Magnetic properties of ternary mixed core/shell Ising nanoparticles within effective-field theory

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Abstract

Magnetic nanoparticles are a subject of great interest for both experimental and theoretical researchers, due to their technological and biomedical applications such as sensors, molecular imaging devices, high density magnetic recorders, and biomedical applications such as magnetic resonance imaging, drug delivery, cell and tissue targeting or hyperthermia [1]. Magnetic properties of nanoparticles have been studied within various Ising systems consisting of core-shell structures by using a variety of theoretical techniques [2]. We purpose a ternary Ising spins 1/2, 1, 3/2 model to investigate the thermal and magnetic properties of magnetic nanoparticles with core-shell structure within the framework of the effective-field theory with correlations. The center site of the core is occupied by $\sigma = \pm 1/2$ spin, while those of surrounded the center site are occupied by $S = \pm 1, 0$ spins and the shell sites are occupied by $m = \pm 1/2, \pm 3/2$ spins. Thermal behaviors of the core and shell magnetizations, susceptibilities and internal energies as well as total magnetization are investigated. In order to confirm the stability of the solutions we also investigate the free energy of the system. According to values of Hamiltonian parameters, the system undergoes a first- and second-order phase transitions. Phase diagrams are calculated and discussed in detail. We find that the system exhibits a tricritical, reentrant and six different types Q, P, R, S, N and M compensation behaviors, that strongly depend on interaction parameters. The results are in good agreement with some experimental [3] and theoretical results [4].

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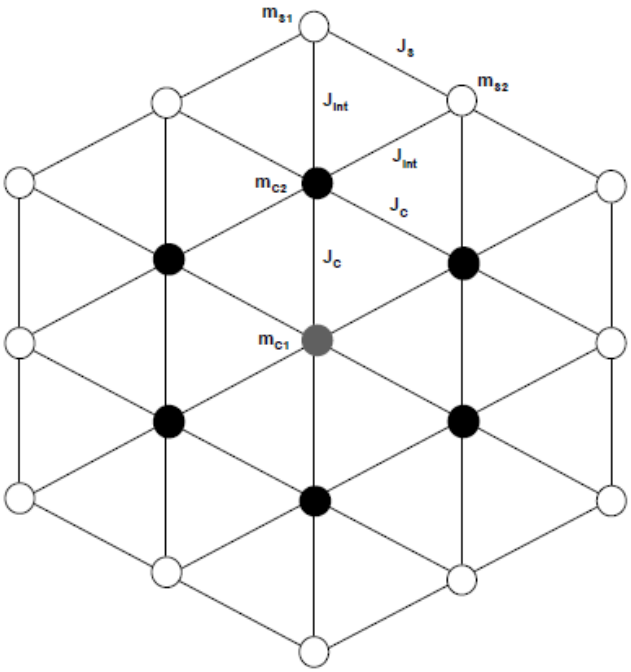
Figures



Schematic representation of a ternary mixed Ising nanoparticles.