

Vortex Confinement in Planar Superconducting/Ferromagnet Hybrid Structures

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Magnetically coupled superconductor-ferromagnet hybrids offer advanced routes for nanoscale control of superconductivity. Scanning tunneling microscopy and scanning magnetic force microscopy coupled to magneto-transport measurements reveal rich vortex phase diagram. The magnetic stripe domain of the ferromagnet induces periodic local magnetic induction in the superconductor, creating a series of pinning and anti-pinning channels for vortices observed with scanning tunneling microscopy and magnetic force microscopy at low temperature. Such laterally confined Abrikosov vortices form chains. We also found general equilibrium condition for which vortex-antivortex pairs are spontaneously formed during zero-field cooling. In the non-equilibrium state the strong magnetic pinning of the vortex lattice results in avalanches of antivortices when changing the polarity of the applied magnetic field. The threshold of avalanches depends upon the specific history and temperature.