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Local structure changes in HgBa2CuO4+y as a function of pressure from ambient to 12 GPa correlated with Tc increase from 64 to 84 K by Cu K-edge XANES in dispersive mode

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While it is known that lattice complexity due to disorder and strain induces exceptional electronic and magnetic functionality in transition metal oxides its role on the emergence of high temperature superconductivity has been not accurately considered in the past 25 years. Recently strong evidence has been reported using advanced experimental methods that the local lattice structure and charge fluctuations in cuprates exhibit complex fractal pattern [1-4]. Therefore these particular materials require novel experimental approaches. While x-ray diffraction or neutron diffraction provide non-local and space averaged information, X-ray absorption spectroscopy (XANES and EXAFS) is the ideal probe to provide local structure [5-10].

We have measured the Cu K-edge XANES of single crystals $HgBa_2CuO_{4+y}$ as a function of pressure from ambient pressure to 20 GPa using the energy dispersive XAS spectrometer at the beam line ID24. We have collected X-ray absorption spectra in transmission mode at Cu K-edge using a DAC with nano-crystalline diamond (ND) anvils. We have first used different pression transmitting media but the data have been collected we using powdered KCl as pressure transmitting medium. The beam line was running very well. The strongly focusing crystal provided a small and stable focal spot of about 3 μm^2 necessary for the high-pressure measurements and the scanning μ-XAS. The samples of size 300x300 microns have been measured from ambient to 20 GPa. We have collected XANES data at 20 different pressures, considering compression and decompression.

Our experiment shows that there is a correlation between the local lattice fluctuations local electronic many body configurations and the critical temperature using XANES on single crystals of $HgBa_2CuO_{4+y}$. The results provide crucial information on the emergence of quantum resonances triggered by networks of lattice fluctuations, puddles of stripes, and percolative superconductivity in a superstripes scenario [11-13].

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