# Local lattice distortions in stripe ordered $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$ system

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## Introduction

Interplay of local lattice distortions and charge stripe ordering in doped perovskites is one of the object of recent studies. We have exploited polarized Cu K-edge extended x-ray absorption fine structure (EXAFS) to address this issue and investigated local lattice displacements in the model charge ordered cuprate, $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$ (LNSC).We find that Debye-Waller factor of the Cu-O, measuring local lattice fluctuations, shows an abrupt increase, the order parameter like change, across the charge–stripe order temperature. The results provide a direct evidence for the local lattice fluctuations to be a response function of the charge stripe order parameter in the cuprate superconductors.

The spectra were recorded by detecting the fluorescence yield (FY) using a 19-element Ge x-ray detector array, covering a large solid angle of the x-ray fluorescence emission. The emphasis was given to measure the spectra with a high signal to noise ratio upto a high momentum transfer.

## Results and Discussion

The Fourier transforms (FT) of the EXAFS spectra (multiplied by $k^2$) recorded in the in-plane geometry of the LNSC at some representative temperatures, below the charge stripe ordering ($T<T_{so}$) and above it ($T>T_{so}$) are shown in Fig. 1. The main peaks are shown enlarged as inset and denoted by Cu-O, Cu-La(Nd, Sr) and Cu-O-Cu representing respectively the scattering of the ejected photoelectron at the Cu site with the in-plane oxygen atoms (at ~1.88 Å), La (Nd,Sr) atoms (sitting at ~3.2Å and 45° from the direction of the photoelectron) and a direct multiple scattering with the next Cu atom (at ~ 3.8Å), across the in-plane oxygen.

Temperature dependence of the Debye-Waller factor of the Cu-O pairs, $\sigma^2_{CuO}$, that takes into account both static and dynamic distortions of the $CuO_2$ plane has been determined by the analysis of the Cu-O EXAFS and shown in Fig. 2. The $\sigma^2_{CuO}$ shows an anomalous upturn at ~60K where the charge stripe ordering is known to occur as shown by several experimental techniques. Indeed appearance of any charge density wave like instability gives an anomalous change in the Debye-Waller factor, known from studies of density wave systems.

In summary, we have used polarized Cu K-edge EXAFS spectroscopy to explore local lattice fluctuations associated charge stripe ordering in the cuprates with $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$ (LNSC) as a model system. We find an order parameter like change in the instantaneous local lattice fluctuations across the charge stripe ordering temperature, revealed by an anomalous increase in the correlated Debye Waller factor of the Cu-O pairs. The anomalous change, associated with appearance of a dynamic rhombic distortion of the $CuO_2$ plane, could be considered as a response function of the charge stripe ordering in the cuprates. Detailed analysis indicates that the contribution of dynamic local lattice displacements to the charge stripe ordering is vital for the system to be superconducting. The results are to be published [1].

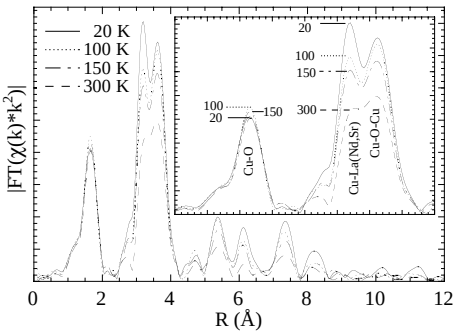


Fig.1 FT of the EXAFS spectra at several temperatures.

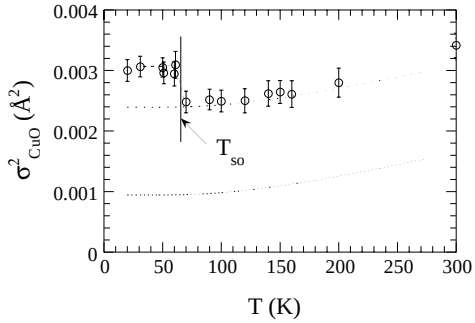


Fig.2 Temperature dependence of the correlated Debye-Waller factors (symbols) of the Cu-O pairs ($\sigma^2_{CuO}$).

## References

[1] N.L. Saini et al., Phys. Rev. B, (in press, 2001).

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