ity, whereas the existence of a maximum thickness l_{max} of the soft-magnetic layers assures a finite nucleation field scaling as $1/l_{max}$.[2] Similar trends are found for ultrathin films with perpendicular magnetic anisotropy.

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CD-11. EXPERIMENTAL AND COMPUTATIONAL MICROMAGNETIC INVESTIGATIONS OF MAGNETIZATION REVERSAL IN LEAN RARE EARTH MAGNETS. S. David*, B. Kevorkian, J. C. Toussaint, and D. Givord (Laboratoire de Magnetisme Louis Neel-CNRS, 25 avenue des martyrs, BP 166 38042 Grenoble cedex 9, France)

Experimental investigation and micromagnetic modelling are used together to better understand the magnetization reversal process in two-phase nanocrystalline magnets. Two samples of approximate composition Nd4Fe78B18 and Pr4Fe78B18 were produced using the classical method of rapid quenching followed by fast annealing.[1,2] The magnetic properties were measured in the range 20–300 K and analyzed using the global phenomenological approach.[3] The results suggest that the demagnetization process involves two steps: reversal of the soft phase followed by that of the hard phase. It can thus be thought schematically that coercivity is determined by domain wall pinning at the boundary between the grains of the two phases. To check the validity of this hypothesis and to explore it further, a micromagnetic numerical 3D calculation was developed and applied. Both equilibrium and transient magnetization configurations are obtained by solving the dynamic Landau-Lifshitz-Gilbert (L.L.G.) equation. A modified forward difference method is used to integrate the time dependent L.L.G. equation without conflicting with the constraint of constant magnetic moment. A continuum view of the material medium is adopted and the spatial finite difference method is used to describe the system as a set of cubic elements. In each element the magnetization is interpolated with quadratic polynomial functions and constrained to follow the Brown condition at the surface. A multigrid approach is developed to calculate both the magnetic potential and the resulting stray field associated with a given microstructure. The calculations show that the magnetic behavior of such systems is largely determined by the ratio grain size/wall width.

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CD-12. INFLUENCE OF THE SYSTEM PARAMETERS ON THE NON-ARRHENIUS MAGNETIC RELAXATION OF SYSTEMS HAVING DISTRIBUTED PROPERTIES. R. Smirnov-Rueda, O. A. Chubykalo, J. M. González (Instituto de Ciencia de Materiales de Madrid- CSIC, Cantoblanco, 28049 Madrid, Spain), and J. González (Departamento de Física de Materiales, Facultad de Química, UPV, Apartado 1072, 20080 San Sebastián, Spain)

Several recent experimental and simulational results[1,2] clearly indicate the occurrence, in highly homogeneous systems, of magnetic relaxation behaviors markedly differing from the predictions of the Arrhenius kinetics. The most characteristic features of the non-Arrhenius behavior are i) the observation, in the time evolution of the magnetization under constant applied field and temperature, of a "waiting time" for the onset of the and ii) the achievement of a fully relaxed state in a finite time. According to the micromagnetic analysis of the phenomenology[2] both features are related to the fact that, differently from the two-level system description of the relaxation (but similarly to hysteresis), thermally activated demagnetization proceeds through a nucleation-expansion-propagation sequence involving domain wall-like. Our purpose in the present work was to investigate the occurrence of non-Arrhenius relaxation behavior in model polycrystalline systems having distributed local properties. Our study was carried out in the framework of the micromagnetic approximation and we used a Monte Carlo algorithm (implemented with Metropolis dynamics) as the energy minimization tool. The considered relaxing systems were formed by sets of grains (subsets of magnetic moments having the same orientation for the local anisotropy axis) which were coupled through exchange and dipolar interactions and we have evaluated the time evolution of the magnetization for constant applied fields in the coercive force range. In all the cases our results were adequately describable by logarithmic laws of the $M(t)=M(0)-S\ \ln(t+t0)$ type (where we considered S and t0 as fitting parameters). Interestingly, the t0 dependence on the degree of texture of the systems showed that i) for highly textured the obtained t0 was compatible with the "waiting time" values obtained in single crystal-like systems (having the same exchange and anisotropy) and ii) as the distribution of orientations of the local easy axes got wider, t0 monotonously decreased. These results, typical from systems with a structural correlation length (grain size) larger than the exchange correlation ones, allowed us to identify the t0 parameter with the typical time required to nucleate (from a quasi-homogeneous magnetization configuration) the partly reversed region underlying the thermally activated magnetization reversal. This idea was supported by the results obtained from the t0 dependence on the structural correlation length-to-exchange correlation length ratio, which evidenced an increase of t0 with the increase of the system exchange stiffness.

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CD-13. A STATISTICAL MODEL FOR DOMAIN WALL MOTION CONSIDERING HYSTERESIS. Anders Bergqvist, Anders Lundgren, and Goeran Engdahl (Teknikringen 33, KTH, SE–10044 Stockholm, Sweden)

This work presents a vectorial model based on statistical thermodynamics for materials where domain wall motion is the dominant magnetization process. A material is considered to consist of a mixture of distinct states $i=1,2,\ldots$ occupying volume fractions v_i and having fixed magnetizations $\vec{m}_i$. The macroscopic magnetization is $\vec{M}=\Sigma_i v_i \vec{m}_i$. The energy per unit volume for state i is $E_i-\vec{H}\cdot\vec{m}_i$ where E_i, $i=1,2,\ldots$ are anisotropy energies. In the lossless, or anhysteretic, case, v_i is in accordance with statistical thermodynamics assumed to have the form

$$v_i=\exp[-p(E_i-\vec{H}\cdot\vec{m}_i)]\Big/\sum_j \exp[-p(E_j-\vec{H}\cdot\vec{m}_j)]$$

where p is an adjustable parameter. The growth of a state i at the expense of state j due to a change $d\vec{H}$ turns out to be $dv_i^j=pv_iv_j(\vec{m}_i-\vec{m}_j)\cdot d\vec{H}$, suggesting that v_iv_j can be interpreted as being proportional to the total domain wall area between domains of types i and j. Experiments on highly anisotropic and nonlinear grain-oriented silicon iron have been compared with calculations using four domain types oriented in the positive and negative x- and y-directions. There is good qualitative and quantitative agreement, including prediction of a hard direction at $\sim 55°$ from the x (easy) axis and a highly non-monotonic susceptibility along the y axis. In addition, hysteresis due to domain wall pinning is treated by assuming the loss due to movement of wall between domains of types i and j to be $k_{ij}|dv_i^j|$, giving a total loss $dQ=\Sigma_{i,j}k_{ij}|dv_i^j|$ where k_{ij} are adjustable loss parameters. The resulting relation between $\vec{M}$ and $\vec{H}$ is derived in the paper. It is found that minor hysteresis loops exhibit the wiping-out property but not in general the congruency property.

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