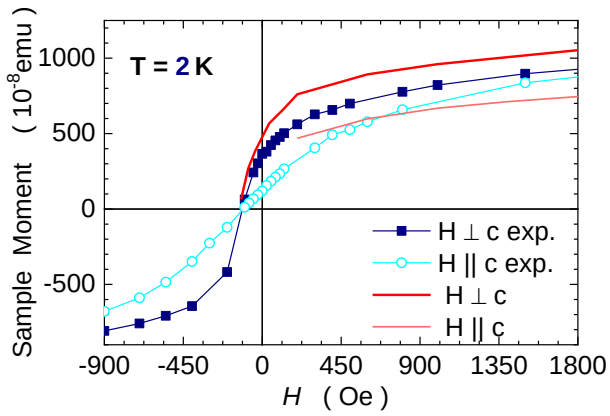
Atomistic spin model simulations of magnetic properties of ferromagnetic (Ga,Mn)N

D. Sztenkiel[1], K. Gas[1,2], N. Gonzalez-Szwacki[3], J. Domagała[1], D. Hommel[2,4], T. Dietl[1,5,6] and M. Sawicki[1]

[1]*Institute of Physics, Polish Academy of Sciences, Warszawa, Poland*
[2]*Institute of Experimental Physics, University of Wrocław, Wrocław, Poland*
[3]*Institute of Theoretical Physics, University of Warsaw, Warszawa, Poland*
[4]*Polish Center of Technology Development, Wrocław, Poland*
[5]*International Research Centre MagTop, Warszawa, Poland*
[6]*WPI-Advanced Institute for Materials Research, Tohoku University, Sendai, Japan*

Switching of magnetization direction between two stable states separated by an energy barrier is one of the most important processes for magnetic recording and information storage. An electric field-control of magnetic anisotropy is a promising candidate. Recently we observed an electric field-induced decrease of coercivity, and a non-reversible magnetization switching at $T \geq 2$ K for magnetic fields close to the coercive field in molecular beam epitaxy grown (Ga,Mn)N layers. The data are interpreted within the theory of the precessional magnetization switching adapted to (Ga,Mn)N by allowing for the control of the magnitude of trigonal deformation along the wurtzite *c* axis by the applied electric field [1]. Here we show that experimental data can be reproduced by theoretical results obtained from the Landau-Lifshitz-Gilbert (LLG) equation that describes how the magnetization direction evolves towards its new equilibrium orientation after a change of an effective magnetic field. We use atomistic spin model simulations [2], applied for ensembles of near ten thousands Mn spins randomly distributed on GaN lattice, with ferromagnetic superexchange included up to 14th neighbour. In general, the parallelization of the code has been applied. As shown in the figure an experimentally established magnetization curve can be adequately reproduced within our approach. Elaboration of such numerical tool allows to theoretically investigate these factors which determine the probability of the precessional magnetization switching induced by electric field.



Blue points: magnetic field H dependence of $Ga_{0.94}Mn_{0.06}N$ magnetic moment at T = 2 K measured along the magnetic easy and hard axis. Red lines: magnetization curve calculated using atomistic spin approach and LLG equation. A small coercive field of about 120 Oe is properly reproduced by simulations.

[1] D. Sztenkiel *et al.*, *Nature Comm.* **7**, 13232 (2016)
[2] R. F. L. Evans *et al.*, *J. Phys.: Condens. Matter* 26 103202 (2014).

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