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Magnetic relaxation due to earth impurities in $\mathbf{Ni_{80}Fe_{20}}$[1]

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The functionality of magnetic devices depends to a large extent on the spin relaxation characteristics of the magnetic materials. Understanding the underlying physics is required in order to tailor the relaxation properties. Here the relaxation due to rare earth impurities in $Ni_{80}Fe_{20}$ is discussed. When rare earth atoms are incorporated into a 3d ferromagnet the magnetization is reduced due to the antiferromagnetic 3d-5d coupling. In addition the Gilbert damping constant can be increased by two orders of magnitude. We investigate the frequency and temperature dependence of the ferromagnetic resonance linewidth of $Ni_{80}Fe_{20}$ films doped with various concentrations of Gd, Tb, Dy, and Ho. From these experiments we conclude that the slow relaxing impurity mechanism driven by the anisotropic 4f-5d exchange interaction is responsible for the strong damping observed in $Ni_{80}Fe_{20}$- rare earth intermetallic alloy films [1].
Using femtosecond laser pulses in an all-optical pump-probe experiment, one can directly study the processes which are responsible for the relaxation of the spin system down to the femtosecond time scale. The magnetization dynamics is probed by the magneto-optic Kerr effect. By studying the above lanthanide doped $Ni_{80}Fe_{20}$ films with this technique we find that films doped by Tb, Dy and Ho show a gradual increase of the demagnetization time from approximately 60 fs for pure NiFe to about 150 fs. In contrast, Gd concentrations of up to 15% do not influence the time scale of the photoinduced quenching of the magnetization. This behavior is a natural consequence of the slow relaxing impurity mechanism [1]. Thus, we propose a demagnetization mechanism that relies on the magnetic inertia of the rare-earth impurities which stabilize the ferromagnetic ordering on a picosecond time scale [2].

[1] G. Woltersdorf, M. Kiessling, G. Meyer, J.-U. Thiele, and C.H. Back, Phys. Rev. Lett. 102, 257602 (2009)
[2] I. Radu, G. Woltersdorf, M. Kiessling, J.-U. Thiele, A. Melnikov, U. Bovensiepen, and C.H. Back, Phys. Rev. Lett. 102, 117201 (2009)

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