A Micromagnetic Simulation considering Grain Boundary Effects

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This work attempts to simulate inhomogeneous magnetic characteristics of a real cell, which is composed of many grains. The grain boundary which contains many defects and has different magnetic properties, e.g. exchange stiffness, from grain inside. This should affect the magnetic switching behavior of the cell.

The simulations were performed using Landau-Lifshitz-Gilbert (LLG) equation[1] applied to Permalloy rectangular cells (640x320x10 nm^3 and 1280x640x10 nm^3) with square grids (10x10x10 nm^3), where a grid represents a grain. The magnetostatic field was calculated with a constant magnetization within grids, as others did.[2] However, the exchange field calculation adopted a model that a grid boundary was composed of disordered 50 magnetic sub-moments to represent the defective and disordered atomic magnetic moments at the grain boundary. With the model, it was possible to vary inter-grain exchange stiffness (A*) while intra-grain exchange stiffness (A) was fixed. Once the stiffnesses were set to produce the total inter-grain exchange field larger than the total intra-grain exchange field, vortices disappeared by applying weaker magnetic field than in the usual homogeneous model. The result of current model is closer to experimental and more realistic.

References

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