A metastable state is stable with respect to small fluctuations, but is different from the system's ground state of the least energy. Recently, researchers demonstrated the metastable superconductivity of the super-cooled state in $IrTe_2$ caused by the pulse-heating and the subsequent rapid cooling*. This metastable superconductivity is a result of the suppression of the first-order phase transition by rapid cooling, applicable for the nonvolatile resistance switching from non-zero to zero and for the reversible optical lithography of superconducting circuits. However, from the viewpoints of applications, the small resistance difference due to the metallic ground state of $IrTe_2$ with low resistivity limits the possibilities in multiple fields. In this thesis, we show the nonvolatile phase transformation from the high-resistance semiconductor into the metastable superconductor by applying the current pulse in the bulk tin-germanium alloy, as well as the inverse transformation. We also observed the stepwise partial phase transition followed by the pulse trains with a microscope system and showed that the metastable superconductor can coexist with the semiconductor at sufficiently low temperatures. Our results demonstrate that the reversible writing and the spatial patterning of superconductor in semiconductor are indeed possible in our procedure. Since resistivity of the semiconductor increases exponentially as the temperature decreases and thus make a stark contrast to metastable superconductor, this study opens the way for applications of superconducting physics in various filed, including superconducting circuits and plasmonics devices.

* H. Oike, M. Kamitani, Y. Tokura, and F. Kagawa. Kinetic approach to superconductivity hidden behind a competing order. Science Advances 4, 10 (2018).