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PROPERTIES OF THE Mn-Zn FERRITE THIN FILMS DEPOSITED BY ION BEAM SPUTTERING

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Mn-Zn ferrite with spinel structure is widely used in magnetic recording head due to good soft magnetic properties such as high permeability and low coercivity. Mn-Zn ferrite films have been prepared by conventional sputtering[1] and Facing Target Sputtering.[2] It was the Co ferrite thin film that was first deposited by the ion beam sputtering among various ferrite system.[3] However, there was no report on the deposition of Mn-Zn ferrite films by the ion beam sputtering.

We deposited Mn-Zn ferrite films on SiO_2(1000Å)/Si(100) by ion beam sputtering at various oxygen partial pressures. The schematic diagram of the ion beam sputtering system with single ion source is shown in Fig. 1. The ion beam (2.1keV, $2.1mA/cm^2$) generated in a DuoPIGatron-type source sputtered the target, and the reflected ion beam from the target bombarded the deposited ferrite film. (110) single crystal and polycrystalline Mn-Zn ferrite disks with or without Fe and Cu metal strips were employed as a target. XRD, SEM, TEM, VSM, and low frequency impedance analyzer were used to investigate the properties of the Mn-Zn ferrite thin films.

Thin films, deposited at the oxygen-deficit ambient using a mosaic target, had an (111)(Mn,Zn,Fe)O wüstite structure, but the crystal structure changed into a meta-stable (222)(Mn,Zn)Fe_2O_4, and into the (111)(Mn,Zn)Fe_2O_4 with increasing oxygen partial pressure. The structure of the (222)(Mn,Zn)Fe_2O_4 was similar to the (Mn,Zn,Fe)O wüstite, whereas its interplanar distance was similar to that of the (Mn,Zn)Fe_2O_4. However, the crystal structure of ferrite film, deposited from a single crystal ferrite target, changed from the mixture of the (111)(Mn,Zn,Fe)O wüstite and the (111)(Mn,Zn)Fe_2O_4 spinel to the (111)(Mn,Zn)Fe_2O_4 single phase with increasing oxygen partial pressure. The occurrence of (111)(Mn,Zn,Fe)O and (222)(Mn,Zn)Fe_2O_4 phases originated from highly oxygen-deficiency in ferrite film, which is caused by low oxygen partial pressure and the preferential resputtering of oxygen atoms in the deposited films on substrate.

Even the ferrite films, mostly composed of (111)(Mn,Zn,Fe)O wüstite, showed typical ferrimagnetic characteristics. Fig. 2 shows a typical M-H hysteresis curve of the as-deposited films. The resistivity of the as-deposited film was mainly governed by the grain boundary, and was almost of the same value irrespective of the substrate temperature.

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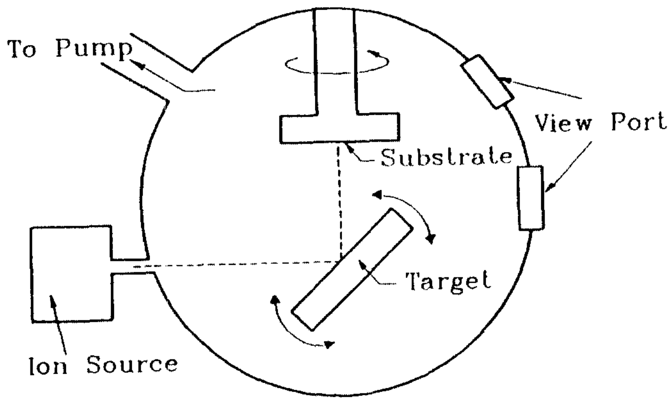

Fig. 1 Schematic diagram of IBS with single ion source. The ion beam reflected from the target bombards the deposited film during deposition.

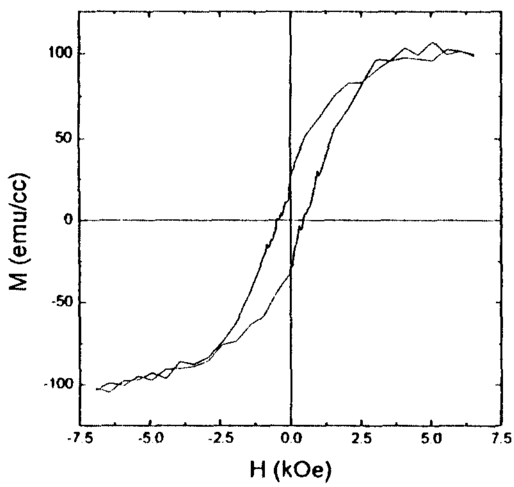

Fig. 2 Typical M-H hysteresis curve of the as-deposited films, which shows the typical ferrimagnetic characteristics.