Nonequilibrium Growth Modes of Interfaces in Type-I Superconductors

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When a superconducting metal is quenched from its normal state into the Meissner phase, the superconducting phase begins to grow by phase separation processes similar to those encountered in classical binary fluids. In comparison to classical fluids, however, the complex nature of the superconducting order parameter and its coupling to the magnetic vector potential are additional degrees of freedom that influence the phase separation process.

In the present paper, a discussion is given of the possible nonequilibrium growth modes in type-I superconductors. For this purpose, a macroscopic dynamic interface model is derived from the time-dependent Ginzburg-Landau equations in the limit of strongly type-I behavior. The macroscopic parameters of this interface model, as e.g. the surface tension and the kinetic coefficient, are related to microscopic material parameters via the relationship of Ginzburg-Landau theory with BCS theory. This relationship poses strong conditions on the observable nonequilibrium growth modes for a large class of superconducting materials.