Micromagnetic simulation of magnetisation reversal in rotational magnetic fields

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In mesoscopic and nanostructured magnets the switching fields and times which are in the order of nano- to picoseconds are controlled by the choice of the geometric shape of the magnets, the intrinsic properties and the orientation and strength of the applied field. Micromagnetic modeling of the magnetization reversal process show that the dynamics of the switching behavior in a constant reversed field differs from the one in a rotating field, especially at high frequencies. We have used a 3D numerical micromagnetic model with tetrahedral finite elements with a constant edge length of 5 nm to study a thin Co square with dimensions 100 x 100 x 20 nm^3 and the materials parameters J_s=1.76 T, K_1=45 MJ/m^3 and A=13 pJ/m. This simulation model combines a hybrid finite element/boundary element method for the magnetostatic field calculation with a BDF/GMRES method for the time integration of the Landau-Lifshitz-Gilbert equation of motion. The numerical results show that the Gilbert damping constant, α, which was varied between 0.1 and 0.02 drastically changes the reversal mode. The rotating magnetic field with a frequency of 1 GHz was applied in the (x,y)-plane and the calculations were started after saturation parallel to the y-direction (easy direction). The quasi-static simulation with $\mu_0\Delta H$=0.02 T showed that switching occurred at 0.2 H_A. Figure 1 shows the transient states during magnetization reversal at a constant reversed field of H_{ext}=0.2 H_A parallel to the –y-direction. For α=0.1 τhe element switches by nonuniform rotation in 0.7 ns. Figure 2 shows that the transient states during magnetization reversal in the high frequency rotational field (H_{rot}=0.2 H_A / 1 GHz) differ from the ones of Figure 1. Under the influence of the rotating field the magnetization starts to rotate near the ends, followed by the reversal of the center. The results of the simulations will compare the influence of frequency and strength of rotating fields and unidirectional fields on switching field and time. This work was supported by the Austrian Science Fund (P13260-TEC).

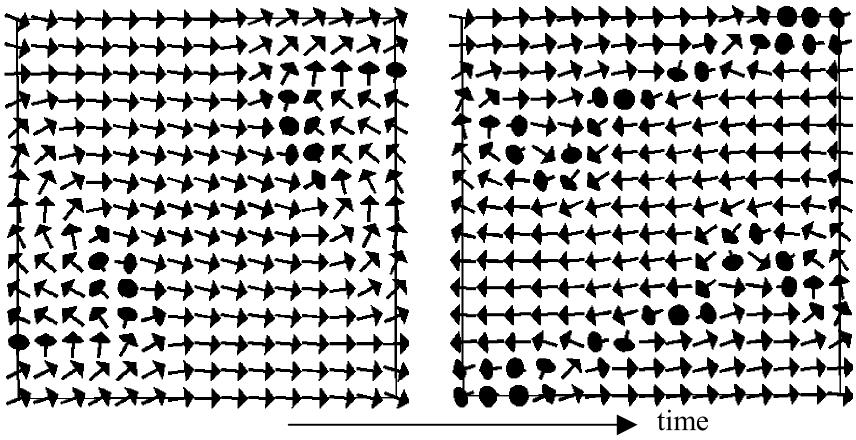
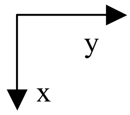


Figure 1



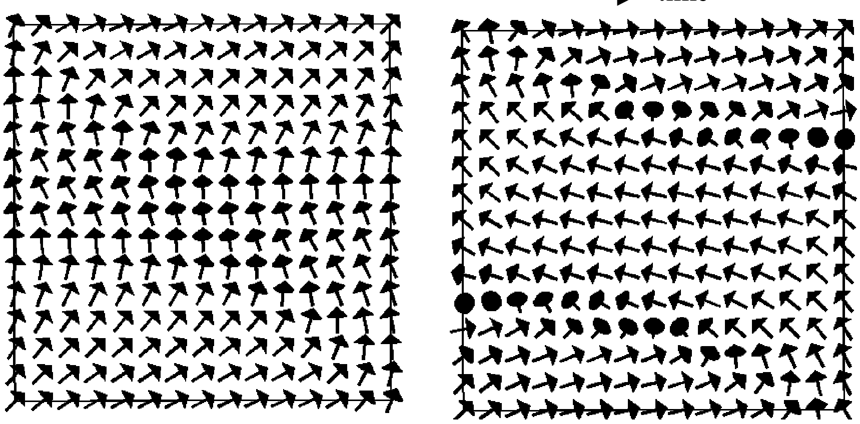


Figure 2

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