Composition dependence of laser-induced THz emission in Ta/$(Co_xFe_{1-x})_{80}B_{20}$/MgO films

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Spintronic terahertz (THz) emitters composed of ferromagnetic metal (FM)/heavy metal (HM) ultrathin hetero-structures have attracted much attentions since it was demonstrated to be an efficient and broadband comparable to conventional ones. The THz emission mechanism proposed was as follows: pulse-laser-induced pulsed spin current flows from FM into NM in sub-ps time regime, which is converted into pulsed charge current via the inverse spin Hall effect, and it emits pulsed-THz radiation[1]. Though FM layer works as a spin current source in the mechanism, only few reports discussed FM dependence of the THz emission[2], [3]. In this study we investigated the composition dependence of the THz emission for Ta/$(Co_xFe_{1-x})_{80}B_{20}$/MgO to clarify the role of FM in the THz emission mechanism.

Ta(5.0)/$(Co_xFe_{1-x})_{80}B_{20}$(1.4)/MgO(2.0)/Ta(2.0) (thickness in nm) multilayer films were deposited on a thermally oxidized Si substrate using ultrahigh vacuum magnetron puttering. The samples were annealed at 250-400°C in vacuum furnace. The THz measurement was performed by means of an electro-optic sampling with a Ti: sapphire laser and regenerative amplifier (a pulse duration of about 120 fs). Figure 1 shows typical time-resolved measurement of the THz wave for the films with various x annealed at 300°C. The THz emission intensity is varied with different x whereas the wave forms are unchanged. The peak value of the detected THz wave is shown as a function of x in Fig. 2. The peak value shows the maximum at x = 0 - 0.1 then monotonically decreases with x. This trend could be partially related to the spin polarization at or above the Fermi level of CoFeB.

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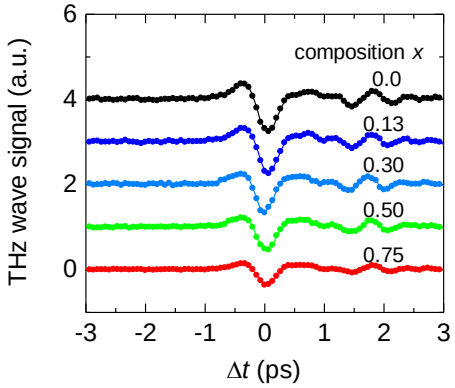

Fig. 1 Typical THz wave form for the films for x=0, 0.5, and 0.75. In-plane magnetic field of 40 mT was applied.

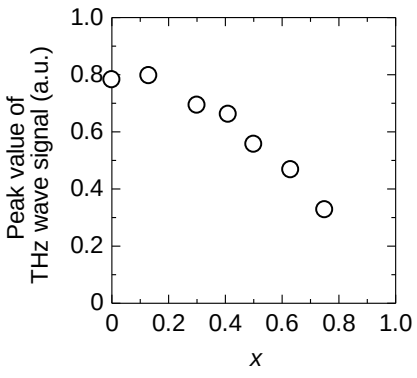

Fig. 2 Peak value of the THz wave as a function of the composition x for the samples annealed at 300°C.