Physica C 235-240 (1994) 1611-1612
North-Holland

PHYSICA C

Mössbauer Studies on Magnetic and Electrical Properties of $La_{1.85}Sr_{0.15}Cu_{0.99}Fe_{0.01}O_{4-\delta}$

V Marquina[a], S Aburto[a], M. L. Marquina[a], R Gómez[a], M. Jiménez[a], R Ridaura[b], R. Escudero[b] and F Morales[b].

[a] Facultad de Ciencias, UNAM 04510 México D F., México

[b]Instituto de Investigaciones en Materiales, UNAM. 04510 México D. F , México

The local magnetic and electric fields in the Cu-O planes of Fe doped and Sr- doped $La_2Cu_1O_4$ superconductor can be sensed ,using Mössbauer spectroscopy, if a small fraction of the Cu atoms is substituted for Fe atoms In this work we report the results of such substitution in the superconducting $La_{1.85}Sr_{0.15}Cu_{0.99}Fe_{0.01}O_{4-\delta}$ system Mössbauer spectra were obtained at different temperatures ranging from 13 to 300 K The observed spectra consist of two quadrupole doublets, associates with two inequivalent sites One site may be associate with a narrow range of x centered at x = 0 15 and the other site with x = 0

Mössbauer spectroscopy may be used as an experimental probe sensitive to both local magnetism and local electrical properties of the systems analyzed. The substitution of a small fraction of Cu atoms by Fe atoms allows to study the local surrounding in the Cu sites of $La_{2-x}Sr_xCu_1O_{4-\delta}$ system D R Harshman et al.[1] and H Takagi et al.[2], claimed they have demonstrated that bulk superconductivity exists only in a narrow range of x while, for x outside this range, the materials are electronically inhomogeneous Indeed superconductivity and magnetism may coexist in some samples, but not in the same microscopic region of the material; their coexistence is indicative only of electronic inhomogeneities In this work, we report the existence of two sites where the Fe atoms substitute the Cu atoms in the structure One site may be associate with a narrow range of x centered at x = 0 15 and the other site with x = 0

The sample was prepared from the component oxides of high purity by the usual solid state reaction, the iron oxide used was 73% ^{57}Fe enriched Fe_2O_3 The obtained pellet was kept for 60 days at 1020 C in air, an then slowly cooled to room temperature

Within of limitation of X-rays technique employed, the diffractogram presents only pure phases The measurements of resistance vs temperature and magnetization vs temperature show that the sample

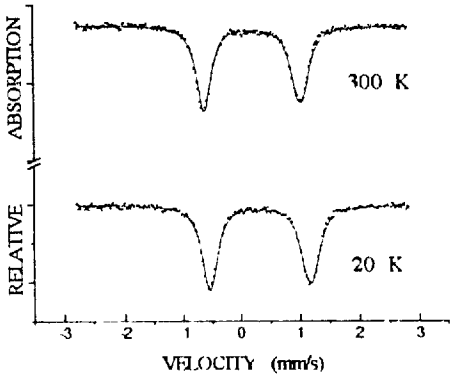

Figure 1 Mossbauer spectra at 300K and 20 K

is superconductor at Tc = 16 k

The Mossbauer sample was prepared by grinding a small piece of the pellet and placing the resulting powder into the sample holder of a closed cycle helium refrigerator. All spectra were obtained in transmission geometry with a constant acceleration spectrometer Mossbauer spectra of a $La_{1.85}Sr_{0.15}Cu_{0.99}Fe_{0.01}O_{4-\delta}$ were obtained at different temperature ranging from 13 to 300 K The fitting of the spectra was done with a least squares restricted program, maintaing fixed the line widths

This work was partially supported by CONACYT, México, and by DGAPA, UNAM, Mexico projects IJN104392 and IN102693

SSDI 0921-4534(94)01372-1

All the spectra present an asymmetric quadrupole doublet (see Fig. 1) that can be understood assuming two superimposed doublets. These results are indicatives of two sites with similar neighborhood (QS) but different chemical environment (I.S.), see Fig. 2. The isomer shift and the quadrupole splitting values correspond to low-spin Fe atoms, which implies a strong local electric field, or strong bonding between atoms. The Mössbauer parameters also exhibit a variation in their values at 250 K

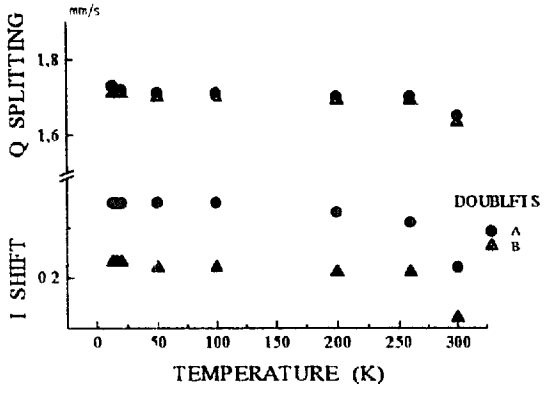

Figure 2 Quadrupole Splitting and Isomer Shift vs Temperature for the two doublets

Magnetization measurement also show a structural change at 250 K, consistent with the Mossbauer results These data were obtained by cooling in an applied field of 100 G (Meissner) and by zero field cooled (shielding), see Fig 3.

In conclusion, the Mössbauer data show the existence of two doublets . This two doublets can be associated with two sites where the Fe atoms enter in the structure and correspond to

$$La_{1.85}Sr_{0.15}Cu_{0.99}Fe_{0.01}O_{4-\delta}$$

and $$La_2Cu_{0.99}Fe_{0.01}O_{4-\delta}$$

compatible with previous results [1,2]

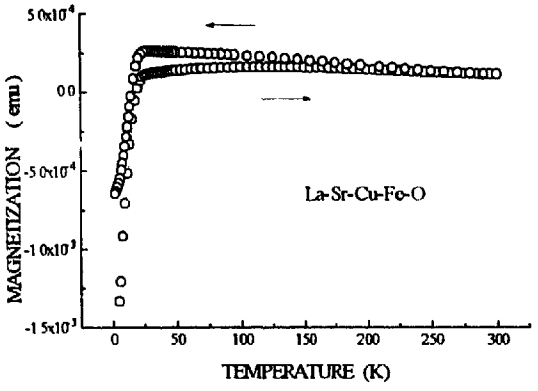

Figure 3. Magnetization vs Temperature

Reference

1. D.R. Harshman et al Phys Rev. Lett.,63, 1187 (1989)
2 H Takagi et al , Phys Rev Lett , 68, 3777 (1992)

We acknowledge the help of Carlos Munive in the presentation of this paper