MEASUREMENT OF THERMAL CONDUCTIVITY OF SUPERCONDUCTING YBCO THIN FILMS AT LOW TEMPERATURE BY PHOTOTHERMAL REFLECTANCE METHOD

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High-Tc superconducting thin film (YBa$_2$Cu$_3$O$_{7-d}$: YBCO) have been developed for practical use. In the application systems, it is necessary to understand the thermal behavior of the YBCO thin films. The purpose of our study is to measure the thermal conductivity of YBCO thin films under practical environment (low temperature and high magnetic field).

We applied photothermal reflectance method for the measurement. In this method, the sample is periodically heated by an intensity modulated laser beam causing a temperature variation. This temperature response is detected by a probing laser beam. The detected signal has a phase lag to the modulated heating beam, and this phase lag contains information about thermal properties of the sample. Therefore, it is possible to obtain the thermal conductivity of the sample in the depth direction by analyzing the phase lag as a function of the frequency.

Fig. 1 shows the schematic of our experimental apparatus. The samples are placed in cryostat which can control the sample space temperature from 1.5 K to 300 K and can generate magnetic field up to 7 T. We use laser diodes for heating and probing beams. The heating beam (wavelength: 445 nm, maximum intensity: 500 mW) is directly modulated by function generator up to 1 MHz in the measurement.

As preliminary measurements, we have measured the out-of-plane thermal conductivity of YBCO thin films (1000, 500, 250 nm in thickness) at room temperature. The result which is shown in Fig. 2 exhibits positive film thickness dependence that is same tendency we measured by photothermal radiometry [1]. Subsequently, we have performed low temperature measurements in the temperature range from 5 K to 300 K, and obtained stable signals. This means that the applicability of our photothermal reflectance apparatus at low temperature measurement is experimentally confirmed.

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