	Experiment title:	Experiment number:
ESRF	EXAFS Study of the underdoped-overdoped transition in the single-layer superconducting cuprate $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$	**HE 1525**
Beamline: **BM 29**	Date of experiment: from: 10-July 2003 to: 15-July 2003	**Date of report:** **28-Aug.-2003**
Shifts: **12**	Local contact(s): Dr. Pier Lorenzo Solari	***Received at ESRF:***

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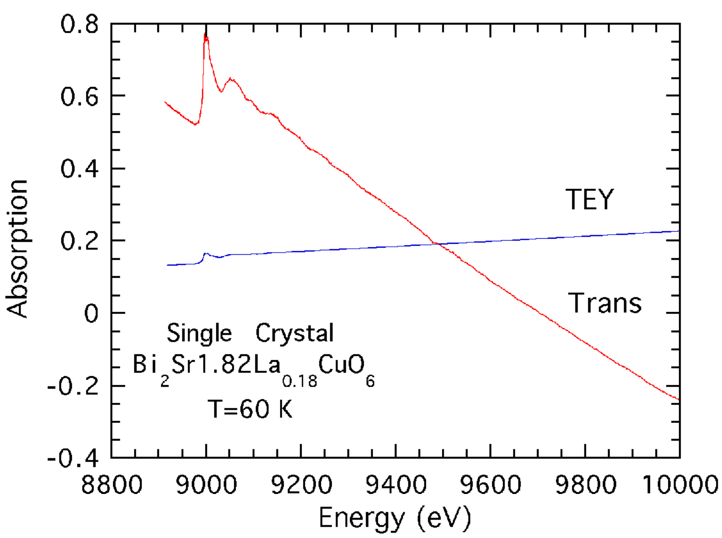
Report: We have measured the doping (x=0-0.52) and some temperature dependencies (60-290 K) of the atomic CuO_2 structure in the superconducting 1-layer cuprate $Bi_2Sr_{2-x}La_x$-$CuO_{6+\delta}$, (T_{cmax} = 28 K) using polarized Cu K-EXAFS with **E**||ab. The single crystals had dimensions of typically 4x2 mm^2 and were simultaneously measured in the transmission and the total electron yield (TEY) modes. The TEY was detected by the ionization current created in the He exchange gas of the cryostat. Usefull transmission spectra could be only obtained from some sufficiently thin platelets yielding an absorption contrast of $\Delta\mu d \cong 0.15$



But TEY spectra with an usefull k-range $\geq$ 14 Å^{-1} were obtained from all investigated crystals. In general the quality of the TEY spectra turned out superior to the transmission spectra, mainly due to the absence of Bragg-reflections from the single crystalline samples. Comparison of high quality transmission data with their corresponding TEY data confirmed that the total electron yield probes the bulk in the range of the Cu K - edge. The probing depth is ≥ 0.3 μm. Hence the

