

# All-optical single pulse magnetization switching of ferromagnetic [Co/Pt] observed for GdFeCo / Cu / [Co/Pt] spin valve structure

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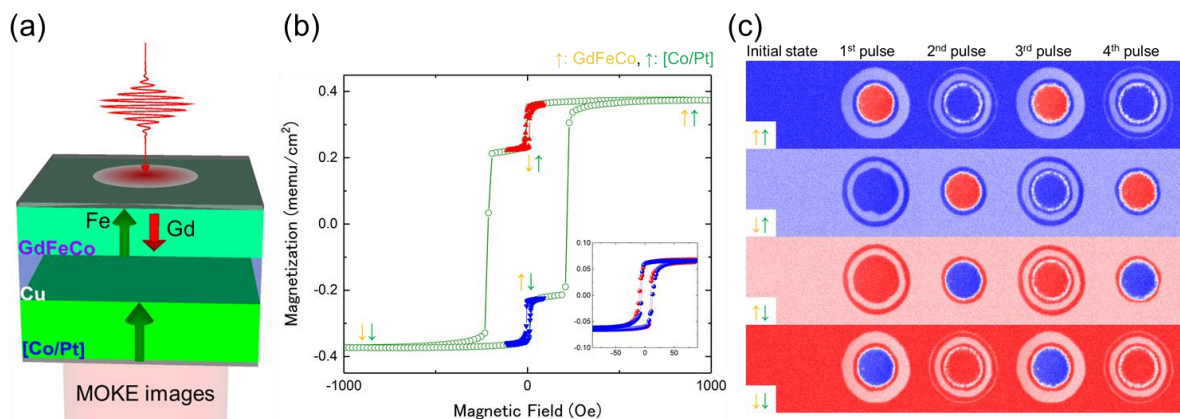
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In 2007, all-optical magnetization switching (AOS) using femtosecond (fs) laser pulse in GdFeCo ferrimagnet was demonstrated [1]. Subsequently, AOS in GdFeCo ferrimagnet was found to be helicity-independent and induced only by single fs-laser pulse [2]. Single pulse switching of GdFeCo is attributed to the antiferromagnetic coupling between Gd and Fe moment and non-equilibrium transient ferromagnetic states [2]. Recently, AOS in not only ferrimagnetic GdFeCo but also ferromagnetic [Co/Pt] multilayer was demonstrated [3]. The AOS in ferromagnetic [Co/Pt] is achieved by multiple pulses and helicity dependent [4]. In this study, we demonstrated that ferromagnetic [Co/Pt] is switched by single fs-laser pulse in GdFeCo / Cu / [Co/Pt] spin valve structure.

Stacking structure is glass sub. / Ta (5) / [Pt (1) / Co (0.6)]<sub>4</sub> / Cu (5) / Gd<sub>25</sub>(FeCo)<sub>75</sub> (5) / Ta (5) (thickness in nm). Schematic illustration of the AOS measurement is shown in figure 1(a). Linear polarized fs laser pulses were irradiated from GdFeCo side and magneto-optical Kerr effect (MOKE) images were obtained from the [Co/Pt] side. Magnetization curves are shown in Fig. 1(b). The minor loop, shows no field shift which proves that no exchange coupling between [Co/Pt] and GdFeCo is present for a 5 nm Cu layer. Figure 1(c) shows MOKE images obtained after several fs-laser pulses with different initial magnetization configuration. Magnetic domain after the irradiation of fs-laser pulse showed complicated structure. Single pulse switching of both layer around center of the spot is observed in addition to the single pulse switching of only GdFeCo around rim of the spot. We will discuss the origin of the single shot switching of the different layers in the presentation.



**Figure 1 (a) Schematic illustration of all-optical magnetization switching experiment in [Co/Pt] / Cu / GdFeCo spin-valve structure. Linear polarized laser pulse is used in this experiment. (b) Out-of-plane magnetization curve for the sample. Red and blue curves are minor loop corresponding to the magnetization reversal of GdFeCo layer. (c) Magneto-optical Kerr effect images after several fs-laser pulses for 4 different initial magnetic configurations. Color indicates intensity of contrast.**

[1] C. D. Stanciu *et al.* Phys. Rev. Lett. **99**, 047601 (2007) [2] T. A. Ostler *et al.* Nat. Commun. **3**, 666 (2012) [3] C. -H. Lambert *et al.* Science **345**, 1337 (2014) [4] M. S. El Hadri *et al.* Phys. Rev. B **94**, 064412 (2016)