Quantitative estimation of coercive force of a magnetic grain by dynamical simulations

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High coercivity is an important property of permanent magnets for application in energy conversion devices. Because coercivity is a long-time relaxation phenomenon, which originates from a strong metastable magnetic state, it is difficult to estimate coercive force (coercive field) studying the time evolution dynamics simulation of a model with atomistic parameters under the limitation of the simulation time. In our recent study [1], we presented a method to estimate coercivity using a statistical method to extend the limitation of simulation time and evaluated appropriately the coercive field of a single grain. In this presentation, we show a more convenient method to estimate coercivity using the field-dependent survival (nonreversal) probability generated by a time evolution simulation under a field sweep [2]. This method is applied for any magnetic materials. In this method, not only coercive force but also the zero-field energy barrier and field for the zero-energy barrier can be estimated. Here, we demonstrate that the coercive field of a single grain of the neodymium (Nd) permanent magnet ($Nd_2Fe_{14}B$) is estimated. The Nd magnet [3,4,5] is known as a high-coercivity magnet, which is used in various electronic devices, e.g., motors and efforts to increase the coercivity have been performed. We discuss detailed features of the estimation of the coercive force, zero-field energy barrier and field for the zero-energy barrier.

References

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