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ESRF

Experiment Report Form

ESRF	**Experiment title:** Exploring the interplay between new ordered phases and electron transfer at cuprate/manganite interfaces with XLD, XMLD and XMCD	**Experiment number**: 88459 HC-4618
Beamline: ID32	**Date of experiment**: from: 02.09.2021 to: 07.09.2021	**Date of report**: 24.02.2022
Shifts: 15	**Local contact(s)**: Dr. Roberto Sant	*Received at ESRF:*

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We performed XAS measurements on $YBa_2Cu_3O_7/Nd_x(Ca_{1-y}Sr_y)_{1-x}MnO_3$ (YBCO/NCSMO) multilayers for which different kinds of Cu-based density wave orders can be induced via the hole doping, x, and the Sr:Ca ratio, y, (or the tolerance factor, t) of the manganite layer. We measured high resolution XAS in TFY and TEY mode around the Cu L-edge as well as Mn-L-edge at grazing incidence geometry. In these samples, the YBCO thickness being 7 nm, the measurement took aprox 6 hours per temperature per magnetic field at LV, LH, C+ and C- polarizations. We measured NYN heterostructures with (1) x=0.5, y=0.25 (2 samples), (2) x=0.35, y=0.3 and (3) x=0.42, y=0.3 (2 samples), (4) x=0.42, y=0.7.

Further, long-range scans from 500 eV-1000 ev and scans around the Oxygen edge (500 – 600 eV) were recorded.

Additionally, we performed similar scans for two Sr_2IrO_4 (SIO, 20nm)/$YBa_2Cu_3O_{7-\delta}$ (YBCO, 14 nm) hterostructure sample.

<u>Summary for NYN heterostructure samples:</u>

They scans reveal that the charge/orbital ordering of NCSMO has a strong influence on the anomalous orbital occupation of the interfacial Cu ions of YBCO. Correlation between the strength of the charge/orbital order in NCSMO and the orbital reconstruction of the interfacial Cu ions in YBCO (Figure 1). Temperature and magnetic field dependence on the Mn-edge shows a complex evolution of Mn-magnetic moemnt. However, the Mn-FY data suffers from self-absorption and hence need to be treated more carefully. In summary, we observe much stronger charge transfer and orbital reconstruction for x ≤ 0.42, whereas we have observed a completely new Cu-TEY peak at ~ 2.5eV higher than Cu-L3 edge, that gets modulated with applied magnetic field (marked by ↓ in Fig. 1).

Summary for SIO/YBCO heterostructure samples:

