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# Electron spin-lattice relaxation of $Er^{3+}$-ions in $Y_{0.99}Er_{0.01}Ba_2Cu_3O_x$

V.A. Ivanshin [a,b,*], M.R. Gafurov [a], I.N. Kurkin [a], S.P. Kurzin [a], A. Shengelaya [b], H. Keller [b], M. Gutmann [c]

[a] *MRS Laboratory, Kazan State University, 420008 Kazan, Russian Federation*
[b] *Physik-Institut der Universität Zürich-Irchel, CH-8057 Zürich, Switzerland*
[c] *Laboratory for Neutron Scattering, ETH Zürich and Paul Scherrer Institut, CH-5232 Villigen, Switzerland*

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**Abstract**

The temperature dependence of the electron spin-lattice relaxation (SLR) was studied in $Y_{0.99}Er_{0.01}Ba_2Cu_3O_x (0 \le x \le 7)$. The data derived from the electron spin resonance (ESR) and SLR measurements were compared to those from inelastic neutron scattering studies. SLR of $Er^{3+}$-ions in the temperature range from 20 K to 65 K can be explained by the resonant phonon relaxation process with the involvement of the lowest excited crystalline-electric-field electronic states of $Er^{3+}$. These results are consistent with a local phase separation effects. Possible mechanisms of the ESR line broadening at lower temperatures are discussed. 

*Keywords:* YBCO; ESR; Electron spin-lattice relaxation time, $T_1$; Crystalline-electric-field

## 1. Introduction

The measurements of nuclear- and electron spin-lattice relaxation (SLR) time $T_1$ can provide an useful information about electronic states and internal fields in high-$T_c$ superconductors (HTSC) [1–9]. The electron relaxation of different paramagnetic centers, either impurities (such as $Gd^{3+}$, $Fe^{3+}$, $Yb^{3+}$) [2–8] or belonging to the host lattice ($Cu^{2+}$) [9] was studied in the perowskite-type compounds $YBa_2Cu_3O_x$ (YBCO) $(6 \le x \le 7)$ by means of measuring relaxation times from electron spin resonance (ESR) linewidth [2–7] or directly using the relation between the ESR absorption magnitude and the response of longitudinal spin magnetization [8,9]. The physical properties of YBCO are very sensitive to the oxygen content $x$, determining the occurrence $(6.4 \le x \le 7)$ and disappearance of superconductivity for $x < 6.4$. For $6 \le x \le 6.5$ the Cu ions align antiferromagnetically, and the interplay between magnetism and superconductivity could be observed. Several reasons caused our choice of the $Er^{3+}$ ion as a paramagnetic dopant in YBCO. Values of $g$-factors of this ion are strongly determined by the symmetry of crystalline-electric-field (CEF). ESR spectrum of $Er^{3+}$ ($S_{eff} = 1/2$; $g \neq 2$) is very simple and is situated far from an unavoidable $Cu^{2+}$-impurity's

* Corresponding author. Kazan State University, MRS Laboratory, Kremlevskaya str. 18, 420008 Kazan, Russia. Tel.: +7-8432-315169; Fax: +7-8432-387418; E-mail: vladimir.ivanshi@ksu.ru

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