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On the theory of hysteretic magnetostriction of soft ferrogels.

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Abstract. The paper deals with theoretical study of hysteretic magnetostriction of soft ferrogels – composite materials, consisting of the micron-sized magnetizable particles embedded into gel matrices. It is supposed that initially, before application of an external magnetic field, the particles are homogeneously and isotropically distributed in an elastic matrix. The theoretical explanation of the hysteresis phenomena is based on the conception that, under the field action, the particles rearrange into the linear chain-like aggregates. The typical length of the chains is determined by the competition between the force of magnetic attraction of the particles and the force of elastic deformation of the matrix.

Magnetic gels; magnetostriction; hysteresis

1. Introduction

The possibility to control physical properties and behavior of polymer and other soft matters by using magnetic fields is very attractive for many industrial and bio-medical applications. However, to the best of our knowledge, all natural soft matters are diamagnetic. Therefore, control of their properties requires very strong magnetic fields and bulky apparatuses. The effective solution of this problem gives the composites of fine (nano- and micron-sized) magnetic particles in polymer matrix. Coupling of high elasticity with high reaction on magnetic field gives new kind of smart composite materials, which find active applications in many industrial, medical and biological technologies. That is why they attract considerable interest of researches and engineers [1-13].

Experiments demonstrate hystereses of mechanic and magnetic phenomena in ferrogels with the micron-sized magnetizable particles (see, for example, [14-18]). The hysteretic effects present significant interest both from scientific point of view and viewpoint of practical applications of these composites.

Analysis shows that rearrangement of the particles under the action of external magnetic field and their unification in heterogeneous structures can be one of internal causes of these hysteresis's. Note that