Local structure imaging of La_2NiO_{4+y}, using scanning nano-XANES

Authors: Nicola Poccia, Markus Bendele, Boby Joseph, Antonio Bianconi , Nathalie Poirot

We have investigated two single crystals of La_2NiO_{4+y} of typical size of few millimeters, with y1= 0.133 and y2=0.17 grown and characterized at Université François Rabelais of Tours (Fr) by Nathalie Poirot. In this crystal the interstitial oxygen atoms form stripes along the [111] directions of the K_2NiF_4-type unit cell with triclinic unit cells characterized by a superstructure peak due to 3D oxygen interstitial ordering with commensurate superstructure The stripes in our crystal have a finite size and form a superlattice with 0.33 unit cell periodicity in the diagonal direction. The oxygen rich stripes puddles are distributed in a oxygen poor background. The density fluctuation of oxygen rich striped puddles form a complex scenario from nanoscale to micron scale in the crystal, called superstripes. We have collect polarized E//ab La LIII-edge XANES using the 300x300 nm x-ray beam size, recorded on beam Line ID 21 at ESRF to probe local lattice fluctuations in the micron scale.

By tuning the x-ray energy at the Lanthanum L-III edge , 5.4827 KeV , we have collected the La LIII-edge XANES spectra in the energy range of 150 eV around the absorption edge to get the x-ray absorption jump and the shape resonances to multiple scattering final states. The intensity of the XANES multiple scattering resonance probes the presence of additional oxygen interstitials near the absorbing atom we have obtained the fluctuations the density of oxygen interstitials. The La L_3-XANES spectra were calculated using full multiple scattering theory based on self-consistent-field potential with muffin-tin approximation, as implemented in the FEFF9.0 code.

The results provide evidence for the phase separation of lattice puddles of micron size of homogeneous oxygen interstitial density that is relevant to understand the spin and charge ordering in these materials.