Dipolar Interactions in Random Nano -granular Magnetic Systems.

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Abstract

In this study, dipolar interaction effects in nano-sized magnetic system are simulated. The results indicate that the nature of the interaction effects cannot be inferred from changes in the mean magnetization of the system. In a randomly oriented system of nano-sized particles, the dipolar interaction fields along the x, y, and z directions are found to be normally distributed with a mean close to zero dipolar fields. Thus, the probability of finding positive and negative dipolar fields is almost the same. The simulations of magnetization curves have shown that the magnetization of the system nonetheless decreases with increasing particles concentration. This has often been taken as denoting predominantly demagnetizing interaction fields and to infer that the overall local interaction fields are negative. Our model alternatively ascribes this reduction in magnetization to the non-linear response of the magnetization to the applied field, which weighs the negative interaction fields more strongly than the positive fields. According to this picture of dipolar interaction fields in random systems, the idea of describing dipolar interactions in terms of a mean field that could be added (positive interactions) or subtracted (negative interactions) from the applied field is not justified. The dispersion of dipolar fields has major effects on the magnetic response of the system. Evidently the nature of interactions cannot be determined from the macroscopic magnetization curves and a simple mean field like interpretation; comparisons with more complex models are important in order to clarify the effects of dipolar interactions on the magnetic properties.