Ferromagnetic shape memory effect: academic and practical importance

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The ferromagnetic shape memory effect (FSME) appears as a magnetic field-induced twinning/detwinning in the martensitic phase, resulting in the recoverable strain of the order of martensitic spontaneous distortion. The FSME is typical for thermoelastic martensites formed as a result of martensitic transformation in ferromagnetic matrix of Ni-Mn-Ga alloys which represent novel multifunctional materials with extreme mechanical, magneto-mechanical and mechano-magnetic properties as well as with peculiar type of magnetic behavior.

The concept of the equivalence of mechanical and magnetoelastic stress is deduced from the magnetoelastic model based on the Landau theory. The main consequences of this model are briefly discussed.

The magnetomechanics of ferromagnetic martensites in quasielastic and anelastic regimes at different schemes of loading will be considered.

The superelastic behavior of Ni-Mn-Ga ferromagnetic martensites at orthogonal magnetic field is described. The proper theoretical treatment combining a magnetoelastic model and statistical approach is developed to describe quantitatively the superelastic strain under transversal constant magnetic field.

As far as applied aspect is concerned, some results of ongoing research on magnetic shape memory thin films will be presented. Emphasis will be given to the transformation behavior and magnetism of submicron Ni-Mn-Ga martensitic films deposited on different substrates. The results are discussed in terms of thickness dependent residual strains as well as microstructural and crystallographic features.