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Coarse-Graining in Micromagnetic Simulations of Magnetic Hyperthermia

Authors : Razyeh Behbahani, Martin L. Plumer, Ivan Saika-Voivod

Abstract : Micromagnetic simulations based on the stochastic Landau-Lifshitz-Gilbert equation are used to calculate dynamic magnetic hysteresis loops relevant to magnetic hyperthermia applications. With the goal to effectively simulate room-temperature loops for large iron-oxide based systems at relatively slow sweep rates on the order of 1 Oe/ns or less, a coarse-graining scheme is proposed and tested. The scheme is derived from a previously developed renormalization-group approach. Loops associated with nanorods, used as building blocks for larger nanoparticles that were employed in preclinical trials (Dennis et al., 2009 Nanotechnology 20 395103), serve as the model test system. The scaling algorithm is shown to produce nearly identical loops over several decades in the model grain sizes. Sweep-rate scaling involving the damping constant alpha is also demonstrated.

Keywords : coarse-graining, hyperthermia, hysteresis loops, micromagnetic simulations
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