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Mechanisms of heat carriers scattering in $La_{1-x}Sr_xMnO_3$ single crystals near the phase transition temperature

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Abstract

We measured the specific heat (C_P), the thermal diffusion (η) and thermal conductivity (κ) of single crystals $La_{1-x}Sr_xMnO_3$ (x=0, 0.175, and 0.20), depending on the temperature and magnetic field. It is shown that in the behavior of κ(T) and η(T) near T_C the lows are observed due to phonons scattering by the fluctuations of the magnetic (and the structural) order parameter. The magnetic field suppresses fluctuations, increases thermal conductivity and shifts the critical temperature towards high T. In the behavior of κ(T) and η(T) around T_S=200 K for the composition with x=0.175 the are anomalies observed associated with a structural transition from the rhombohedral (R) to the orthorhombic (O*) phase. The anomaly observed in the κ(T) dependence in antiferromagnet $LaMnO_3$ near T_N is associated with the presence of the magnetic contribution to thermal conductivity.

Introduction

Considered established that the main heat-transfer mechanism in perovskite manganites is a phonon one, and lattice defects are viewed as the dominant mechanism of phonon scattering. It is known that the thermal conductivity value is low, slightly higher than the minimum theoretical value of lattice thermal conductivity. At the same time, specific questions related to the peculiarities of phonon scattering at temperatures of various kinds of orderings (magnetic, charge, structural) are not fully understood.

The study of magnetic field influence on phonon component of the thermal conductivity of manganites deserves high attention. It is believed that the magnetic field has no effect on the phonon thermal conductivity of a solid body, changing only the electronic component. But this is not true in respect to manganites as phonon component may also depend on the magnetic field, not directly, but mediately, by changing the phonon scattering mechanism, which leads to increase or decrease of thermal conductivity.

Compounds $La_{1-x}Sr_xMnO_3$ is the most studied of the manganite family. Its magnetic and structural phase diagrams, electrical, magnetic and elastic properties have been well studied (see. eg, [1-6] and references therein), while at the same time, information about the thermal properties (thermal conductivity, specific heat, thermal diffusion) and the impact on them of the magnetic field are not fully reflected in the literature. This work is an attempt to somewhat fill this gap and is dedicated to the study of heat transfer characteristics in single crystals of La_{1-}