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ESR AND X-RAY ANALYSIS OF SUPERCONDUCTING TRANSITIONS IN $c \approx 31$ AND $c \approx 37\AA$ BSCCO SYSTEMS

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Abstract: The effect of starting composition on the formation and superconductivity of the two crystallographic phases characterized by $c \approx 31\AA$ and $c \approx 37\AA$ in pure and Pb-doped $Bi-Sr-Ca-Cu-O$ systems has been examined by x-ray diffraction and field-modulated microwave absorption techniques.

1. Introduction

The complex behaviour of the superconducting transition in the $Bi-Sr-Ca-Cu-O$ system has been attributed to the existence of two phases with $T_c \sim 110K$ and $T_c \sim 80K$ respectively. The lower-T_c phase was identified as $Bi_2Sr_2CaCu_2O_z$ (2212) and shows a layered structure with $c \approx 31\AA$. In analogy with the Tl-based compounds, the higher-T_c phase has been assumed to have a composition $Bi_2Sr_2Ca_2Cu_3O_z$ (2223), with $c \approx 37\AA$. We have studied the superconducting properties of several pure and Pb-doped compounds, which are representative of the two crystallographic phases, by x-ray diffraction and field-modulated microwave absorption.

2. Results and Discussion

The examined samples are:

(a)	$Bi_2Sr_2CaCu_2O_z$;	(d,e)	$Bi_2Pb_{0.4}Sr_{2.2}Ca_{2.2}Cu_{3.3}O_z$;
(b)	$Bi_2Sr_2Ca_2Cu_3O_z$;	(f)	$Bi_2Pb_{0.4}Sr_2Ca_3Cu_4O_z$;
(c)	$Bi_2Sr_2Ca_3Cu_4O_z$;	(g)	$Bi_2Pb_{0.4}Sr_2Ca_4Cu_5O_z$.

Samples **d** and **e** have the same nominal composition but were subjected to different thermal treatment. The x-ray powder diffraction pattern show that samples **a-d** have the $c \approx 31\AA$ structure and **f-g** the $c \approx 37\AA$ one. Sample **e** shows predominantly the c-longer phase peaks, but appreciable $c \approx 31\AA$ contribution is still present. We have recorded the low-field non-resonant microwave absorption, which characterizes the new high-T_c materials in the superconducting phase [1]. The details of X-band ESR measurements are reported in [2]. In Figs. 1 and 2 the absorption profiles vs temperature are shown for **a-c** and **d-g** respectively. In a temperature-sweep mode a peak in the derivative absorption is expected at T_c [3]. It appears (Fig. 1) that samples with $c \approx 31\AA$ are characterized by a complex superconductive transition in the $75-110K$ temperature range. By increasing the Ca and Cu content, the relative importance of the $110K$ absorption region increases

correspondingly. However, the absence of a sharp peak indicates a possible wide distribution of transition temperatures. It must be noticed that, in spite of the significant increase of the higher-T_c absorption in Fig. 1, the x-ray diffraction patterns don't show any appreciable trace of the $c \approx 37\AA$ phase.

As regards the Pb containing samples, those showing the $c \approx 37\AA$ structure are characterized by a single transition at $T \sim 105K$ (Fig. 2) more pronounced for higher nominal Cu content. The case of sample **e** is indicative of superposition of spectra in line with the mixed structure shown by the x-ray data. The influence of the thermal treatment is illustrated by the behaviour of sample **d** that, by annealing, is progressively transformed into the c-longer compound **e**, as evidenced by the appearance of the characteristic peak.

In the $c \approx 31\AA$ samples, the $110K$ transition was frequently attributed to intergrowths of the $c \approx 37\AA$ phase. This explanation seems us somewhat doubtful. In fact, apart from the lack of a specific x-ray indication in this sense, the ESR spectra show systematic differences between the two c possibilities in the superconductive onset and in the absorption profile. Moreover, in sample **c** (Fig. 1) an important contribution of higher-T_c transition is found, without any x-ray evidence of the $c \approx 37\AA$ phase. A different explanation may be related to electronic structure modification induced by Ca, Sr or Cu substitution for Bi, which could influence the transition temperature.

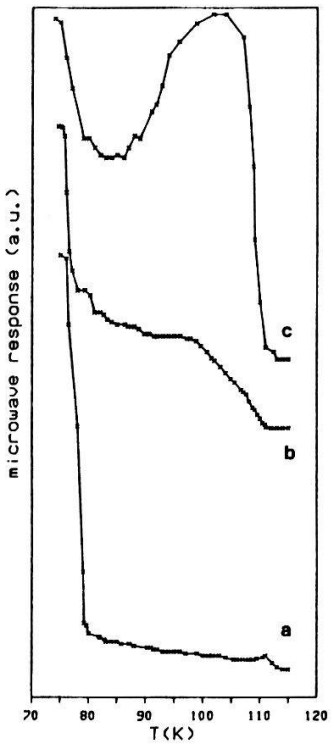

Fig. 1

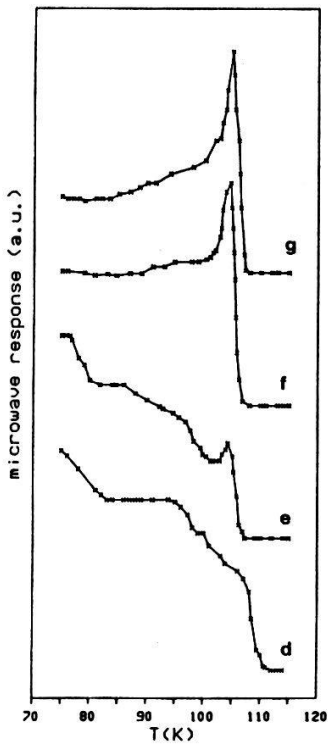

Fig. 2

3. References

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