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PINNING OF ABRIKOSOV VORTICES AND CRITICAL CURRENT IN HIGH-T_c SUPERCONDUCTORS WITH EXTENDED LINEAR DEFECTS

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Extended linear defects, such as dislocations, columnar radiation tracks, nanorods (formed by self-organized admixture phase nanoparticles) with a diameter of few nanometers, are known to be a strong pinning sites for Abrikosov vortices in high-T_c superconductors (HTS), which prevent vortex motion under the Lorentz force action and related resistivity emergence at $T < T_c$. The latter significantly enhances the current-carrying abilities of these materials, making them favorable for modern electric power engeneering and electronics [1, 2].

In the present work the problem of Abrikosov vortex depinning from extended *c*- oriented linear defect in 3D – anisotropic (layered) superconducting plate with a thickness $d > 2\lambda$ (λ - is the London penetration depth) under the influence of inhomogeneously distributed transport current is solved for the case of low temperatures. This problem is considered in the framework of classical mechanics as a behaviour of an elastic vortex string which is settled in the potential well of linear defect and exerted to the action of inhomogeneously distributed Lorentz force within the screening layers of width λ near the specimen surfaces. We search the mechanical stability problem for the vortex string inside the potential well of linear defect and obtain conditions for the instability threshold, which are related to the attainment by transport current its depinning critical value. The results of suggested model agree well with experimental data obtained for HTS single crystals and films with columnar defects.

The obtained results are also applied for calculation of the critical current dependence on the misorientation angle in HTS bicrystal with a dislocation low-angle [001] tilt grain boundary [3,4]. It's argued that in the case of relatively small values of the bicrystal misorientation angle θ ($\theta \leq 10 \div 15^0$) the critical current as well as the resistive state emergence are determined by depinning of Abrikosov vortices, which are locked by edge dislocations aligned along the bicrystal grain boundary. Dependence of the depinning critical current on the misorientation angle of bicrystal is determined and it reveals a good agreement with experimental data obtained on RE-Ba-Cu-O [3] (and also pnictides RE-Fe-As-O [4]) bicrystals with [001] tilt low-angle grain boundaries.

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