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Magnetic properties of magnetic elastomers filled with magnetic particles with internal magnetic anisotropy

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Smart materials, including magnetic elastomers, are currently attracting considerable attention from researchers. The ability to control various magnetic and mechanical properties of magnetic elastomers using an applied external magnetic field, magnetic particle distribution, size, and polydispersity [1–2] forms the basis for their practical application in both industry and medicine [3]. Magnetic elastomers are magnetic particles embedded in a non-magnetic elastic matrix.

This research examines two simple models of magnetic elastomers filled with magnetic particles with internal magnetic anisotropy. The magnetic particles are modelled as ideal spheres with an easy axis of magnetisation and a magnetic moment, which, in mathematical modelling, is represented as a vector of constant magnitude, the direction of which depends on the external magnetic field and the internal structure of the particle. A magnetic dipole-dipole interaction and short-range repulsion (the Weeks-Chandler-Andersen potential) are specified between the magnetic particles. The elastic nonmagnetic matrix is modelled using a classical harmonic potential. The first model constrains only the motion of the magnetic particles, while the second model constrains both the motion and rotation of the particles. The interaction between the magnetic particles and the external magnetic field is specified using the Zeeman potential. Computer simulations were implemented in the ESPResSo software package[4] using molecular dynamics. The computer simulations were aimed to obtain the dynamic magnetic response, as well as the distribution of the first-order reversal curves (FORCs) of a magnetisation.

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