Journal of Superconductivity: Incorporating Novel Magnetism (© 2005)
DOI: 10.1007/s10948-005-0040-z

Evidence for Irradiation Triggered Nonuniform Defects Distribution in Multiharmonic Magnetic Susceptibility of Neutron Irradiated $YBa_2Cu_3O_{7-\delta}$

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Received 15 May 2005; accepted 2 June 2005

Multiharmonic ac-magnetic susceptibility χ_1, χ_2, χ_3, of neutron irradiated Li-doped $YBa_2Cu_3O_{7-x}$ has revealed a nonmonotonic dependence of all harmonics on the neutron fluence. The irradiation has a strongly depressive influence on the intergrain connection suggesting an increase of the effective thickness of the intergranular Josephson junction at a neutron fluence of 0.98×10^{17} cm^{-2}. Less damaged are the intragrain properties. A spectacular enhancement of the superconducting intragranular properties reflected in the characteristics of all harmonics was observed at highest fluence $\Phi = 9.98 \times 10^{17}$ cm^{-2}. We assume that this effect results from the development of a space inhomogeneous distribution with alternating defectless and defect-rich regions.

KEY WORDS Neutron irradiation; radiation damage; multiharmonic susceptibility; $YBa_2Cu_3O_7$.

INTRODUCTION

Radiation effects in ceramic superconductors have applicative potential for current carrying superconducting cables as long as irradiation remains an attractive source of strong pinning and the depression of the superconducting properties is maintained at a satisfactory level.

The structure of these materials with high structural anisotropy, displaying multiple sublattices populated with ions having a large range of atomic masses (spanned from oxygen to barium), and combined with the presence of the free charge, makes them a complex challenge in the attempt to understand the connection between superconductivity and radiation damages. A sustained effort was focussed on this issue in the past decade and the data accumulated allowed a better picture of the processes concerning the superconducting state [1–8]. However, few attempts were dedicated to the creation of a reliable model regarding the evolution of the defect distribution and its influence on the superconducting properties. Except the model proposed by Kulikov *et al.* [9], which is focussed on the oxygen sublattices, we have no information concerning another one dedicated to cuprates. In the case of metallic systems, which have certain resemblance with cuprates, it was developed as a more elaborate model consisting in a coupled nonlinear equations systems [10,11]. This model not only has a uniform solution but also opens the possibility of the formation of an inhomogeneous distribution of defects which alternate with defectless regions at high neutron fluence. The latter effect can appear if the fraction of line defects exceeds a certain threshold [12]. The possibility of such space variation of the defect distribution can change the picture of a continuous suppression of the superconductivity due to neutron damages when the fluence is increased and leaves the possibility of a recovery of the superconducting properties exactly at high fluence.

In this paper, we present the results of multiharmonic magnetic susceptibility measurements on

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