Temperature Dependence of X-ray Irradiation Effect in $EuBa_2Cu_3O_y$

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Introduction

Oxide superconductors show a persistent decrease in electrical resistivity when irradiated by using low-energy light sources, such as Ar laser source or halogen lamp[1-3]. This phenomenon is known as persistent photoconductivity (PPC). Only a limited number of studies of PPC has been reported for oxide superconductors irradiated with high energy X-ray, and the origin of PPC is still remains uncertain. In the previous report[4], we have shown that in oxygen-deficient $EuBa_2Cu_3O_y$ PPC is observed when 9keV X-ray is irradiated at 20K. In this paper, the temperature dependence of X-ray-induced PPC is reported.

Experimental Procedure

A thin film of oxide superconductor $EuBa_2Cu_3O_y$ was deposited on MgO substrate by dc magnetron sputtering method. It was then annealed at 520℃ in $Ar+O_2$ gas atmosphere. The annealed sample showed a semiconducting behavior and did not show superconducting transition in the temperature region of T>16K and the oxygen content was relatively small (y<6.5). The sample was irradiated at 20K, 100K and 250K with 9keV X-ray at BL27B in the Photon Factory of High Energy Accelerator Research Organization (KEK, Tsukuba). The resistivity as a function of time was measured in situ during the irradiation. The number of photons was measured by using an ion chamber.

Results and Discussion

Although the temperature was precisely kept constant, the gradual decrease in the resistivity was observed during irradiation with X-ray at 20K, 100K or 250K. Even after interrupting the irradiation, no change in the resistivity as a function of time was observed. Above result indicates that lattice defects were created by 9keV X-ray irradiation. Since X-ray does not directly transfer its energy to lattice system, the atomic displacements were attributed to the electronic excitation induced by the X-ray irradiation. As can be seen Fig. 1, correlation is found between resistivity change per unit photon density and irradiation temperature. The origin of this correlation is still uncertain, but several explanations are possible. Varying irradiation temperature may change the thermal energy which can annihilate irradiation-induced lattice defects. Another possibility is that varying temperature corresponds to changing carrier concentration, and therefore it changes the electronic excitation effect induced by X-ray irradiation.

References

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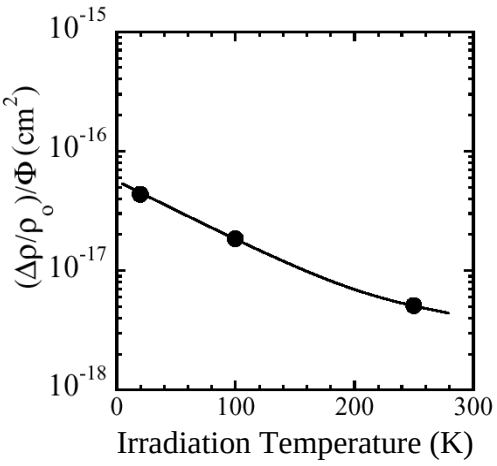

Fig.1 Resistivity change normalized by the resistivity before irradiation per unit photon density as a function of irradiation temperature.