Nonlinear flux flow, resonances and phase locking of vortices on grain boundaries.

Alex Gurevich
Applied Superconductivity Center, University of Wisconsin, Madison WI, USA

Exact solutions that describe nonlinear dynamics of mixed Abrikosov-Josephson (AJ) vortices on grain boundaries in strong ac and dc magnetic fields are obtained. Simple formulas for the nonlinear V-J characteristics and the flux flow resistivity $R_F(B)= [B/(B + B_0)]^{1/2}R$ where $B_0 = \phi_0/4\pi^2l^2$ were found. Based on these formulas, measurements of the $R_F(B)$ field dependence have unambiguously indicated the existence of AJ vortices in low-angle YBCO bicrystals and enabled us to extract the intrinsic depairing current density of the grain boundary, the Josephson core length $l(T) = l_0/(T_c - T)$ and the quasiparticle resistance R on nanoscales of few dislocation spacings (~ 50-200 Å). It is shown that dynamics of AJ vortices on grain boundaries in ac field is fully integrable, and the complex rf resistivity $R(\omega)$ exhibits the flux flow resonance due to phase locking between viscous vortex motion and the ac current. These effects result in resonance peaks in averaged V-J curves of AJ vortices driven by superimposed ac and dc currents.