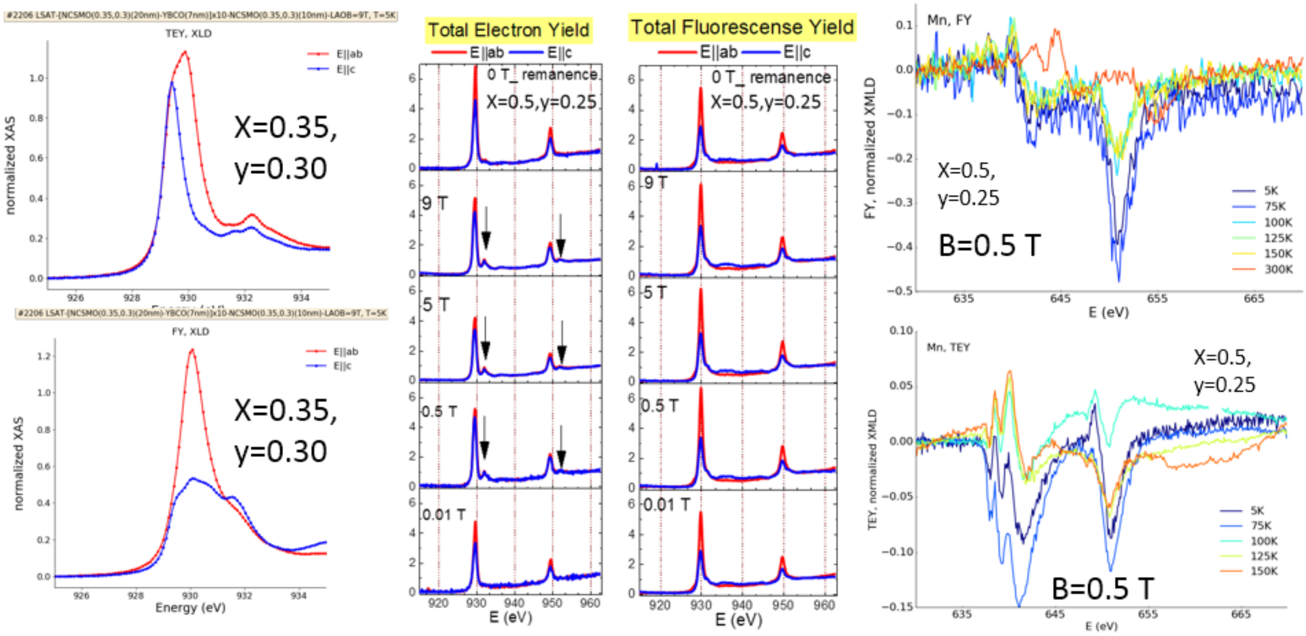

Figure 1: XAS spectra aquirred for NYN trilayers with x: 0.35 and 0.5 at Cu-L and Mn-L edge.

Summary for S/Y heterostructure samples:

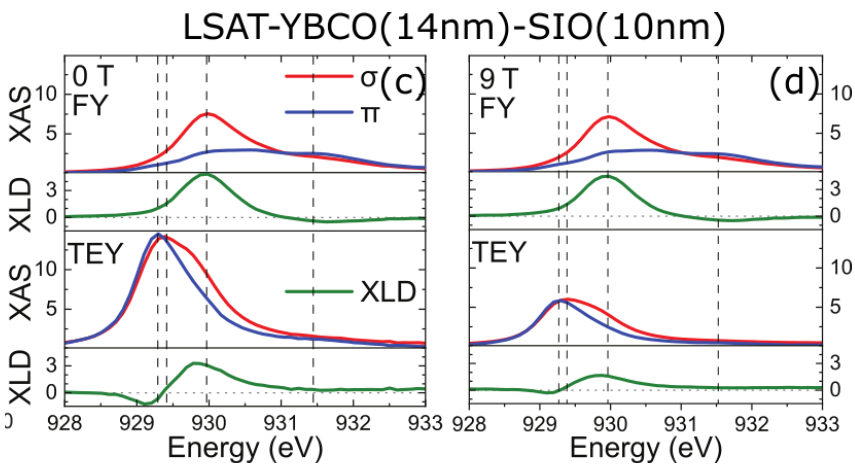

Figure 2: The Cu L-edge XAS spectra show distinct features in the bulk and at the interface. The XLD data are calculated as XLD=y||ab-y||c.

We have measured XAS spectra of the Cu L-edge (see Fig. 2(c), (d)) for a LSAT-SIO-YBCO sample. The XAS data in zero field (Fig. (c)) exhibit ≈ 500 meV difference for the in-plane polarization between the interface (Total Electron Yield (TEY)) and bulk contributions (Fluorescence Yield (FY)) from the YBCO layer indicating a charge transfer at the interface. While the maximum of the TEY line is polarization dependent (with a difference of ≈ 100 meV), the differently shaped 2-component FY spectra exhibits a much larger XLD. An increase of magnetic field to 9 T decreases the TEY absorption dramatically even though the line shapes remain unchanged. To obtain a complete picture of the electronic/spin interactions in these samples, we need complimentary information from the absorption on the Ir-L edge. This will help us to explain the nature of the atomic orbitals involved in forming the electronic structure at the interface.

We are still analyzing the remaining dataset by means of simulation and are trying to correlate with the measurements from other experiments like RIXS, REXS and transport measurements.