Dissipation in ultra-thin current-carrying superconducting bridges; evidence for quantum tunneling of Pearl vortices

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Zero-field current-voltage characteristics (IV's) of artificially layered high-T_c thin-film bridges are reported. Scanning SQUID microscopy of these films provides values for the Pearl lengths Λ that exceed the bridge width W, and shows that the current distributions are uniform across the bridges. At high temperatures and high currents the voltages follow the power law $V \propto I^n$, with $n=\Phi_0^2/8\pi^2\Lambda k_B T+1$, in good agreement with the predictions for thermally activated vortex motion made on the basis of a known barrier shape. At low temperatures the thermal activation model fails, and a consistent picture can be made by fitting the IV's to $ V\propto \exp(- {\rm const}\, W^2/I^2)$, as expected if the low temperature dissipation is dominated by quantum tunneling of individual Pearl vortices.

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