ESRF	**Experiment title: Local structure and residual strains induced distortion in Pt/ Co/Pt trilayers after ultrafast electromagnetic irradiation**	**Experiment number**: HC-1849
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Report:

The possibility to control of magnetic anisotropy with external effects is very important for various magnetic materials, e.g, soft magnetic materials, spintronic devices, magnetic recording materials. Magnetization reorientation driven by femtosecond light pulses has been found in Pt/Co/Pt sandwiches. Observed effects can be explained in terms of irradiation induced formation of Co-Pt alloy exhibiting high perpendicular magnetic anisotropy created on the Co/Pt interface or residual in-plane strain appeared in cobalt film after heating and cooling cycle. Thermal annealing is a typical technique for modification of magnetic properties of layers systems. On the other hand, one of the alternative methods is ultrafast laser irradiation, as light also carries energy, it may increase the temperature in metals due to absorption. For low energies of light pulses, the induced changes of the magnetization and magnetic anisotropy are reversible and may trigger a magnetization precession, while with higher light intensities, irreversible changes of the structure can be achieved. In comparison with conventional thermal annealing of the sample the ultrafast laser annealing provide possibility of localisation of deposited energy near the surface regions while substrate temperature is almost unchanged; this is important for technological applications. Recently, oscillatory behaviour of the magnetization orientation driven by femtosecond light pulses irradiation has been found in Pt/Co/Pt sandwiches. It appears to be a rather simple method to tune magnetic anisotropy - the out-of-plane magnetization region induced by different energy density obtained from femtosecond laser pulses (λ=800 nm). We have also recently found increase of magnetic anisotropy using extreme ultraviolet (λ=11 nm) pulses with nanoseconds duration.

We had investigated the as-grown sapphire/Pt/Co/Pt trilayers (as the references) as well as the samples irradiated with ns XUV pulses using laser produced plasma source or irradiated with fs optical laser pulses. The EXAFS and XANES measurements at the Co K-edge were gathered in a fluorescence mode at 77 K in a normal and grazing incidence configuration.

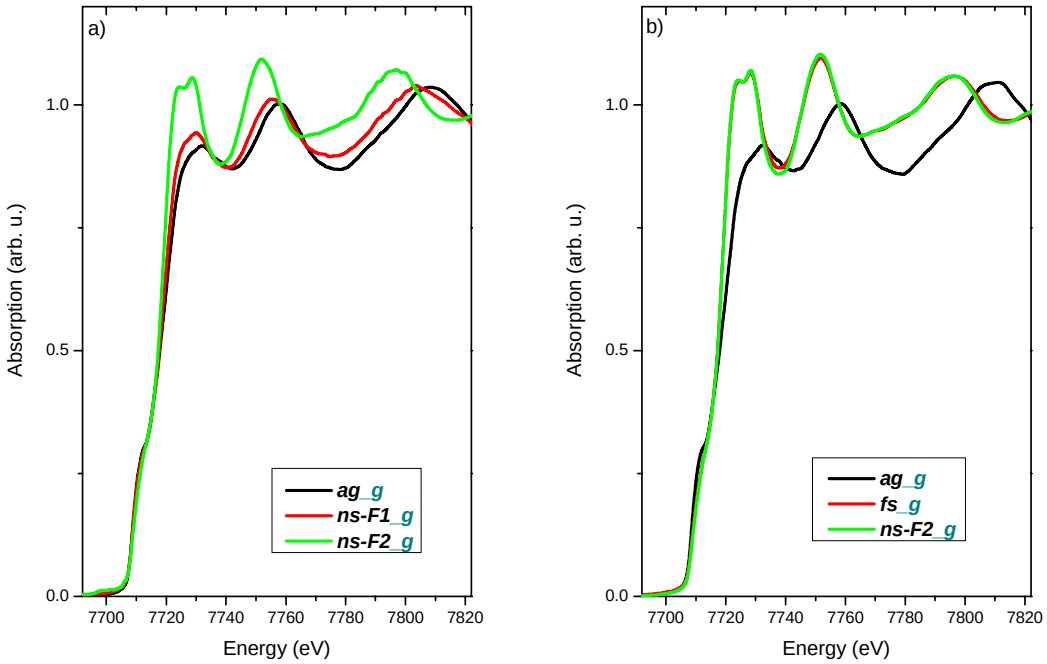

Fig.1. Comparison of the normalized XANES spectra in grazing incidence for the as-grown sample and: a) samples irradiated with fs optical laser pulses at two levels of light fluency; b) samples irradiated with ns XUV pulses using laser produced plasma source and fs optical laser pulses.

Fig. 1 presents comparison between different types of irradiation. The irradiation process causes visible changes in the XANES and EXAFS spectra. (Here only the XANES spectra are shown.) In case of the samples irradiated with fs optical laser pulses at lower (ns-F1) and higher (ns-F2) level of light fluency (Fig. 1a) there is quite significant difference between both irradiated spectra. For both the position of maxima moves toward lower energy. However, the lower light fluency (F1) causes smaller changes, while higher (F2) tremendously changes the structure. We had already reported that this kind of evolution can be connected with increasing level of the Co-Pt intermixing since shapes of the XANES spectra for the Co, CoPt and $CoPt_3$ models calculated with FEFF9.6 reveal the same tendency.

Fig. 1b shows comparison between the effects of ns XUV pulses using laser produced plasma source and fs optical laser pulses irradiations. It can be noticed that the modified spectra look very similar which leads to conclusion that the level of ns optical laser pulse with higher level of light fluency (ns-F2) is close to fs optical laser pulse. All the conclusions are confirmed by the EXAFS analysis. [1]

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References:

[1] Wolska, A., Sobierajski, R., Klinger, D., Klepka, M.T., Jacyna, I., Wawro, A., Jakubowski, M., Kisielewski, J., Kurant, Z., Sveklo, I., Bartnik, A., Maziewski, A." Polarized XAFS study on the ultrathin Pt/Co/Pt trilayers modified with short light pulses", Nuc. Instr. Met in Phys. Res, Section B: 411, 15 November 2017, Pages 112-115, DOI: 10.1016/j.nimb.2017.02.028