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Features of the formation of pinning centers in HTS tapes under the laser irradiation action

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In high-temperature superconducting films and tapes, optical switching are complex and are determined not only by the laser pulse energy, but mainly by its duration. Thermal processes play the main role at durations from tens to hundreds of ps. To study the physical processes occurring in an HTS tape under ultrashort laser irradiation, using the Comsol Multiphysics software, a multiphysics FEM model of the dynamic description of the system was developed based on the phase field approach. In view of the complexity of the processes occurring during the interaction of laser radiation with matter, when implementing the model, the processes of current flow through the HTS tape and the heat release associated with it, phase transitions, processes of melting, solidification, evaporation, and thermal decomposition of matter under the action of laser radiation were considered. The governing equation of the model is reduced to the thermal equation of the two-phase zone model. The liquid phase is limited by surface tension, and the solid phase is described as a highly viscous liquid whose speed is limited to zero. The cases of a Gaussian laser beam, as well as a beam with a uniform distribution of the laser radiation intensity along the radius, are considered. The limiting regimes of laser action that do not damage the material when a transport current of different magnitude flows, as well as regimes of action that lead to a short-term complete or partial thermal transition of a superconductor to the normal state are estimated, switching times are calculated for different durations and powers of laser radiation, and also at different amplitudes of the transport current flowing through the superconductor.
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