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Local structure around Co atoms in the ion and light irradiated magnetic trilayers

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Ultrathin film systems containing magnetic component, e.g. Fe, Ni or Co with tunable magnetization direction (in-plane and out-of-plane), sandwiched between nonmagnetic metals, are of particular importance for spintronics as well as for technology of magneto-optical memory devices. The oscillatory behavior of the magnetization orientation driven by Ga^+ ion irradiation has been already observed in the Pt/Co/Pt sandwiches. It is possible to change irreversibly magnetic anisotropy to one of two out-of-plane magnetization branches induced by Ga^+ ion irradiation dose [1]. Moreover, recent investigations showed that magnetization can also be affected by femtosecond light pulses irradiation [2]. Magnetic states of the irradiated spots depend on the intensity of the femtosecond laser pulses (λ=800 nm). In case of low fluence the changes of the magnetization and magnetic anisotropy are reversible and may trigger a magnetization precession [3,4]. With higher light intensities irreversible changes of the structure are achieved [2]. In comparison with conventional thermal annealing of the sample [5] the ultrafast laser annealing provides possibility to localize deposited energy near the surface regions while substrate temperature is almost unchanged, which is important for technological applications.

Presented studies were focused on the Au/Co/Pt and Pt/Co/Au trilayers irradiated with the Ga^+ ions and the Pt/Co/Pt trilayers irradiated with light pulses. The X-ray absorption fine structure (XAFS) experiment was performed at the BM08 beamline in ESRF. Both regions X-ray Absorption Near Edge Structure (XANES) and Extended X-ray Absorption Fine Structure (EXAFS) were investigated. The signal was registered in a fluorescence mode at 77 K in a normal incidence configuration. The measurements were carried out at the Co K-edge for the as-grown reference and modified samples in order to determine changes in the local atomic structure around the Co atoms. The investigations were performed for the series of the Pt/Co/Au and Au/Co/Pt trilayers grown by the MBE method on the sapphire single crystal substrates and irradiated with the Ga^+ ions. For each configuration the as-grown samples (reference) and irradiated ones with 2 different doses were chosen. The applied doses corresponded to the level for which the out-of-plane magnetization of the sample reaches local maxima. In case of the Pt/Co/Pt trilayers the light irradiation fluences corresponded to appearance of the out-of-plane magnetization state. The whole sample surfaces were irradiated point by point with light to achieve quazi-uniformly irradiated area.

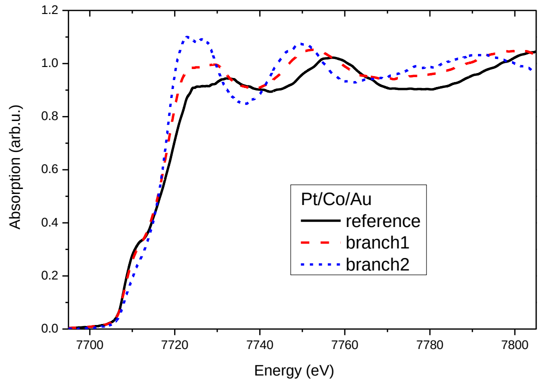

Figure 1. XANES spectra at the Co K-edge of the as-grown sample and the samples irradiated with the Ga^+ ions.

The analysis of the samples irradiated with Ga^+ ions showed that in both configurations, Pt/Co/Au and Au/Co/Pt, the modifications of the atomic structure around the Co atoms are similar. This kind of evolution can be connected with the increased number of the Pt/Au neighbors in the first coordination sphere of the Co atoms. As an example, the XANES spectra for the Pt/Co/Au structures before and after irradiation are presented in Fig. 1. XANES spectra of the samples irradiated with light correspond to the spectra of the samples irradiated with the higher dose of the Ga^+ ions. The detailed XANES and EXAFS analysis revealed that both irradiation methods have similar influence on the local structure introducing Pt or Au atoms into the first coordination sphere.

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[1] A. Maziewski *et al.*, *Phys. Rev. B* **85** (2012) 054427.
[2] J. Kisielewski *et al.*, *J. Appl. Phys.* **115** (2014) 053906.
[3] M. van Kampen, *Phys. Rev. Lett.* **88** (2002) 227201.
[4] J. Kisielewski *et al.*, *Phys. Rev. B* **85** (2012) 184429.
[5] M. Galeotti, *Surf. Sci.* **297** (1993) 202.