

# Observation of vortex movement of oxide superconductors by means of the Bitter pattern technique

Shigetoshi Ohshima\* Akira Kamimura and Masanobu Kusunoki

*Yamagata University, Yonezawa 992-8510, Japan*

## Abstract

Direct observation of a vortex lattice and vortex movement is very important in discussing the Abrikosov vortex lattice, the degree of anisotropy of superconductors, interaction between the vortex and crystal defects-pinning center and so on. We have reported evidence of a vortex flux lattice for Bi2212 single crystal at high temperature, 30-65K. In these experiments, we could observe the random movements of the vortices. This movement was caused by the thermal energy. As the temperature was higher the vortex moved more actively, and the movement could be explain by the cleap model qualitatively. We also observed the vortex movements of Bi 2212 single crystal under Meissner conditions. The vortex moved into the specimen normal to the edge of the sample, and vortices in the sample moved randomly. Recently, we could observed vortex movements in a Bi2212 single crystal under application of a transport current. There was a random arrangement of vortices in the sample without transport current, and a slightly ordered movement for the sample with a small transport current. A chain-like arrangement was observed for the sample with a current of approximately  $J_C$ . The chain-like arrangement of the vortices was caused by the hopping movement of the vortices among the pin potentials. The direction of the chains is approximately normal to the

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\*E-mail: ohshima@eie.yz.yamagata-u.ac.jp

direction of the transport current. Owing to explain such vortex arrangement we must consider the weak pins, which should stand in a straight line in the sample. The pin type may be a surface pin, for example, a step-edge pin. The step edge was easily formed during cleaving by the adhesive tape, because a Bi2212 single crystal was easily cleaved in the  $ab$  plane. We could not clearly observe the step edge using SEM or AFM observation, because the surface was covered with a thick Ni film. In order to observe the step edge, the sample was etched by Ar ion, however, we could not find the step edge on it clearly. The vortex loci by Bitter technique could not be observed for the sample with transport current larger than  $1.5 J_C$ .