Experimental report

16/09/2019

Proposal: TEST-2999 **Council:** 4/2019

Title: Soft acouostic phonons in LCO+O

Research area:

This proposal is a new proposal

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Samples: La2CuO(4+y)

Instrument	Requested days	Allocated days	From	To
IN3	7	7	23/06/2019	29/06/2019

Abstract:

Softening of the Phonon Acoustic Modes in LCO+O

The La_2CuO_4 family of compounds is equipped with a number of structural phases, depending on doping and temperature. At high temperature we find the high-temperature tetragonal (HTT) phase which is identified by the I4/mmm space group. Below a certain temperature T_s there is a second-order displacive structural transition to the low-temperature orthorhombic (LTO, space group: Bmab) phase which is characterized by an orthorhombic distortion as well as a tilting of the CuO_6 octahedra along the b-axis.

The structural phases can be identified by diffraction experiments, while the nature of the transitions can be investigated by measuring the excitations of the lattice (phonons). At the HTT-LTO transition, the X-point phonon splits into two degenerate modes (Z, Γ) corresponding to tilts in a-and b-directions. The Γ-point mode is generally stable, while the Z-point mode softens at lower temperatures, suggesting an instability towards a low temperature tetragonal (LTT) phase. In optimally doped $La_{2-x}Sr_xCuO_4$ (LSCO), it was discovered that this instability 'breaks` close to the superconducting transition temperature T_C, suggesting that the superconducting state is preventing the LTT instability.

The purpose of this experiment was to investigate the LTT instability in oxygen-doped La_2CuO_{4+y} (LCO+O). The oxygen interstitials in LCO+O is known to produce unique CuO_6 octahedral tilt patterns, so one would expect a distinct expression of the instabilities at low temperatures. On the other hand, if the temperature-dependance of the Z-point phonon is dictated by the superconducting state, one would expect similar results as for optimally doped LSCO.

Our result (Fig. 1) point to a slight suppression of the Z-point phonon softening at the onset of superconductivity (T_C = 40 K). However a cold neutron spectrometer with a better energy resolution would be necessary in order to draw a definite conclusion.

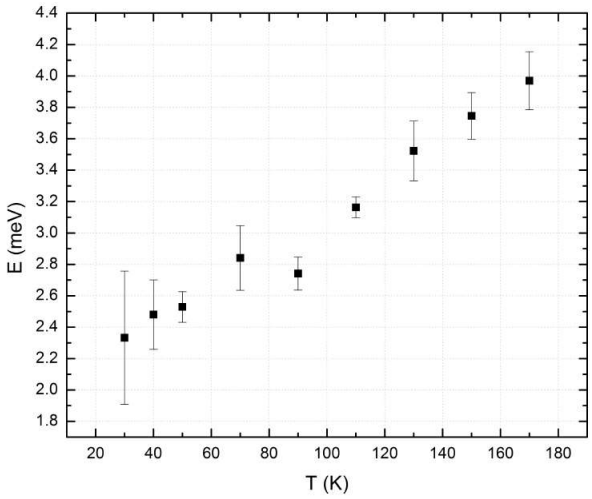

Fig. 1 Acoustic phonon measurements showing a slight suppression of the softening at the onset of superconductivity (T_C = 40 K).