# Generation of Vortices by Current Injection into Mesoscopic Superconductors: Numerical Study

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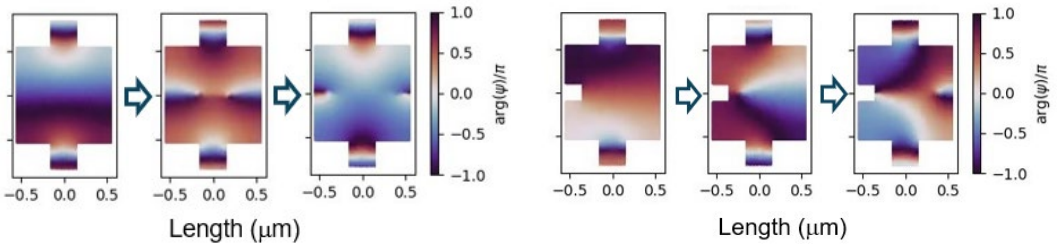
Abstract

Due to their high-speed operation and low power consumption, superconducting digital devices are important for classical and quantum computing. However, small (micro-meter-sized) memory devices that operate at low temperatures have not yet been implemented. Abrikosov vortices in mesoscopic superconductors with sizes approaching superconducting coherence length are one of the promising candidates for information carriers in low temperature memory devices. In mesoscopic superconductors, the number of vortices and their configurations strongly depends on the sample shape,[1)] and applied magnetic field, and can be controlled by current injection.[2)] Here, to explore the possibility of applying vortices in mesoscopic superconductors to memory devices, we numerically investigate basic properties of vortex states under current injection.

We used a program, pyTDGL,[3)] which solves the TDGL equation for two-dimensional superconductors for the simulation. The sample is a square superconductor with a side length of 1.1 μm and a thickness of 40 nm with superconducting leads 0.3 μm wide attached to the centers of two opposite sides. We assumed an aluminum film under zero magnetic field. Examples of results are shown in Fig. 1. Figure 1(a) shows the time-evolution of the superconducting phase under a current injection between two leads. Here, a vortex and an antivortex form at the center of the square, move in opposite directions and then exit the sample. One the other hand, when a surface defect exists at the center of the left side (Fig. 1(b)), under a current injection, a vortex enters at the position of the surface defect and pass across the sample. These results indicate that surface defects strongly influence vortex generations. In the presentation, we will focus on the effect of surface defects and holes on the vortex states and their stabilities and discuss the realization of vortex memories.




(a) (b)

Figure 1: Color-map of time-evolution of superconducting phase in a superconducting square without surface defect (a) and with a surface defect (b) under current injection.

References

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