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Mesoscopic Simulation of the Properties of Ferromagnetic Materials

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Summary

Magnetic materials exhibit strikingly different performance at different length scales, especially when their sizes reach nanometer scale, such as ultra-thin films, at which their magnetic properties vary dramatically with changing of material length scale. In order to demonstrate such peculiar behavior, a numerical simulation was carried out using a carefully devised model, in which the Landau-Lifshitz-Gilbert (LLG) equation governs the evolution of magnetization. The simulation results clearly showed that there was a critical length at which the coercivity reached a maximum value. In addition, when the length scale was sufficiently small, for example when it was comparable to or smaller than the exchange length of the material, the phenomenon of hysteresis vanished and the material was in the so-called superparamagnetic state. The effect of external stress field on magnetic domain pattern was also taken into account in the present study. The former can affect the latter due to the coupling of the magnetization and elastic fields.

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