Fingerprints of super spin-glass state in magnetic iron oxide nanoparticles deposited on the polymer surface

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The potential formation of super spin-glass (SSG) state in Fe_3O_4 nanoparticles modified by adding 10% citric acid and deposited on the polymer surface using grafting technique was studied. The Fe_3O_4 nanoparticles of the nominal size 7 nm create agglomerates with sizes ranging from nominally 20 nm to 80 nm. The phase diagram glassy temperature vs. magnetic field indicating the onset of the SSG state, as a static and disordered magnetic state, was studied using Almeida-Thouless model [1]. More specifically, the analysis of zero-field cooled, and field-cooled static susceptibility data obtained at various magnetic fields yielded the value of the glassy temperature $T_g = 82$ K. In addition, the relative shift in the maxima in real susceptibility with changing the excitation frequency $\Gamma = 0.015$ and the value $z\nu = 10.2$ obtained from critical slowing down analysis of the relaxation time revealed good agreement with theoretical predictions and reported experimental results for the magnetically three-dimensional (3D) systems in which SSG behaviour was confirmed [2,3]. However, dynamic scaling with the values $T_g = 82$ K, $z\nu = 10.2$ and $\beta = 0.7$ showed no collapse. Pronounced renormalization of these parameters necessary to obtain the collapse in dynamic scaling may indicate deviation towards anticipated 2D magnetic behaviour. The observed memory and aging effects represent other features supporting the presence of SSG in the studied system. The obtained results suggest the presence of SSG state in 2D nanoscopic system with dominant dipolar coupling. The manufactured assembly may represent a potential step towards 2D matrix of thermal memory cells and may find its applications in data storage technology.

References:

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