ESRF	**Experiment title:** Stufy of effect of isotope substitution on local lattice of high T_c superconductors by XANES and EXAFS	**Experiment number:** HS-1071
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Report:

The aim of proposed work was to explore role of the lattice fluctuations in charge-stripe ordering in the high T_c superconductors. For the purpose our approach has been to study effect of oxygen isotope substitution on the local lattice of the CuO_2 plane by Cu K-edge x-ray absorption spectroscopy. The study is motivated by the fact that if the lattice excitations are coupled to the charge carriers, the isotope mass should influence the local lattice displacements. This time we had focussed our attention to an underdoped $La_{2-x}Sr_xCuO_4$ compound (x=0.06) showing largest oxygen isotope effects on both superconducting transition temperature and the effective supercarrier mass. The allotted beamtime was used to measure high resolution x-ray absorption near edge structure (XANES), to investigate the instantaneous lattice displacements and explore the effect of the isotope substitution on these lattice displacements. The attention was paid to obtain the high resolution data with high signal to noise ratio in order to uncover small changes in the local displacements due to the oxygen isotope substitution in the system.

Cu K-edge absorption measurement were performed on well characterized powder samples (T_c~10K) of $La_{1.94}Sr_{0.06}CuO_4$ with ^{16}O and ^{18}O showing an isotope shift ΔT_c~1K. The high resolution fluorescence yield (FY) measurements were made at the beamline BM29 using Si(311) double crystal monochromator. The Cu Kα fluorescence yield was collected using multi-element Ge element X-ray detector array.

The effect of isotope substitution on the distribution of local Cu site can be seen in Fig. 1, where we report the XANES spectra and difference between the two spectra of the two isotopes at 200 K. There is a large variation of the XANES spectrum due to isotope substitution, of the order of 2% of the normalised absorption. These changes are clearly related with the effect of changing the oxygen mass on polaronic lattice fluctuations involving the tilting of apical oxygens (out of plane) and rhombic distortion of the Cu-O square planes.

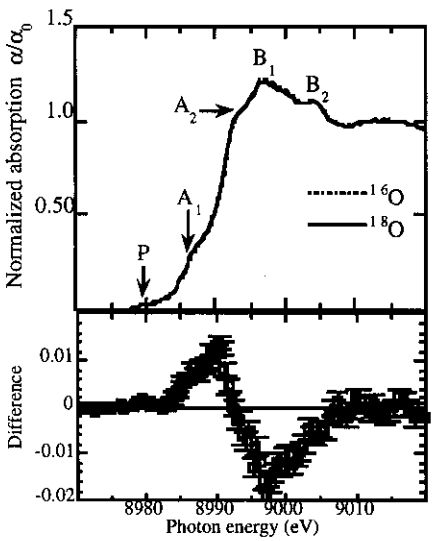

Fig. 1: Cu K-edge X-ray absorption near edge structure (XANES) of $La_{1.94}Sr_{0.06}CuO_4$ for the ^{16}O and ^{18}O isotope samples (upper) and their difference (lower) at 200K. The $^{16}O \rightarrow ^{18}O$ isotope effect on the Cu site structure fluctuations induces a decrease of the peak B_1 with an increase of A_1.

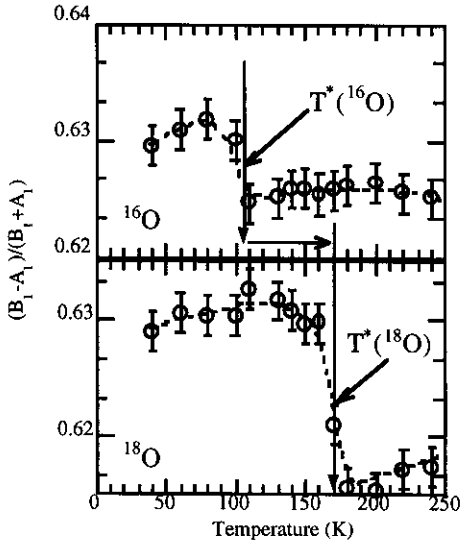

Fig. 2: Temperature evolution of the intensity ratio $R=(B_1-A_1)/(B_1+A_1)$ for the ^{16}O (upper) and ^{18}O (lower) samples. There is an upturn of the R at a characteristic temperature T^* ~110(±10)K for the ^{16}O sample, and ~170 (±10)K for the ^{18}O sample giving a large oxygen isotope shift of ~60 K.

To explore the temperature dependence we taken the intensity ratio $R=(B_1-A_1)/(B_1+A_1)$ as a conformational parameter (Fig. 2). The ratio has been shown to be a useful parameter to explore charge stripe ordering in the high T_c superconductors. Indeed, by decreasing the temperature the ratio R shows an increase at T^* where the local lattice fluctuations slow down at the temperature for the polaron ordering in lattice-charge stripes. The crossover temperature T^* increases by about 60 K upon replacing ^{16}O with ^{18}O (Fig. 2). This result indicates that the isotope substitution leads to a large change in the polaronic lattice fluctuations. It should be mentioned that it is the first study focussing on the effect of isotope substitution on the local lattice uncovered by X-ray absorption spectroscopy.

In summary, we have studied isotope effect on the charge stripe ordering in the CuO_2 plane of by high resolution X-ray absorption spectroscopy measured with high signal to noise ratio. The large oxygen isotope shift suggests that electron-phonon interaction plays an important role in the charge stripe ordering in the cuprates. The present experiment places important constraints on the microscopic mechanism of charge stripe ordering and the high-temperature superconductivity. Further studies at different doping are required.