phys. Lett. **100**, 262413 (2012).
[3] L. Engelhardt and C. Schröder, in Molecular Cluster Magnets, World Scientific Publishers, Singapore (2011).

MA 14.9 Tue 11:45 H 0112

Simulation of coercivities and magnetization reversal mechanisms in fourfold ferromagnetic systems of different dimensions and orientations — •Tomasz Blachowicz[1] and Andrea Ehrmann[2] — [1]Silesian University of Technology, Institute of Physics, Poland — [2]Niederrhein University of Applied Sciences, Faculty of Textile and Clothing Technology, Germany

The stability of magnetic states during magnetization reversal, especially at remanence, belongs to the important issues in examination of magnetic nanosamples. Our presentation gives an overview of different fourfold magnetic wire systems, simulated by Magpar. Wire lengths have been chosen from 30 nm to 70 nm, while the single wires have length-to-diameter ratios between 3 and 11. Simulations have been carried out for angular in-plane directions of the externally applied field from 0° (parallel to one pair of wires) to 45°. Depending on system dimensions and external field angle, different magnetization reversal mechanisms could be observed as well as changes between stable and instable magnetic states [1].

Intermediate states at vanishing external field, reached by minor loops starting at steps in the hysteresis loop, are of special interest for application in novel data storage media systems. The presentation shows different possibilities to create such states and examines their stability by comparing hysteresis loops, special distribution of magnetization, and exchange energy as function of the externally applied field for a number of sample dimensions and external field angles.

[1] T. Blachowicz, A. Ehrmann, J. Appl. Phys. 113, 013901 (2013)

MA 14.10 Tue 12:00 H 0112

Micromagnetic analysis of nucleation and pinning processes in supermagnets — Dagmar Goll[1], Therese Dragon[2], Matthias Katter[3], and •Helmut Kronmueller[2] — [1]Aalen University, Materials Research Institute (IMFAA), Aalen — [2]Max Planck Institute for Intelligent Systems — [3]Vacuumschmelze GmbH & Co. KG, Hanau

The large discrepancy between theoretical predictions and realized magnetic properties of hysteresis loops of high-quality permanent magnets, known as Brown-paradox, has been the matter of discussions over decades of years. In particular whether the leading hardening mechanism is due to a nucleation mechanism or to domain wall pinning has been the topic of many publications with contrary statements. Here the existence of single or multi-domain grains plays a central role. This contribution presents the following basic results which allow a distinction between the two types of hardening mechanisms: 1. Coercive field H_c as a function of maximum applied magnetic field. 2. Change of domain patterns as a function of applied magnetic field. 3. Angular dependence of H_c. 4. Temperature dependence of H_c. Experimental results obtained for nanocrystalline systems of FePt and MnBi and sintered Nd-Fe-B based permanent magnets are compared with micromagnetic analytical results. It is shown that for high-quality permanent magnets the dominant hardening mechanism corresponds to the nucleation process.

MA 14.11 Tue 12:15 H 0112

Nonlinear frequency-dependent effects in the dc magnetization of uniaxial magnetic nanoparticles in superimposed strong alternating current and direct current fields — •William Coffey[1], Nijun Wei[1], Sergey Titov[1], Yuri Kalmykov[2], and Declan Byrne[1] — [1]Department of Electronic and Electrical Engineering, Trinity College, Dublin 2, Ireland — [2]Université de Perpignan Via Domitia, Laboratoire de Mathématiques et Physique, F-66860, Perpignan, France

The dc component of the magnetization of noninteracting fine magnetic particles possessing simple uniaxial anisotropy and subjected to strong ac and dc bias magnetic fields is calculated via the magnetic Langevin equation. In the presence of an ac driving field, the dc component of the magnetization of uniaxial particles alters drastically leading to new nonlinear effects; in particular, it becomes frequency-dependent. In axial symmetry, where the strong ac field is parallel to the easy axis of a particle, two distinct dispersion regions in the dc magnetization at low and mid-frequencies emerge, corresponding to longitudinal overbarrier and intrawell relaxation modes. Such frequency-dependent behavior allows one to estimate the magnetization reversal time via the half-width of the low-frequency dispersion band. Otherwise, by applying the strong ac field at an angle to the easy axis of a particle so breaking the axial symmetry, a third high-frequency nonlinear resonant dispersion in the dc component of the magnetization appears accompanied by parametric resonance behavior due to excitation of transverse modes with frequencies close to the precession frequency.