Study of Quantum Phase Transition in Submicron Superfluid ^{3}He Film Induced by Continuous Thickness Control

Masamichi Saitoh and Kimitoshi Kono

Low Temperature Physics Lab., RIKEN, 2-1 Hirosawa, Wako, 351-0198, Japan.

Superfluid ^{3}He 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 thickness. Recently, inhomogeneous superfluid phase (stripe phase) was predicted in the B phase in the vicinity of the A-B phase boundary.

To study submicron superfluid ^{3}He film in saturated vapor pressure, we have investigated a technique utilizing inter-digitated capacitors (IDC). As shown in Fig. 1, a substrate, which has two pairs of IDC, is installed perpendicular to the surface of the bulk liquid ^{3}He. Because of the dielectric property of liquid ^{3}He, continuous controls of flow and thickness of superfluid ^{3}He film on IDCs can be realized by measuring capacitance and applying dc voltage to each capacitor.

Here, we will report recent experimental results that measured a thickness dependence of critical current as an onset of dissipative flow for a thickness range from 0.3 to 4 μm.

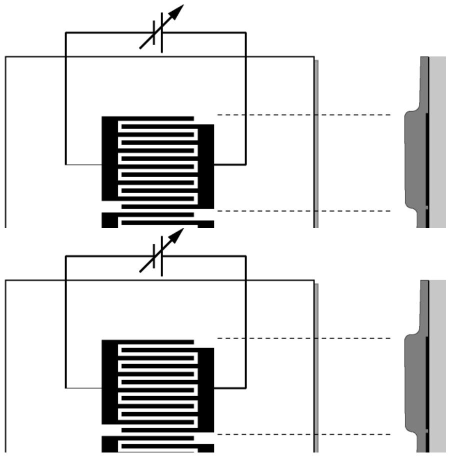

FIG.1: Schematic diagrams of IDCs: (a) front view of IDCs and (b) cross sectional view of IDCs on glass substrate. Each finger of the IDC is 10 μm wide and separated by 10 μm from its neighbors. Two IDCs have in total 200 fingers. The film flow and thickness were controlled by applying dc voltage on each IDC.