MLF Experimental Report	提出日 Date of Report 30 April 2010
課題番号 Project No. 2009A0053 実験課題名 Title of experiment Flux pinning induced stress and magnetostriction in bulk superconductors 実験責任者名 Name of principal investigator Kozo Osamura 所属 Affiliation Research Institute for Applied Sciences	装置責任者 Name of responsible person Stefanus Harjo 装置名 Name of Instrument/(BL No.) BL19 実施日 Date of Experiment 10 −12, November, 2009

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

YBCO ($YBa_2Cu_3O_{6+d}$) bulk with diameter of 27 mm and height of 10 mm.

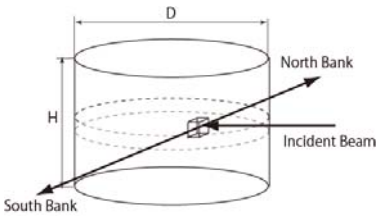

Fig. 1 YBCO bulk superconductor and the measurement condition of the present diffraction experiment.

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。)
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

As the crystal imperfection and fine second dispersions are used to be introduced during the solidification process, its mechanical strength tends to be weakened and the crystal breaks easily due to the electromagnetic force. In order to improve this brittle behavior, it is important to get information with the inhomogeneous microstructure in the bulk crystal and distributions of residual stress and remanent electromagnetic force.

Till now, it has been not possible to observe the interior of the bulk crystal by means of any nondestructive techniques.

In the present study, in order to get information with local changes of microstructure, crystal orientation and residual stress/strain, the neutron diffraction study has been carried out. By selecting the condition of incident slit, radial collimator, the gauge volume was fixed with 2x2x5 mm^3. The two dimensional mapping was carried out on the cross section of the cylindrical sample.

Fig. 2 shows the profile of two dimensional diffraction intensity on the cross section of the cylindrical sample. Here the ToF is proportional to the diffraction angle and the Pixel ID is proportional to the rotation angle. Two outer peaks correspond to the (200) and (020) of orthorhombic phase and the third inner peak is the (200)

2. 実験方法及び結果（つづき） Experimental method and results (continued)

diffraction peak of the tetragonal phase. The intensity ratio of tetragonal to orthorhombic phase was 20 % and two phase coexisted in the 40% of total area. Fig. 3 shows the distribution of residual strain on the cross section, which was evaluated from the change of lattice constant. Almost 70 % of the first quadrant was covered, which was divided into 21 areas with the gauge area of 2x2 mm^2. The observed residual strain was ranged between -0.024 and + 0.019 %, while the sensitivity of strain measurement by means of the present techniques was 0.005%. Therefore the present data were judged to be meaningful. The corresponding residual stress with 0.02% strain corresponds to 3 MPa for the YBCO crystal. Further The crystal orientation of the orthorhombic phase rotated place by place around the average axis within a few degrees.

The present experimental results are summarized as follows;

(1) The diffraction experiments were carried out at room temperature in order to detect the crystalline inhomogeneity in the YBCO bulk superconductor. The local residual strain, the scattering of crystal orientation of sub-grains and the distribution of 211 fine particles have been evaluated.

(2) We tried to detect the local magnetic strain from the cooled bulk superconductor. However it was not succeeded because of the insufficient instrumentation.

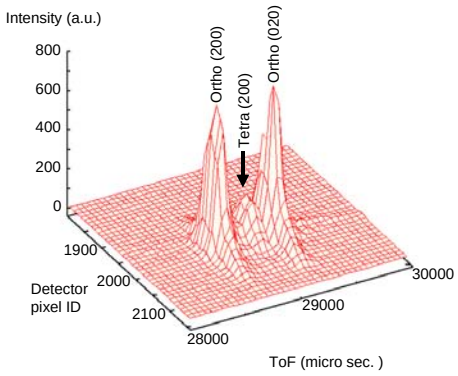

Fig. 2 Diffraction profiles from tetragonal and orthorhombic phases at the second cell from the right of bottom in Fig. 3.

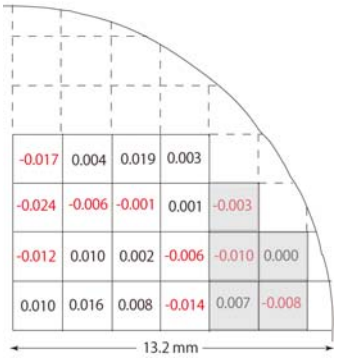

Fig. 3 Residual strains (%) observed in each cell, where the shaded area indicates the appearance of tetragonal YBCO phase.

From the present preliminary result, we suggest the possible research subjects in the successive study;

(1) It is made clear that it is possible to detect the residual magnetic strain at 77K after the magnetization, because the maximum remanent magnetic flux density was reported to reach 1 T at 77 K.

(2) The degree of the mixing of both orthorhombic and tetragonal phases can be detected place by place in order to examine the volume fraction of superconducting phase.

(3) The fluctuation of crystal orientation of the superconducting phase can be precisely investigated place by place.