Experiment title: Interface magnetism and charge transfer in [Co/Au] multilayers	Experiment number: MA-3974

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Report:

X-ray magnetic reflectivity (XRMR) opens a direct way to get connection between a charge redistribution and an to clarify the origin of induced magnetic moments on the nonmagnetic atoms like Au, Re, W, Pt etc. in the interface regions with ferromagnetic layers. That was the main goal of the project N° MA-3974: “Interface magnetism and charge transfer in [Co/Au] multilayers”.

At first the x-ray reflectivity curves were measured for Si/[Fe/Re]$_{20}$/Si sample (at energy near L_3 Re absorbtion edge), [Fe/W]$_{15}$/Ni sample (at energy near L_3 W absorbtion edge) and Ti/TbCo film (near L_3 Tb absorbtion edge including XAS measurements) at room temperature without external magnetic field. Model calculations show that a small variation of the electronic density in interfaces can be detected in the reflectivity curves at rather high grazing angles. The obtained reflectivity curves did now show acceptable signal-to-noise ratio and reflectivity measurements at high angles were not reliable.

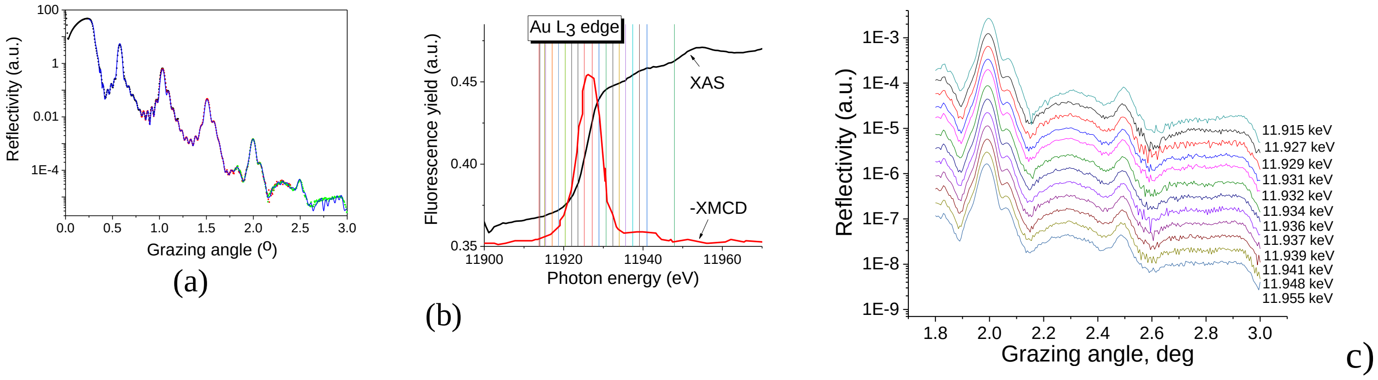
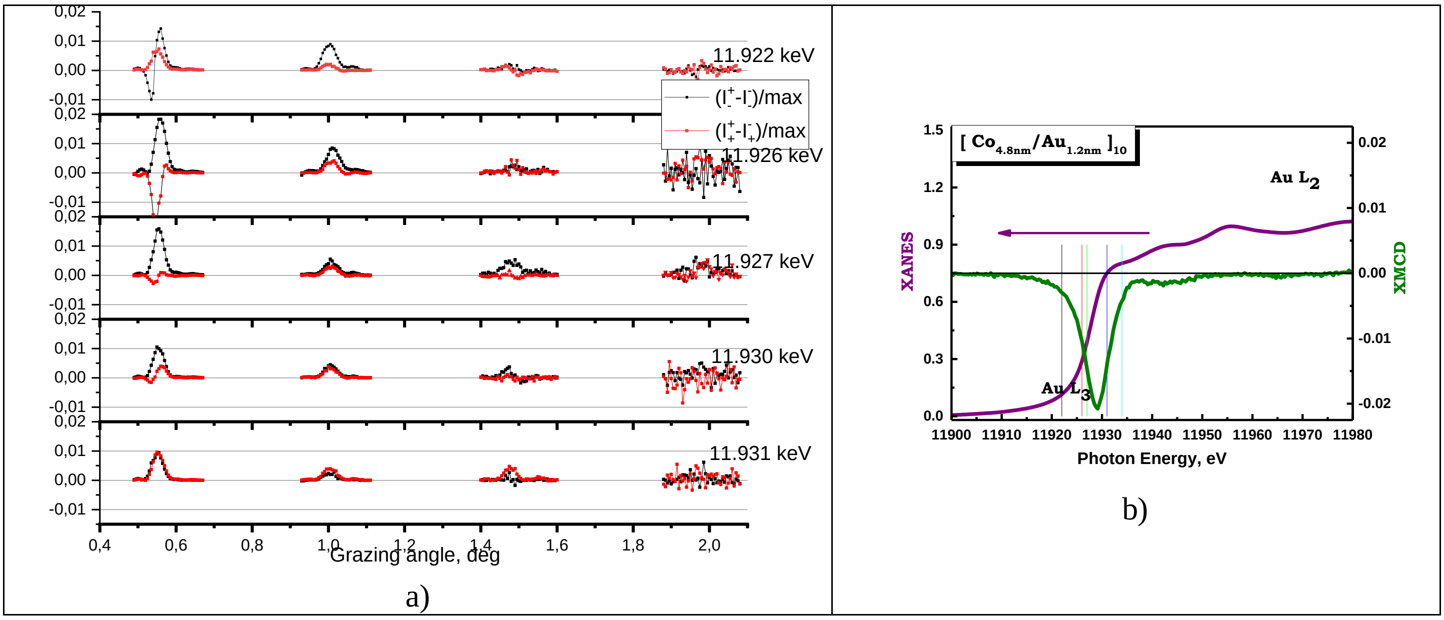


