ESRF	Experiment title: Study of the U-As/Co multilayers by X-ray magnetic circular dichroism (XMCD) at the U M-edges	Experiment number: HE420
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Report:

Some years ago a group at IBM Yorktown Heights manufactured a series of multilayer films of Co and U-As layers with in mind that polarisation could be induced in the U through exchange coupling to the Co layers [1,2].

We have three of these multilayers with the formula Co(200 Å) [U-As(t Å) /Co(20 Å)]$_n$ with atomic ratio U/As $\simeq$ 1.5 and t = 40 Å, n = 20; t = 60 Å, n = 15; t = 80 Å, n = 12; with a total thickness for each of these multilayers of $\sim$ 1400 Å. We performed XMCD measurements on these multilayers at 35 K (for experimental reasons, we were not able to take reliable spectra at room temperature) with a magnetic field of 4 T applied perpendicular to the multilayer plane. The signal recorded at the uranium M_4 and M_5 edges, was detected in fluorescence mode.

Figure 1 show the absorption spectra and dichroic asymetry spectra obtained after correction of the fluorescence spectra [3] for self absorption effects due to uranium. Assuming a U^{3+} configuration, the first sum rule gives $\langle L_Z \rangle = -1.4(1), -1.3(1), -0.74(7)$ and taking $\langle T_Z \rangle / \langle S_Z \rangle = 0.62$ [4], the second sum rule leads to, $\langle S_Z \rangle = 0.29(3), 0.29(3), 0.17(2)$ for $t = 80, 60, 40$ Å, respectively. Finally, we have $\mu_L(5f) = 1.4(1), 1.3(1), 0.74(7)\mu_B, \mu_S(5f) = -0.59(6), -0.59(6), -0.34(3)\mu_B$ and, therefore, $\mu(5f) = 0.8(2), 0.7(2), 0.4(1)\mu_B$ in good agreement with the value claimed by IBM of $\simeq 0.7\mu_B$.

If we assume a U^{4+} configuration, $\langle L_Z \rangle = -1.5(1), -1.4(1), -0.81(8)$. Theoretical preditions give $\langle T_Z \rangle / \langle S_Z \rangle = 1.16$ [4],thus $\langle S_Z \rangle = 0.21(2), 0.20(2), 0.12(1)$ for $t = 80, 60, 40$ Å, respectively. These values imply that $\mu_L(5f) = 1.5(1), 1.4(1), 0.81(8)\mu_B, \mu_S(5f) = -0.41(4), -0.41(4), -0.23(2)\mu_B$ and, therefore, $\mu(5f) = 1.1(2), 1.0(2), 0.6(1)\mu_B$.

For t = 40 Å, we roughly obtained the expected value of the magnetisation of amorphous U_{61}-As_{39} that is 0.5 μ_B /U [5]. The sudden drop of the magnetization for this multilayer could be explained by the interdiffusion of the U-As layers with the Co layers, forming a non magnetic U-As-Co alloy.

This experiment was performed in the 1/3 fill mode, with a good beam stability on the contrary of our preliminary experiments (HE226) performed in the 16 bunch mode.

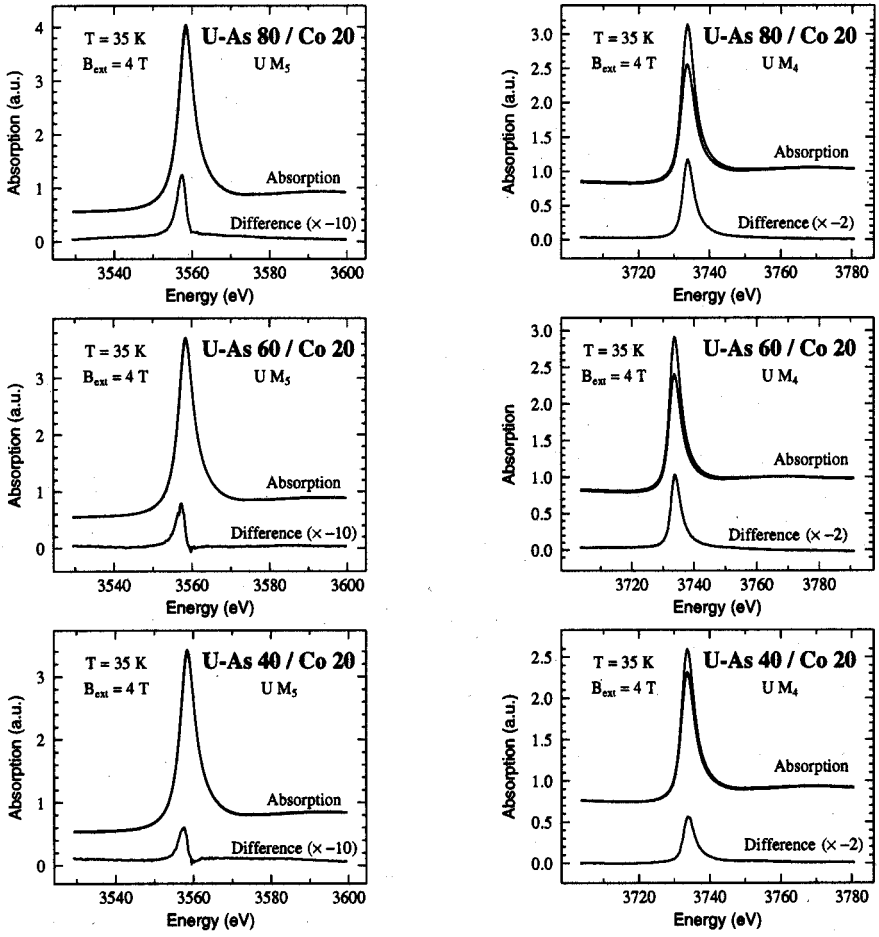

Figure 1 : *Absorption spectra and dichroic asymmetry spectra ΔI ($\Delta I = I_+ - I_-$) measured at the M_5 and M_4 edges of uranium in a U-As/Co multilayers. The intensity of the field was 4 T. The index + (−) specifies that the field is parallel (antiparallel) to the x-ray helicity. The data have been corrected for the energy dependence of the circular polarization rate of the monochromatic x-ray beam.*

References

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