

LOW-DIMENSIONAL EFFECTS AND LATTICE DYNAMICS IN ANISOTROPIC CUPRATE HTS

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Investigation of lattice dynamics plays an essential role in understanding the peculiarities of phonon subsystem and electron-phonon interaction in anisotropic cuprate high-temperature superconductors (HTS).

In the present paper the theoretical model accounting for the main features of phonon spectrum (the presence of high-frequent lattice vibrations, phonon modes dispersion and characteristic lattice dimensionality) is proposed. It is based on the minimum number of initial parameters, which are taken directly from the experiment, and allows to calculate unambiguously the complete set of thermodynamic characteristics of cuprate HTS. The analytical expressions for the phonon density of states (PDOS) are derived and PDOS dependence on the characteristic lattice dimensionality is analyzed for YBCO HTS.

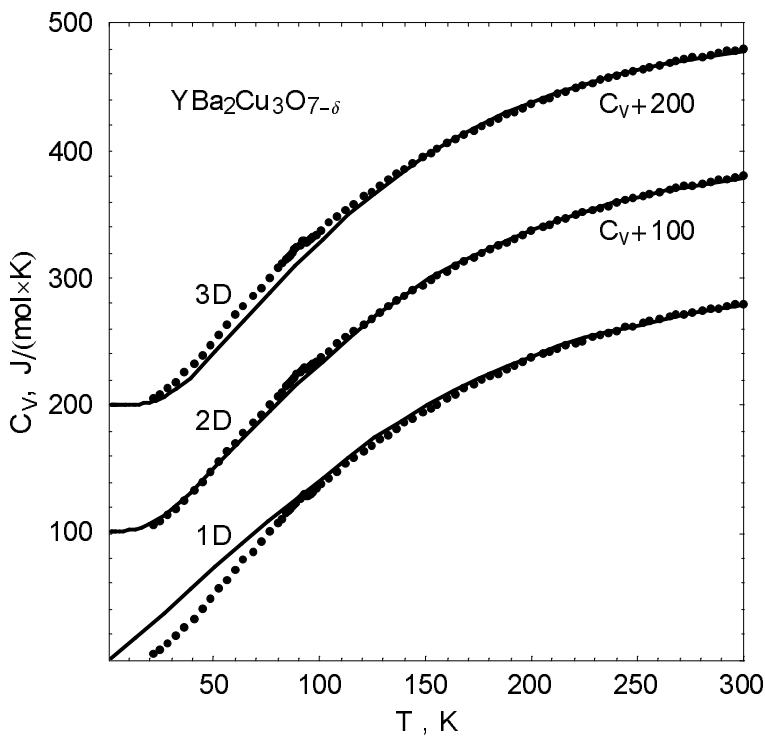


Fig.1 Calculated phonon heat capacity for different values of lattice dimensionality (curves) and experimental data (points) [1] for $YBa_2Cu_3O_{7-\delta}$ HTS ($\delta = 0.1$, $T_c = 92$ K)

The numerical calculations of the lattice heat capacity for $YBa_2Cu_3O_{7-\delta}$ HTS, accomplished within the framework of the approach proposed, are presented in Fig.1 along with the experimental data [1]. As it follows from Fig.1, the phonon heat capacity is sensitive to the variation of the characteristic lattice dimensionality in low and intermediate temperature regions and the best agreement with experiment is achieved for the two-dimensional (2D) lattice structure. In this case heat capacity is determined mainly by the planar longitudinal and transverse (buckling) vibrations of $Cu - O$ layers in bulk HTS. Such a result correlates with the low-dimensional character of the carrier subsystem [2,3] and seems to be useful for adequate reconstruction of the phonon spectrum and calculation of the electron-phonon coupling parameters in cuprate HTS.

1. W.Schnelle, E.Braun, H.Broicher et al., *Physica C* **168** (1990) 465.
2. V.Z.Kresin, S.A.Wolf, *Phys. Rev. B* **41** (1990) 4278.
3. C.W.Chu, *Journal of Superconductivity* **12** (1999) 85.