

Critical Current Measurement of Superfluid ^3He Film in Magnetic Field

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Superfluid ^3He film is the most advantageous super-clean material to understand boundary effects of unconventional superfluid/superconductor systems. Since the anisotropic A phase becomes more stable than the isotropic B phase because of a boundary effect in a thickness range of submicron, the $A - B$ phase boundary is predicted as a function of the thickness. Recently, an inhomogeneous superfluid phase (stripe phase) was predicted in the vicinity of the $A - B$ phase boundary [1].

To investigate these characteristic phase transitions in superfluid ^3He film, we have measured the critical current J_c as the onset of dissipative flow over the thickness range from 0.3 to 4 μm using inter-digitated capacitors. In the thickness dependence of J_c , two distinct behaviors were observed at a thickness close to the predicted phase boundary of $\sim 1 \mu\text{m}$ [2].

In order to investigate the relation between phase transition and the change of J_c , it can be useful to measure J_c in magnetic field. As a function of magnetic field, a stable superfluid phase in bulk ^3He can be changed even in saturated vapor pressure. For the measurement in magnetic field, a new silver sample cell is preparing. To improve the measurement of the temperature of the liquid ^3He , in addition to a vibrating wire thermometer, the cell has a capacitive liquid level controller to detect a superfluid transition temperature of bulk ^3He .

[1] A. B. Vorontsov and J. A. Sauls, Phys. Rev. Lett. **98**, 045301 (2007).

[2] M. Saitoh and K. Kono, J. Low Temp. Phys. in press.