KMS-1-S7

Negative coercivity observed on a surfaces of $Fe_{76.5}Cu_1Si_{13.5}B_9$ ribbon annealed by light on a surface

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Negative coercivity hysteresis loops have been observed for a number of single layer films, multilayers, assemble of magnetic particles and bulk alloys[1-3]. They were explained by exchange-coupling between magnetic thin film layers or by magnetostatic interaction between the magnetic nanoparticles, thin film layers or superlattices. A. Aharoni demonstrated that a negative coercivity can appear in an exchange-coupled bilayer when a magnetically soft material is affected by the demagnetizing field of the hard material[4].

This work reports that normal and negative coercivity hysteresis loops, the magnetization as a function of applied magnetic field, are observed on different side surfaces for a Fe-Cu-Si-B ribbon. The ribbon has been annealed by lightening up one side surface and the loops were measured by a magneto-optical Kerr effect magnetometer. The hysteresis loops can be simulated by assuming that the ribbon consists of two homogeneous layers of different real hysteresis loops, the magnetization as a function of internal magnetic field, coupled through magnetostatic interaction. The negative coercivity does not appear in these real hysteresis loops.

The amorphous ribbon of nominal atomic composition $Fe_{76.5}Cu_1Si_{13.5}B_9$ was prepared by single-roll melt-spun method under argon atmosphere. The quartz nozzle is rectangular (3mm×0.3mm) and the surface speed of Cu wheel was 25-30 m/sec. The ribbon of 3 mm width and 13 μm thickness was fixed on a silicon wafer with the free side facing the wafer. Two ends of the ribbon were silver-pasted on the wafer. The sample was put in a vacuum chamber of 10^{-6} Torr and the wheel side was irradiated by a halogen light, during which the temperature of the sample is increased from room temperature to 200℃ within 3~4 min. The sample is kept for ~10 seconds at 200 ^{0}C after which the light was put out and the sample was cooled down naturally.

Figures 1a and 1b show the hysteresis loops of the free and wheel side surfaces measured by using a magneto-optical Kerr effect (MOKE) magnetometer. The abscissas H_a are the applied magnetic field. The annealing being inhomogeneous the two loops are quite different. While the loop of the free side surface is a normal rectangle with H_c=3.7 Oe and minor tilt (figures 1a), the loop of the wheel side surface has negative coercivity and is fairly tilted with saturation field 18 Oe (figures 1b). The magnetization of the free side surface reverses from positive to negative saturation in a field range of ~3.7 Oe and the magnetization of the wheel side surface remains nearly constant in this field range.

The XRD pattern of the annealed sample shows there is a small amount of crystalline α-Fe(Fe_3Si) phase of grain size ~21.5 nm (figure 2). No structural difference between the two layers was observed by scanning electron microscope (SEM) (figure 3).

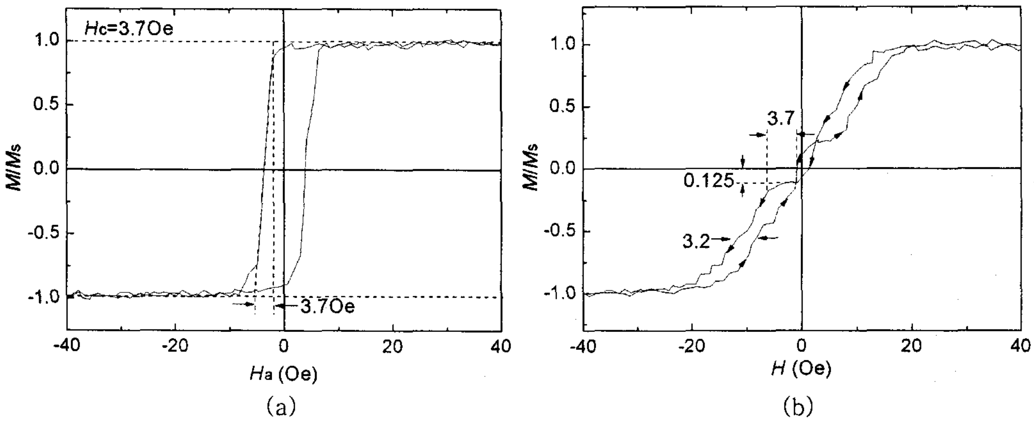

Fig.1 The hysteresis loops (M/Ms as a function of Ha(a, b).
(a) Measured on the free side surface. (b) Measured on the wheel side surface.

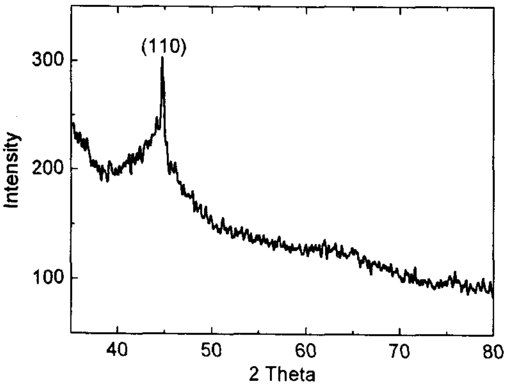

Fig. 2 XRD pattern of the light-annealed Sample

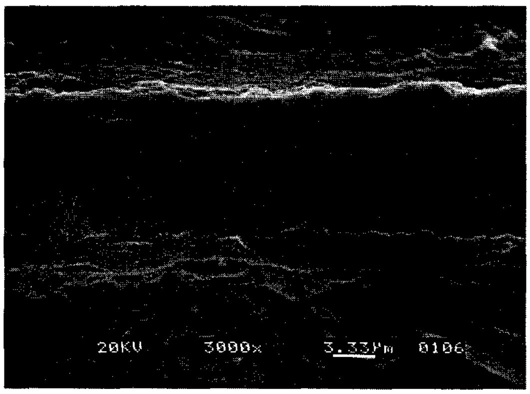

Fig.3 SEM photo of the rapid-annealed sample: cross section of the whole ribbon

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