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Evaluation of spin and orbital magnetic moment of Fe and Co in Ferrimagnetic metallic alloy GdFeCo

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1 Introduction

The well-known ferrimagnetic metallic alloy, GdFeCo is extensively used for materials in magneto-optical recording. This is composed of two subsystems: rare-earth (RE, Gd) subsystem and 3d transition-metal (TM, FeCo) subsystem. These subsystems couple antiferromagnetically each other. The magnetization compensation temperature (T_M), at which the net magnetization of the ferrimagnet becomes zero, can be defined, depending on a component ratio of the alloy. This material also has been intensively investigated in terms of magnetization reversal in sub-picosecond timescale [1]. A sample measured at Bl-16A in Photon Factory this time was also utilized for an experiment of ultrafast magnetization reversal through time-resolved resonant magneto-optical Kerr effect (RMOKE) measurement with a seeded type free electron laser, FERMI@ELETTRA in Italy [2]. We characterized static magnetic properties of GdFeCo by measuring X-ray magnetic circular dichroism (XMCD) and applying sum rules[3] to this system.

2 Experiment

Figure 1 shows a schematic diagram of the thin-film sample structure, where the ferrimagnetic alloy has the composition $Gd_{21}(Fe_{90}Co_{10})_{79}$. The $T_M \sim 250$ K of the $Gd_{21}(Fe_{90}Co_{10})_{79}$ is lower than room temperature. For this alloy composition, the magnetic moment at room temperature of the TM sublattice is higher than the RE and the direction of the magnetic moment of the Fe atom is parallel to that of the external magnetic field. The Ta (2 nm) capping layer prevents the GdFeCo oxidation and the Ta (10 nm) underlayer helps the adhesion to the Si substrate.

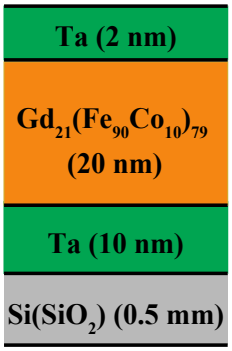

Fig. 1 sample structure

XMCD spectra of the sample were measured with the total electron yield mode under magnetic fields generated with an electromagnetic coil. The XMCD spectra were recorded with the sample at 20 K in an external magnetic field of 0.47 T. The spin and orbital magnetic moment of Fe and Co were determined by applying sum rules.

3 Results and Discussion

Figure 2 (a), (b) shows X-ray absorption spectra (red solid line) of the GdFeCo film at the $L_{2,3}$ edge of Fe and Co, respectively. Its integrated intensity (blue solid line) are also depicted. The two resonant L_3 and L_2 peaks originate from the $2p_{3/2}$ and $2p_{1/2}$ core excitations, respectively. The Fe and Co $2p \rightarrow 3d$ XMCD spectrum and its integrated value are indicated in Fig. 2(c), (d), respectively.

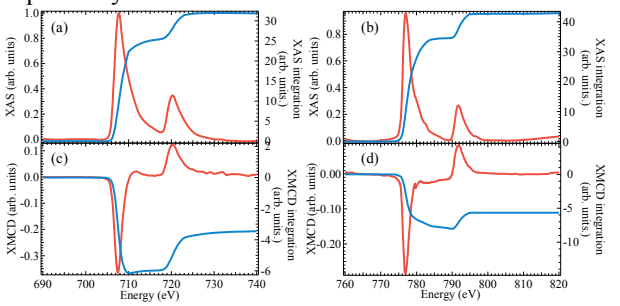

Figure 2 (a) X-ray absorption spectrum around Fe $L_{2,3}$ edges (b) around Co $L_{2,3}$ edges (c) X-ray Magnetic circular dichroism spectrum around Fe $L_{2,3}$ edges (d) around Co $L_{2,3}$ edges

By applying sum rules, spin (m_{spin}) and orbital (m_{orb}) magnetic moment of Fe and Co are estimated and tabulated in Table 1.

	m_{orb}	m_{spin}
Fe	0.50	2.33
Co	0.14	1.17

Table 1: spin and magnetic moment per atom

The spectra obtained from the measurement were utilized for simulation of RMOKE spectra using cluster model with configuration interaction.

Acknowledgement

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