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To the theory of shear elastic properties of magnetic gels.

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Abstract

We present results of theoretical study of elastic shear modulus of magnetic gels, consisting of single non Brownian magnetic particles, homogeneously (gas-like) distributed in an elastic matrix. The composite is placed in magnetic field, perpendicular to the direction of the sample shear. Effect of both, magnetically hard and soft particles is studied. In order to get mathematically rigorous results, we have restricted ourselves by the analysis of the composites with low concentration of the particles and neglected any interactions between them. Only small deformations of the system were considered. Analysis shows that effect of magnetic field on the macroscopic (measurable) shear modulus of the composite can be comparable with that, provided by the presence of the rigid inclusions in the elastic matrix. The suggested asymptotic model can be a robust background for the study of the systems with moderate or high concentration of the particles.

Keywords: Magnetic gels; shear deformations; elastic modulus

I. Introduction.

Magnetic gels and elastomers are composites of fine magnetic particles in soft polymer matrixes. Coupling of rich set of physical properties of polymer and magnetic materials is very promising for many modern and perspective technologies. Discussions of technical and biomedical application of these systems can be found, for example, in [1-12]. A short overview of works on mechanical properties and behavior of magnetic polymers is given in [13].

Uniaxial elongation and magnetostriction effects in magnetic gels have been studied in many works (see, for example [13-19]). The shear deformations of these systems also present significant interest both from scientific and practical points of view. Theoretical studies of the shear effects in the composites with the particles, united in linear chain-like aggregates, have been done in [20-22]. The general conclusion of these works is that an external magnetic field can significantly increase the shear modulus of these composites.