MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2015A0248 実験課題名 Title of experiment Crystal structure analysis of $Fe_{1-x}Sr_2YCu_{2+x}O_{6+\delta}$ superconductor with intrinsic magnetic Josephson junction 実験責任者名 Name of principal investigator Takashi Mochiku 所属 Affiliation National Institute for Materials Science	装置責任者 Name of responsible person Toru Ishigaki 装置名 Name of Instrument/(BL No.) iMATERIA (BL20) 実施日 Date of Experiment March 16, 2016 and May 12, 2016

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.

We measured the $Fe_{1-x}Sr_2YCu_{2+x}O_{6+\delta}$ power samples (x = 0.3), which were prepared using solid-state reaction of mixture of Fe_2O_3, $SrCO_3$, Y_2O_3, and CuO powers and annealing technique. There is an anomaly of superconducting transition temperature, T_c, in the $Fe_{1-x}Sr_2YCu_{2+x}O_{6+\delta}$ system (x = 0–0.7). A drop of T_c of 25 K is observed at x = 0.3 although the compounds with x = 0 and 0.7 exhibit superconductivity at 60 K.

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.

The TOF neutron powder diffraction data of the sample were collected at 3.8, 5, 8, 13, 18, 20, 25, 25, 30, 50, 100, 200, and 300 K using the closed cycle refrigerator. The data were analyzed by the Rietveld refinement program Z-Rietveld on the basis of the tetragonal $Ba_2YCu3O_{6+\delta}$-type structure (space group *P4/mmm*), which can be derived by stacking FeO_δ, SrO, CuO_2, Y, CuO_2, and SrO layers alternately along the *c*-axis. The structural model is supported by the good fit between the observed and calculated patterns coupled with the low *R* factors (for example, R_{wp} = 7.22%, χ^2 = 4.14 for 3.8 K). The results of the refinement indicate that 45,3% Cu and 7.6% Fe was substituted for Fe on the FeO_δ layer and for Cu on the CuO_2 layer, respectively, and that the oxygen content, 6+δ, is equal to 7.308. Those results are consistent with the previous neutron diffraction study of $Fe_{1-x}Sr_2YCu_{2+x}O_{6+\delta}$ solid solution (2014B031). The site distribution of Cu and Fe and the oxygen deficiency do not influence the drop of T_c at x = 0.3. Although the lattice parameters, *a* and *c*, decrease monotonously with decrease in temperature, we have observed anomaly below T_c in the temperature dependence of the interatomic distances (Fig. 1).

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

The interatomic distances along the *c*–axis (Cu–Cu and Cu–O(2)) vary more drastically than those perpendicular to the *c*–axis (Fe–O(1) and Cu–O(3)) below T_c. Therefore, it indicates that the redistribution of the carrier between Cu and Fe is exhibited below T_c. There is a possibility that the redistribution causes the drop of T_c.

