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One-dimensional vortex flow channels in high-T_c superconductor bicrystals

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Bicrystal grain boundaries in high-T_c superconductors (HTS) represent the natural one-dimensional easy flow channels for vortices in the mixed state of HTS [1,2]. In the present work we explore theoretically some peculiarities of 1D vortex chain motion in the mixed state of HTS bicrystals with [001] tilt grain boundaries. The items of our consideration are as follows: a) dependence of the critical current density on the misorientation angle θ in high-temperature superconductor [001] tilt bicrystal, $j_c(\theta)$, is theoretically examined. It is shown, that specific form of the periodic vortex pinning potential $U_p(s)$ created by dislocation rows along a such kind grain boundaries [1], allows to reproduce the main features of $j_c(\theta)$ dependence, experimentally observed in HTS [001] tilt bicrystals, namely: existence of plateau at small misorientation angles, and exponential dependence $j_c(\theta)$ at higher angles: $j_c(\theta) \sim exp(-\theta/\theta_0)$ [3]; b) the current-voltage characteristic (CVC) and flux-flow resistivity ρ_f (T,H,j), defined by vortex chain motion along the low-angle [001] tilt grain boundary are explored. The main features of CVC in applied magnetic field are following: existence of the linear part in the transport current range $j_{c1}(T,H) < j < j_{c2}(T,H)$, followed by crossover to the nonlinear (power-like) $j(E)$ dependence at $j > j_{c2}(T,H)$. The linear part of CVC corresponds to the coherent flow of vortex chain, locked within the bicrystal grain boundary. It is characterized by $\rho_f \sim H^{1/2}$ dependence [2], while at higher currents ($j > j_{c2}$) the nonlinear $j(E)$ dependence resembles an extension of the vortex stream inside grains.

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