Fig. 1. Reflectivity for [Co)/Au]$_{10}$ sample at E_{ph}=11915 eV; (b) absorption and (-XMCD) signals, measured near Au L_3 absorption edge (vertial lines mark the selected photon energies E_{ph} for reflectivity measurments); (c) reflectivity near 4th and 5th order Bragg maxima for the set of E_{ph}.

A good signal-to-noise ratio for the reflectivity curve was obtained for the [Co(4.8 nm)/Au(1.2 nm)]$_{10}$/Ti(60 nm)/SiO2/Si sample (Fig.1). So the series of reflectivity curves were measued for a set of energies near L_3 Au absorbtion edge. The main difference of these curves was detected in vicinity of 4th order Bragg maxima (Fig. 2b). The intensity of this maximum decreases with increasing photon energy that is, with an increase of the absorption by Au atoms. We suppose that a fit of these curves allows us to reconstruct the difference in L_3 XAS spectra for Au atoms in the interfaces and in the middele part of Au layers, however a visible difference in these curves is hardly observed.



a) b)

Fig. 2. (a) Difference of the reflectivity of the two circular polarization of the synchrotron beam for two directions of the external field along the beam, measured in four Bragg peaks from [CoAu]$_{10}$ sample for several photon enegies at Au L_3 edge, marked by verticla lines in b).

The normalized reflectivity difference $(I^+(\theta)-I^-(\theta))/I_{maxBr}$ for the right and left circular polarized radiation were measured for the two opposite orientations of the external magnetic field of 2 kOe applied along the beam. The obtained result of the reflectivity difference near 4 Bragg maxima for 5 energies near L_3 absorbtion edge are shown in Fig. 2. Reflectvities were measured at short angular intervales due to the unstable positions of the incident beam (or the sample position ?). The unstable beam position can shift the sample adjustment even in short time, so we are not sure that the dispersive shape of some asymmetries is caused by the interference of magnetic contriutions but not by the shft of the angle. The obserbed reflectivity difference did not show the expected opposite sifgn. The possible shapeof the difference will be checked by model calculaitons.

In summary:

The desired peculiarities of the reflectivity curve (needed for the depth resolved resonant $L_{2,3}$ Au spectra with atomic layer resolution), measured as a function of the photon energy in vicinity of the $L_{2,3}$ Au absorption edges, were not observed. For the detecting a charge redistribution between Au and Co atoms in the interface regions this kind of measurements had not shown a suffisient accuracy.

The measurements directly show the existence of the induced magnetic moments on the Au atoms in the investigated [Co(4.8 nm)/Au(1.2 nm)]$_{10}$ structure. However, the detailed analysis of the obtained asymmetry ratio for the depth distribution visualization of the Au magnetic moments needs the additional measurements with higher accuracy.