SIMULATIONS OF MAGNETIZATION DYNAMICS USING LLG EQUATION AND FINITE ELEMENT METHOD

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Magnetization dynamics is currently one of the most interesting areas in modern micro-electronics research. A wide range of possible applications for electronic devices makes this subject very attractive from business and scientific perspective. Currently the most popular uses are: hard drive read-heads and magnetic random-access memories (MRAM).

Manufacturing and examination of magnetic structures in nano-scale is a very expensive and time consuming process. This problem can be addressed with numerical analysis, which makes examination much easier and faster. The magnetic effects in nano-scale are well described by the Landau–Lifshitz–Gilbert (LLG) equation. There are already quite a few LLG solvers available. We report here results obtained by the use of Parallel Finite Element Micromagnetics Package (MAGPAR) [1] software, which utilizes a finite elements method and parallel computing.

During research a computer cluster based on 16 PC's was applied. The first simulations were based on a family of ultra-thin cobalt nanostructures (wires and disks) previously examined with a different numerical approach [2]. The maps of magnetization profiles for different widths and thicknesses are discussed. The domain patterned leaf and vortex states were obtained under the same physical conditions.

Another simulations were carried out for the Permalloy dot, for which the magnetization dynamics was tested experimentally using the Brillouin light scattering [3] spectroscopy. The simulations were done for Permalloy and Cobalt dots with elliptical shape in the wide range of widths and thicknesses. The obtained magnetization oscillations, the reversal time, and the dots-shape influence on the magnetization behavior were elaborated. The main scope of this work was to utilize numerical simulation in order to test more easily magnetic materials in micro-electronic applications.

[1] http://magnet.atp.tuwien.ac.at/scholz/magpar/
[2] Maziewski, V. Zablotskii and M. Kisielewski, Phys. Rev. B **73**, 134415 (2006).
[3] V. Novosad, M. Grimsditch, K. Yu. Guslienko, P. Vavassori, Y. Otani and S. D. Bader, Phys. Rev. B **66**, 052407 (2002).