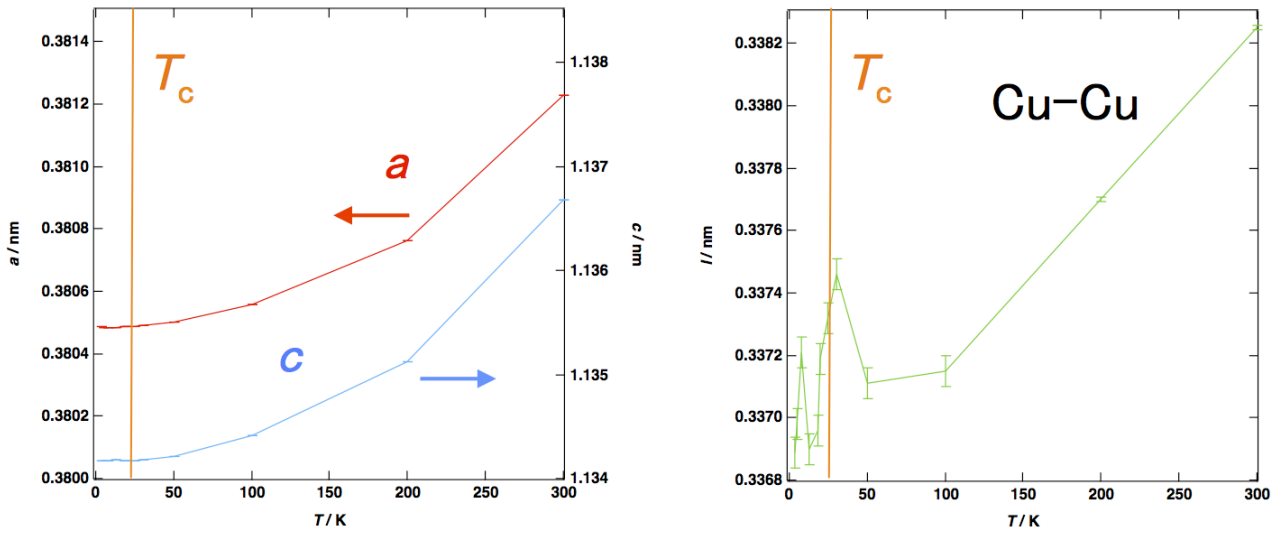

Fig. 1. Temperature dependence of lattice parameter, *a* and *c*, and interatomic distance between Cu and Cu.

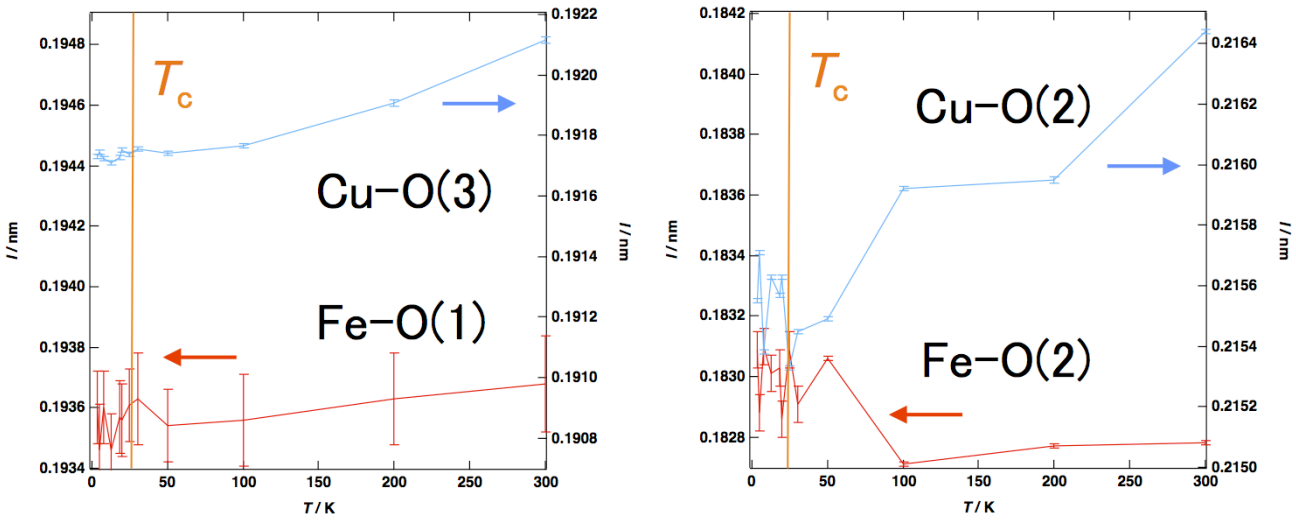

Fig. 2. Temperature dependence of interatomic distances between Fe and O(1), Cu and O(3), Fe and O(2), and Cu and O(2). We assigned O(1), O(2), and O(3) for the oxygen site on the FeO_2, SrO, and CuO_2 layers, respectively.