Abstract

In the present work we introduce an isoperimetric mathematical model of ferromagnetic shape memory alloys (FSMAs). FSMAs are a special class of magnetostrictive materials, i.e. materials which deform their shape on account of external magnetic field or which change magnetization as a consequence of strain. This property originates from phase transformations that occur within the material when being exposed to external loading.

First, the stationary model of FSMA is formulated. The thermodynamical potential is composed (Helmholtz free energy) and its non-quasiconvexity is discussed. The quasiconvexification is performed via the relaxation theory, i.e. quasiconvex envelope construction. For such a model the existence theory is built.

Then, taking advantage of the stationary case the evolutionary model is developed. The attention is drawn to hysteresis, which arises from energy dissipation. The time discretization leads to a sequence of hysteresis-modified stationary problems (the concept of energetic solution). Benefiting from the existing abstract results, the existence of the energetic solution for FSMA is shown. The model relies on the experimental fact that the energy dissipation is a rate-independent process.

The advantage of the formulated model is its straightforward numerical implementation. Numerical aspects of the model are discussed in the final part of the thesis. Several concrete results are included for various combinations of a material type and loading.

Keywords: Magnetic shape memory; Magnetostrictive materials