TUTORIAL

Magnetic Fluxon Behavior and Resistance Development in a Superconductor

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Though electrical resistance is certainly zero in a superconductor, practical observation of the resistance is rather complicated because of geometrical effect under observation. It is also the case when the applied field is greater than (lower) critical field, at which the superconductor is out of the Meissner state. The complexity of the resistance development is due to characteristic behavior of the magnetic flux lines penetrated into the superconductor. For type I superconductors, the flux penetration is not genuine, but related to the geometrical effect. The resistance and critical current are highly dependent upon the flux penetration area of the superconductor volume. For type II superconductors, the flux penetration is due to negative surface energy and the flux is divided into the minimum size of magnetic flux quantum or fluxon, which is typically called (Abrkosov) vortex. The floxons or vortices, which behave like small mobile-magnets, may dissipate energy during interaction with transport current, resulting in electrical resistance. Application of type II superconductors usually demands large critical current, which is strongly dependent upon controlling the vortex mobility, that is, flux pinning. This lecture will focus on students who are more interested in practical application of superconductors. We will phenomenologically handle flux penetration behavior into a superconductor and electrical resistance development. Enhancement of the flux pinning to increase the critical current will also be discussed.

Keywords : zero resistance, magnetic flux quantum, vortex, critical current