ESRF	**Experiment title:** Study of the distribution of the oxygen ordering in La2CuO4+y by microndiffraction scanning	**Experiment number**: HE-2258
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Report:

There is a strong interest on the multiscale phase separation near a bicritical point in correlated oxides [1] We have investigated the multiscale phase separation at the bicritical point in La_2CuO_{4+y}, close to the hole doping $\delta=1/8$ where a crystalline electronic phase of ordered polarons is in competition with a High Tc superconducting phase[2-3].

The La_2CuO_{4+y} is a high Tc cuprate with a large misfit strain between the CuO_2 metallic layer and the LaO rocksalt layers. In the presence of the random field due to interstitial oxygen ions, the competition between $\delta=1/8$ polaron crystal and a superconductor results into a phase separation between domains of a superconductive phase [4,5] and crystalline polaron strings .[6]. We have associated the commensurate 3D oxygen ordering in the LaO plane with the polaron string crystals in the CuO_2 plane.

We have investigated the statistical distribution of the interstitial oxygen crystals by micro-diffraction. We have found that the interstitial oxygen crystals are made of strings of 20-8 unit cells that could be the mirror of the polar strings in the CuO_2 plane that get crystallized.

Our crystal show also a diffuse q_3 superstructure that is been assigned to a smectic liquid phase of polarons in the CuO_2 plane. Therefore we have focused our attention to the mapping of the domains characterized by the q_2 and q_3 superstructure.

During the allocated beam time we have measured the distribution of the superstructures along all the sample using a wavelength λ = 0.9762227 Å, a micron size focused x-ray beam and a detector-sample distance of about 100.024 mm. First of all we have aligned the sample. After that we have done a low resolution mesh of q_2 and q_3 superstructure at fixed angle along the sample at room temperature, and we observed a strong inhomogeneity .

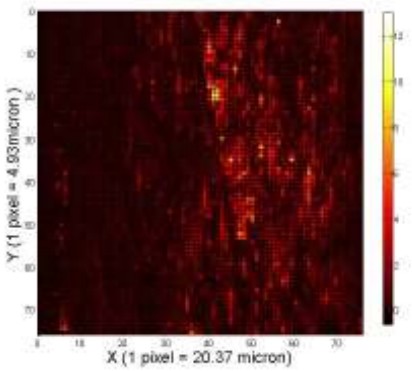

Fig.1: Mapping of the size of charge ordered domains by X-ray microdiffraction plotting the intensity of the commensurate superstructure q2(corresponding to the Q2 phase) with a beam size of 1 micron

So we have divided the sample in three regions (up, centre and down) and we have done three high resolution meshes. In the figure 1 we report the mapping of the Q2 phase in the central region of the La_2CuO_{4+y} single crystal by a synchrotron radiation x-ray beam of 1 micron size . The figure shows the intensity on 5000 spots of the q2 diffraction superstructure spots, corresponding to Q2 phase due to charge ordered 1/8 domains, showing a commensurate modulation of 4 unit cells in the planar b direction and 2 unit cell in the c direction.
We have observed that the q2 superstructure diffraction intensities show a power law distribution typical of the Barkhausen noise in continuous phase transitions in magnetic materials .
In figure 2 we report the high resolution mapping of the Q3 phase and we can observe that it shows a power law distribution.

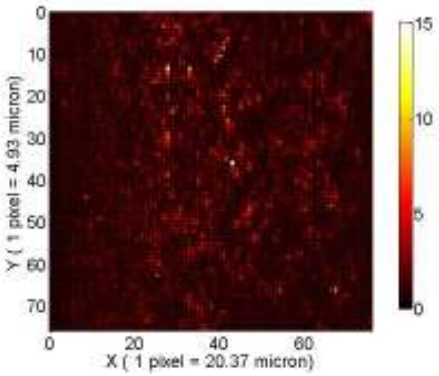

Fig2: Mapping of the size of charge ordered domains by X-ray microdiffraction plotting the intensity of the incommensurate superstructure q3 (corresponding to the Q3 phase) with a beam size of 1 micron.

This experiment provides for the first time the mapping of the interstitial oxygen ordered domains showing the characteristic features expected in the proximity of a bicritical point supporting the theories [4] of a critical competition between charge ordering crystal and High Tc superconducting domains.

References:

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