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XAFS studies of the local lattice structure in $La_{1.85-2x}Sr_{0.15+2x}Cu_{1-x}Mn_xO_4$ system

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Introduction

In recent years there has been a growing interest in the possibility that the metallic phase of cuprate superconductors has an instability towards microscopically charge and spin inhomogeneities. It is also found that some kind of local lattice instability may play an important role on the superconductivity. X-ray absorption fine structure provides information on local structure, i.e., the radial distribution and the electron states around a particular atomic site. The superior capabilities of EXAFS as a local structural probe are fully exhibited in the studies of dilute, impurity-doped systems, in particular, those with short range order/disorder. In this repoet, EXAFS is used to determine the local lattice structure around Cu atoms in Mn-doped $La_{1.85}Sr_{0.15}CuO_4$ superconductor. We find that the local lattice instability plays an important role in the occurrence of superconductivity.

Experimental

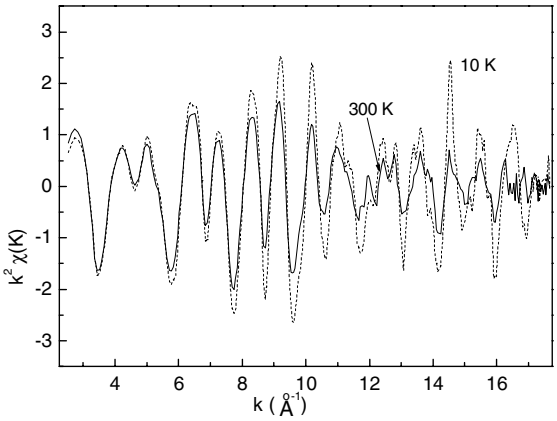

Fig. 1 Representative example of the EXAFS oscillation at Cu K edge as a function of photon wavenumber.

All XAS measurements were performed in a fluorescence detection mode at BL-13B1, Photon Factory. A novel Ge pixel array detector (PAD) with 100 segments was used in order to gain high throughput and energy resolution and as a result, high signal-to-noise Mn K-edge x-ray absorption spectroscopies for dilute Mn doped samples are achieved. Samples are mounted on an Aluminum holder and attached to a closed-cycle helium refrigerator. The holder rotates on a high precision goniometer (Huber 420) to change the incidence angle.

Results and Discussion

Figure 1 shows the Cu K-edge EXAFS oscillation functions for a typical LSCO superconductor. A very good statistic is achieved both at high temperature and at low temperature.

Figure 2 (a) and (b) give the Fourier transform spectra of LSCO with Mn doping at x=0 and x=0.15, respectively. The first-shell Cu-O bond is analyzed and the temperature dependence of mean-square relative displacement is shown in Figure 2(c). The results are discussed in terms of electron-phonon interaction.[1,2] And the effects of local lattice distortion on high temperature superconductivity is discussed.

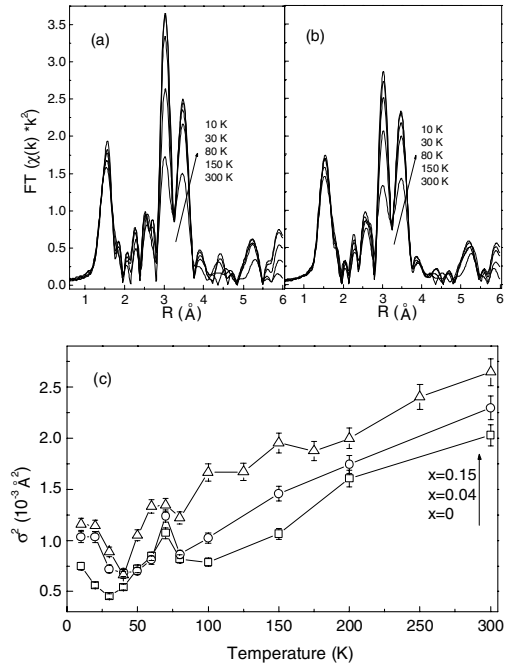

Fig.2 Fourier transform spectra of $La_{1.875-2x}Sr_{0.125+2x}Cu_{1-x}Mn_xO_4$ with (a) x=0 and (b) x=0.15. (c) The temperature dependence of Debye-Waller factors for Mn-doped samples.

References

[1] C. J. Zhang, H. Oyanagi, B. H. Kim, Y. W. Park, and Y. H. Zhang, *Phys. Rev. B* 75, 174504 (2007).
[2] C. J. Zhang, H. Oyanagi, *J. Phys: Conf. Series* 108, 012038 (2008).

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