Study on the Magnetism of Gd/Fe and Y/Fe amorphous multilayers via MCD

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An amorphous 3d transition metal(TM) - 4f rare earth(RE) system received a lot of attention partly due to pure scientific interest but also because of its technical applications in magneto-optical recording. In this system, the structure of 3d TM is known to vary from an amorphous to a crystal state, depending on the bilayer period of TM/RE multilayers, and the magnetism of TM is considered to be different between these two states. We performed, therefore the MCD experiments at Fe 2p - 3d excitation region for Gd/Fe and Y/Fe multilayers with various bilayer periods to investigate the magnetism of amorphous Fe.

Gd/Fe and Y/Fe multilayers with the thickness ratio of Fe to RE layers is about 1 : 1 were prepared by the rf magnetron sputtering. A Pt capping layer of 5 nm were deposited on the multilayer to avoid the surface oxidization. The MCD spectra were measured utilizing the total yield method at room temperature, and recorded in a 14 kOe external field parallel to the film normal direction.

The X-ray measurements demonstrate that the structure of Fe in Gd/Fe multilayers is the amorphous state for the bilayer period of less than 2 nm and the crystal state for the other. Figure 1 (a) and (b) show the total yield and the MCD spectra at Fe 2p - 3d excitation region for Gd/Fe multilayers, respectively. As seen in Fig. 1 (b), the rather small MCD signals for $t_{Fe} > 2.5$ nm compared to that of a bulk Fe is probably due to the insufficient external field to saturate the magnetization along the film normal direction. In the case of $t_{Fe} = 0.5$ nm (amorphous state), the large MCD signal are observed even though the Fe layer is thin enough. In addition, it is found that the peak position of $L_{2,3}$ edges shown in Fig. 1 (a) systematically sifts towards lower energy side with decreasing the bilayer period. On the other hand, this feature is not observed in the MCD spectra as in Fig. 1 (b). Although the reasonable explanation for these results is under consideration, these results might reflect the difference of 3d band structure and/or 2p core state between the amorphous and the bcc Fe.

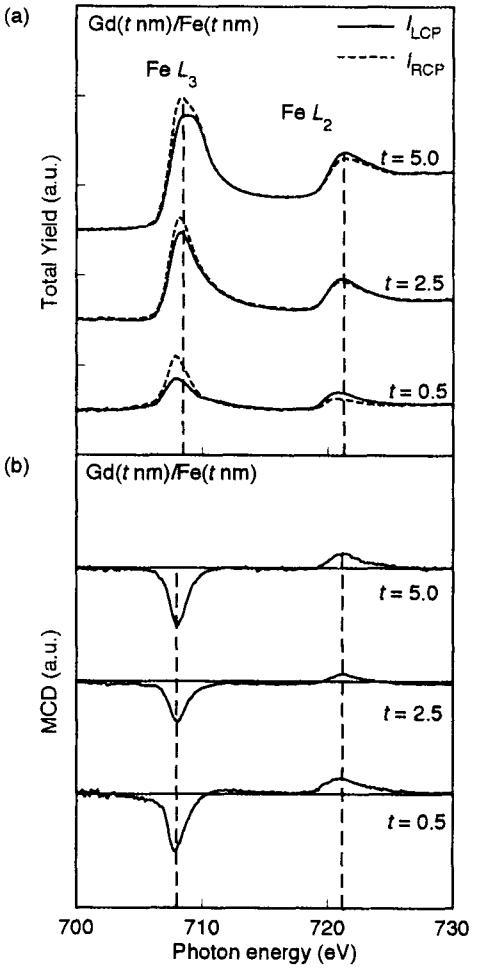

Fig .1 (a) Total yield and (b) MCD spectra at Fe 2p - 3d excitation region for Gd/Fe multilayers with various bilayer period.