High Sensitive Capacitive Dilatometer for Investigation of Quantum Critical Phenomena near Absolute Zero

S. Abe, F. Sasaki, T. Oonishi, D. Inoue, and K. Matsumoto

Department of Physics, Kanazawa University, Kanazawa, Japan

We have developed the capacitive dilatometer for measuring the small length change of heavy fermion compounds in order to investigate the critical phenomena at ultralow temperatures, because thermal expansion and magnetostriction are more singular than specific heat in the approach to a quantum critical point. With decreasing temperature blow 1 K, thermal expansion becomes small in approximately proportional to the square of temperature, thus, high sensitivity and reproducibility are necessary for the dilatometric measurements in milikelvin temperatures. The cylindrical shape of a single crystal $CeRu_2Si_2$ with 3-mm-diameter and 5-mm-length was glued by the silver paste to the dilatometer made of oxygen-free copper. The dilatometer with 12-mm-diameter and 15-mm-hight was installed in the 52 mT superconducting solenoid on the dilution refrigerator or in the helium 4 gas flow cryostat of 15 T magnet. Our dilatometer and the capacitance bridge using a lock-in amplifier, the decade transformer and register, and vacuum type co-axial cables have provided the extremely high resolution, $\Delta L/L \sim 10^{-10}$.