MODELING OF LOCAL MAGNETIC FIELDS IN MULTILAYER COMPOSITE SYSTEMS

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In recent years magnetic composite systems consisting of magnetic nanogranules distributed in non-magnetic matrix have been actively investigated. Such materials are promising for microwave technology. Multilayer structures that consist of granular magnetic layers and non-magnetic dielectric or semiconductor interlayers represent a separate class of composite systems. The properties of such systems can be influenced by changing both the concentration of granules in the magnetic layer and the thickness of the layers and interlayers. An important factor that determines the magnetoresonance characteristics of these objects is a value of local magnetostatic field. The calculations of magnetostatic fields for ensembles of magnetic dipoles were carried out in many works with the aim to obtain analytical expressions for regular infinite systems. The objective of this work is to study the degree of influence of various deviations from ideal models on the value of internal fields in a multilayer system of finite dimensions. Numerical calculations of the magnetic field component in the central part of the structure that consists of dipoles with the same magnetic moment orientation were performed in accordance with the principle of fields superposition. The cases of periodic and non-periodic arrangement of particles in systems with different concentration of granules were considered (the scheme is shown in Fig. 1a). For systems of equal concentration (below the percolation threshold) but with a different particle size distribution (for example, see Fig. 1b), a comparison of local fields in closely located positions was performed. The calculations were carried on using the physical parameters of real structures (granule diameters of 2–3 nm, layer and interlayer thicknesses of 2–4 nm, material magnetization equals 1250 G, number of layers was equal to 60). The sizes of the particle array in the layer varied from 10×13 to 1000×1000 dipoles. Analysis of the calculation results showed that non-uniformities of inner fields that occur in non-ideal systems are conditioned by the character of particle size distribution to a greater extent than by the statistical straggling of the granule positions.

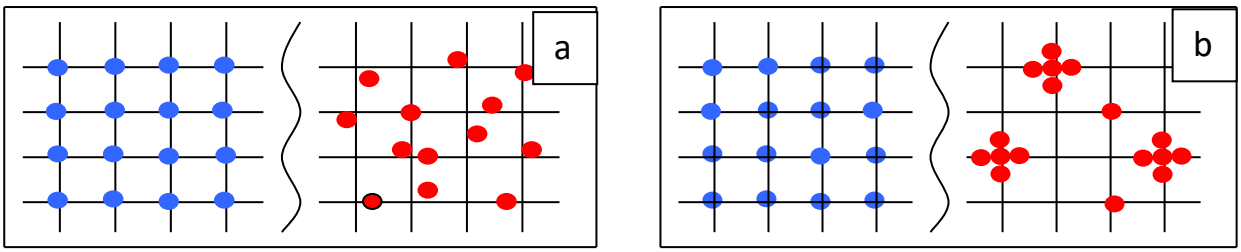

Figure 1 – Schemes of magnetic dipole arrangements in the individual layers that were used at calculating the fields at certain points of multilayer structure.