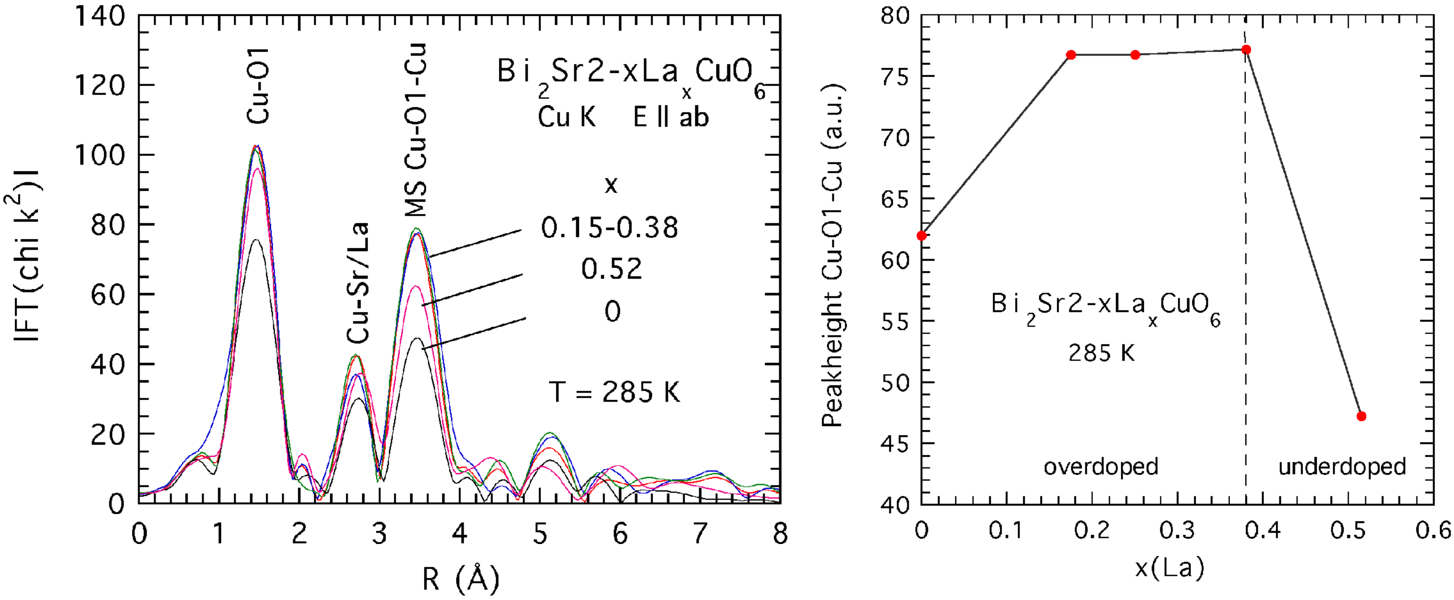


Fig. 1 *Left*: Fouriertransform spectra of the Cu *K* - EXAFS (k =2.3 - 12 Å^{-1}) of $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$ single crystals measured in the TEY mode. The AUTOBK code together with a theoretical reference spectrum was used for background removal and normalization. *Right*: Peakheight of the multiple scattering (MS) RDF Cu - O1- Cu as a function of doping. The plateau between x(La)=0.38 (optimum doping) and x=0.18 in the overdoped regime points to a relative minimum of structurual deformations (or relatively flat) metallic CuO_2 planes in this doping range. The underdoped crystal (x=0.52) exhibits strong disorder in both the *nn* Cu-O1, and the Cu-Cu shells.

TEY mode turns out experimentalist's first choice for high energy absorption studies of mm sized single crystals; due to its simplicity and high countrates the TEY mode is also superior to the fluorescence mode.

The peakheight of the planar *nnn* Cu-Cu RDF (Fig. 1) is strongly affected by the forward scattering geometry through O1. Thus it is a direct measure of the structural disorder in the planes. The planar disorder is increased in the La-free overdoped crystal (T_c/T_{cmax} = 0.27), and strongly enhanced at the onset of the underdoped regime (x=0.52, T_c/T_{cmax} = 0.89). The latter points to the expected structural transformation in the CuO_2 plane at the underdoped - overdoped phase border line, similar to the recent findings in $YBa_2Cu_3O_7$ [1] and $HgBa_2CuO_6$ [2]. A detailed and quantitative analysis of this transition in $Bi_2Sr_{2-x}La_xCuO_{6+\delta}$ deserves however additional experimental shifts allowing to focus on more concentrations in underdoped regime, and around optimum doping.

The preliminary analysis of the temperature dependent scans (60-280 K) shows interesting step-like intensity variations of *nnn* Cu-Cu RDF between 130 and 180 K, possibly connected with the pseudogap phenomenon.

Literature:

[1] E. Kaldis, J. Röhler, E. Liarokapis, K. Conder, Phys. Rev. Lett. 79, 4894 (1997).

[2] J.D. Jorgensen, O. Chmaissem, J.L. Wagner, W.R. Jensen, B. Dabrowski, D.G. Hinks, J.F. Mitchell, Physica C282-287, 977 (1997).