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Local distortions in the BiO_6-octahedra sublattice of $BaPb_xBi_{1-x}O_3$ as seen by ^{137}Ba NMR/NQR

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Abstract

The ^{137}Ba NMR and NQR spectra as well as the spin–lattice relaxation rate were measured for the first time in the $BaPb_xBi_{1-x}O_3$ samples with $x = 0.91$(normal metal), $x = 0.75$ (superconductor) and $x = 0.64$ (semiconductor). The strong quadrupole broadening of the NMR lines with lowering temperature was found for all the samples. An evolution of static distortions in the BiO_6-octahedra sublattice along with asymmetry of the electric field gradient at the Ba-sites is discussed. This asymmetry caused by the nearest non-cubic surrounding of barium is originated from the temperature dependent tilt of BiO_6-octahedra. Spin–lattice relaxation rate of ^{137}Ba is monitored by fluctuating part of electric field gradient at the Ba-site and its exponential growth at low temperatures evidences the thermally activated collective rotations of BiO_6-octahedra around their static tilt. An activation energy and a strength of these dynamic distortions are evaluated and found to increase in going from metallic to semiconducting phase of $BaPb_xBi_{1-x}O_3$.

Keywords: Nuclear magnetic resonance (NMR); Nuclear quadrupolar resonance (NQR); $BaPb_xBi_{1-x}O_3$; BiO_6-octahedra tilting

1. Introduction

A general feature of superconducting metallooxide phase diagrams is the appearance of superconductivity just near metal–insulator transition (MIT) which depends on the carrier concentration in the conduction band. For high-T_c cuprates an insulating phase is antiferromagnetic semiconductor and the resulting new electronic state is a mixed state of antiferromagnetically correlated spins and hole carriers. This circumstance gives rise to various theoretical proposals for nontraditional spin-dependent models of Cooper pairing. A low density of states (DOS) at the Fermi level in metallic phase of bismutate $BaPb_xBi_{1-x}O_3$ (BPBO) makes the usual electron–phonon interaction questionable as to be responsible for superconductivity in these oxides [1].

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