INFRARED ABSORPTION AND FAR-INFRARED DIFFUSE REFLECTION SPECTRA IN Pb-DOPED Bi-Sr-Ca-Cu-O HIGH-TEMPERATURE SUPERCONDUCTOR

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ABSTRACT

In this paper we study the room-temperature infrared transmission spectra (400-1600 cm⁻¹) and far-infrared diffuse reflection spectra (50-450 cm⁻¹) in Pb-doped Bi-Sr-Ca-Cu-O (2223) single phase (Tc=107k, sp1), multiphase (Tc=110k, sp2) and nonsuperconducting samples (sp3). The spectral features in superconductor are totally different from those in nonsuperconductor, which show the different crystal structure. The correlation existing between a factor group analysis of the phonons in (2223) and (2212) compounds affords a tentative assignment of ir-active modes in Pb-doped (2223) single phase by comparison with reported data in (2212) materials. The Cu-O stretching E_u vibration (605 cm⁻¹) of CuO₂ layers is the characteristic vibrational mode related perovskitelike crystal structures. Two phonon coupling effect emerges in the infrared transmission spectra in Pb-doped superconductor. The Ca-O vibration A_{2u}(254 cm⁻¹) might be related to superconductivity of Bi-based family.
1. INTRODUCTION

The discovery of superconductivity at temperatures above 100k in Pb-doped Bi-Sr-Ca-Cu-O systems has further stimulated the efforts to identify the relevant superconductivity mechanisms involved. The Bi-based system forms a new class of structure containing more than just corner-sharing Cu-O polyhedra and non one-dimensional Cu-O chain. The structure difference must result in some different behavior when approaching the superconducting transition. The superconductivity of this kind of substances also might come from some non-phonon mechanisms as in the case of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$. However, the mechanism of high $T_c$ superconductivity in the latter is still not yet settled at present. Therefore, the information of the phonon aspect may be very useful, because even if the non-phonon mechanism is eventually found to play the most important role in superconductivity we must make clear why the electron-phonon interaction is not so effective in the high $T_c$ superconductivity in oxides, in spite of having some advantages in symmetry properties associated with Cu-O bond. Furthermore, for optical studies such as Raman scattering and infrared absorption experiments on phonon properties, the present study must be quite useful in interpreting the mechanism of superconductivity. Up to now, great efforts have been made to Raman spectra and infrared spectra of $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_8$ (labeled 2212) phase while little on Pb-doped $\text{Bi}_2-x\text{Pb}_x\text{Sr}_2\text{Ca}_x\text{Cu}_2\text{O}_{8-y}$ (labeled 2223) phase. We know that the substitution of Pb for Bi make $T_c$ to increase from 80k to 110k, and the substitution must affect the structure of Bi-based family. In this paper we report the infrared transmission spectra (400-1600 cm$^{-1}$), far-infrared diffuse reflection spectra (50-450 cm$^{-1}$) in Bi-based family.