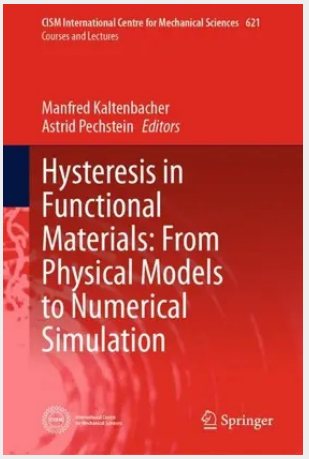
Kaltenbacher / Pechstein

Hysteresis in Functional Materials: From Physical Models to Numerical Simulation



The book provides an overview of the physical phenomena in ferromagnetic and ferroelectric materials on the micro-scale, including the origin of domain structures, domain wall motion and magnetisation or polarization rotation. This discussion leads to multiscale and phenomenological macroscopic models which account for the hysteretic behaviour, followed by a detailed derivation of variational inequalities as the main mathematical tool in hysteresis modelling, hysteresis energy balance and continuous data dependence. Classical elasto-plasticity is used as an example application where thermodynamic potentials and dissipation functions are defined and their relationship to commonly used yield conditions and associated flow rules is shown. The concepts developed there provide the basis for modelling the ferroelectric material behaviour that occurs in piezoelectric ceramics, as well as ferromagnetic behaviour through scalar and vector hysteresis models. These models are complemented by efficient finite element strategies, and identification methods to determine the necessary material parameters in the hysteresis models based on measurements.

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