Effects of the Ar pressure on the magnetic properties of amorphous Fe-Zr thin films

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Amorphous Fe-Zr thin film is one of promising materials for $[Pt/Co]_n$ multilayers for p-MTJ with strong PMA, which suppresses crystallization at the interface with the multilayer side during annealing.[1,2] It is also well known that the magnetic properties of amorphous materials are extremely sensitive to their microstructure.[3,4] This study deals with the change in the magnetic properties of Fe-Zr thin films depending on Ar pressure during sputtering. The thin films with the structure of Fe-Zr/Ta were fabricated on a Si/SiO_2 substrate by using a DC magnetron sputtering system. The sputtering conditions were fixed, except for the Ar pressure which was varied widely from 2 to 10 mTorr in steps of 4 mTorr. The composition of was controlled by varying Fe chips placed on an $Fe_{20}Zr_{80}$ alloy target. The amount of Fe, relative to Zr, decreases with increasing Ar pressure due to the fact that Fe atoms which have reduced mass (55.845 g/mol) compared to Zr atoms (91.224 g/mol) are subject to stronger scattering with the Ar atoms. Magnetic properties of as-deposited samples fabricated with the same number of Fe chips were dramatically changed with increasing Ar pressure, which is shown in Fig. 1. For the as-deposited samples which were fabricated with 16 Fe chips(Fig. 1(b)), their *M* values were increased almost 20 times with increasing Ar pressure from 2 mTorr to 10 mTorr. Also, high field susceptibility was emerged with increasing Ar pressure. After annealing at 150°C, the *M* value and high field susceptibility were considerably decreased for samples fabricated at 10 mTorr, whereas only slight changes in both values were observed for samples fabricated at 2 mTorr. This indicates that samples fabricated at 2 mTorr has more relaxed microstructure than samples fabricated at 10 mTorr. The magnetic property changes depending on Ar pressure were dominated by the number of Fe cluster rather than the size of Fe cluster, which was analyzed by the Langevin fitting.

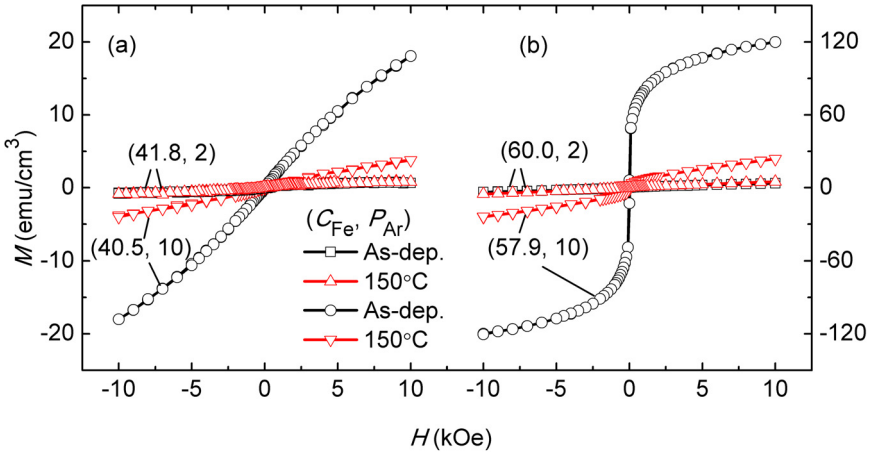

Fig. 1. *M-H* loops for Fe-Zr thin films for as-deposited and annealed samples. (a) $C_{Fe} \simeq 40$ at.% (b) $C_{Fe} \simeq 60$ at.%

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