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Visualization of trapped fluxoids in $FeTe_{0.5}Se_{0.5}$ thin film deposited on a CaF_2 single crystalline substrate

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1. Introduction

In order to understand fundamental properties and to improve practical performances, fluxoid dynamics is one of the critical issues. However, the behavior of fluxoids in iron-based superconductor is not yet well understood. In this study, we have studied trapped fluxoids in $FeTe_{0.5}Se_{0.5}$ thin film using scanning SQUID microscopy (SSM) to clarify the fundamental local superconducting properties.

2. Experiment details

$FeTe_{0.5}Se_{0.5}$ thin film was fabricated on a CaF_2 single crystalline substrate by a pulsed laser deposition method. The film has a *c*-axis orientation and its critical temperature (T_c) is 17.4 K at 90% of the resistivity transition onset. Perpendicular component of the surface magnetic field, B_z, is measured by a pickup coil with a 10 μm diameter in the SSM system. The sample temperature was controlled from 5 K to 40 K in order to investigate the temperature dependence of trapped fluxoids.

3. Results and discussion

Fig. 1 shows scanning SQUID micrograph on $FeTe_{0.5}Se_{0.5}$ thin film surface at 5 K in the external magnetic field of 1 μT. The dotted circles show trapped fluxoids. B_z of single flux quantum is calculated by the theoretical expression[1)]. Averaging B_z over the pickup coil area, we obtained theoretical curve shown by the solid curves in Fig. 2. From fitting between measurements and the theoretical calculations, we estimated local magnetic penetration depth (λ) in a single vortex and its temperature dependence from 4.3 K, 9.1 K and 14.2 K. From these results it has been found that the penetration depth shows linear dependence on the temperature. It means that the superconducting carrier density is influenced by thermal fluctuation, and this might come from nodal gap structure of this system.

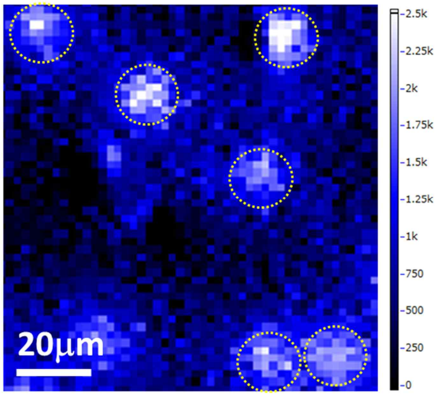

Fig.1. Scanning SQUID micrograph on $FeTe_{0.5}Se_{0.5}$ thin film surface at 5 K in 1 μT. Each white circle corresponds to a fluxoid.

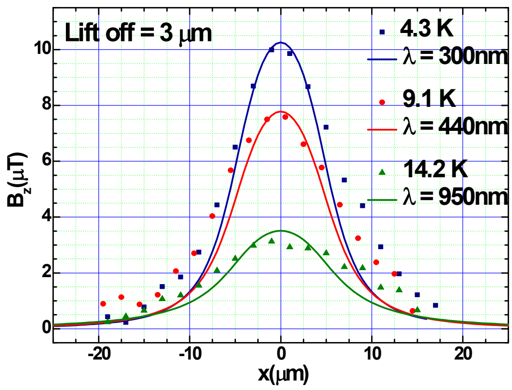

Fig.2. Temperature dependent field profile of a single fluxoid from 4.3 K, 9.1 K and 14.2 K. Solid curves are theoretical calculations with different values of λ.

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1) R.B. Dinner et al., *Rev. of Scientific Instruments*, **76** (2005) 103702.