Simulation of Nonlinear Magnetorheological Particle-filled Elastomers

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Polymer matrix filled with ferromagnetic particles is a class of smart materials where the mechanical properties can be changed under different magnetic field. They are usually referred to as magnetorheological elastomers (MREs). A finite element simulation was presented to describe the mechanical behavior of MRE with the nonlinearity of the particle magnetization being incorporated. By introducing the Maxwell stress tensor, a representative volume element (RVE) was proposed to calculate the Young's modulus and shear modulus of MRE due to applied magnetic field. The influences of the applied magnetic field and the particle volume fractions in the shear modulus and Young's modulus were studied. Results show that the shear modulus increases with the magnitude of the applied magnetic field, while the Young's modulus decreases. The numerical data are in a good agreement with the theoretical results from the dipole model.

Keywords: Mgnetorheological elastomers; Mechanical properties; Maxwell stress tensor; Representative volume element