Tortional oscillator measurements for superfluidity of ^{4}He confined in a porous Alumina nanopore array

S. Murakawa[a], Y. Chikazawa[a], T. Tanaka[a], R. Higashino[a], K. Yoshimura[a], K. Kuriyama[b], K. Honda[b], Y. Shibayama[a], and K. Shirahama[a]

[a]Department of Physics, Keio University, Yokohama, Japan
[b]Department of Biological Science and Chemistry, Yamaguchi University, Yamaguchi, Japan

Superfluid helium-4 (^{4}He) confined in nanoporous materials is an attractive system in the quantum fluid studies. Previous work[1] revealed that superfluidity of ^{4}He confined in 2.5 nm pore was strongly suppressed at higher pressures. This result is very surprising because the superfluid coherence length is much smaller than the pore size at the transition temperature inside the pore. Using this anomalous suppression, a novel Josephson device might be realized at arbitrary temperature.
As nanoporous media, we employed well-characterized porous alumina (PA). As a preliminary experiment, we started to study superfluid properties with a PA regular triangular nanopore array by developing an annulus-type torsional oscillator. The PA's pore size is 45 nm and thickness is 165 μm.
The frequency shift from normal fluid at the lowest temperature showed that almost all fluid was decoupled. In the vicinity of the transition temperature of bulk ^{4}He, two frequency shift onsets, which were assigned to superfluid transitions inside and outside of the pores, were observed. In addition, many dissipation peaks caused by the second sound coupling were detected.

[1]K. Yamamoto *et al.*, Phys. Rev. Lett. **93**, 075302 (2004).