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Improved Sensitivity of GMR Sensor by Reducing the Induced Anisotropy Field of Free Layer

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A number of sensitive magnetic field detection devices have been developed that are suitable for biosensing application, including giant magnetoresistance, spinvalve and so on. The ultimate purpose of these biosensors is single molecule detection. For this reason, recently, magnetoresistive sensors have been focused on biological devices due to high sensitivity and an even lower detection limit may be reached in the future by using more sensitive magnetoresistive sensor. Therefore many researchers make an effort to obtain higher sensitivity of magnetoresistive sensor [1]. Here, we demonstrate the higher sensitive GMR sensor by reducing the induced anisotropy field (H_k) of free layer.

Factors determining the sensitivity of magnetoresistive sensor are the MR ratio and the switching field interval [2]. The switching field interval is related to anisotropy field of the free layer that determines the field sensitivity [1]. For that reason, we observed that GMR sensor with reducing the Hk was showing the higher sensitivity than that with induced anisotropy at the same size.

GMR sensors were fabricated with the structure SiO_2/Ta30 Å/NiFe30 Å /CoFe5 Å /Cu28 Å /CoFe40 Å /IrMn80 Å /Cu10 Å /Ta20 Å by a magnetron sputter system and then were patterned by photolithography to various junction sizes (MR ratio~5.5%). Two systems with the same structure were compared: one with induced anisotropy and one with un-induced anisotropy of the free layer. The first one was deposited with magnetic field of 200 Oe and the second one was deposited without magnetic field.

The free layer of GMR sensor deposited without magnetic field was not showing the induced anisotropy from MH curve. At the same junction size (10×50 μm^2) the sensitivity of the first one is ~0.24%/Oe and the second one is ~0.29%/Oe. As a result, the sensitivity (%/Oe) was enhanced by reducing the switching field interval.

In conclusion, the sensitivity of GMR sensor can be improved by controlling theinduced anisotropy of free layer. Itwill ultimately allow overcoming the detection limit of GMR biosensor.

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RD01

Influence of Film Thickness on the Soft Magnetic Properties of Sputtered Co-Fe-Hf-O Films

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In recent years, the micromagnetic devices, such as magnetic thin-film inductors, transformers for microswitching converters, ultrahigh density recording heads and thin film fluxgate sensors [1], have been developed to miniaturize the magnetic components in electronic equipment. To achieve this, the electrical resistivity of such a ferromagnetic thin film must be high to minimize energy loss due to eddy currents while the large values of saturation magnetization ($4\pi M_s$) and hard axis anisotropy field (H_k) are required to increase the switching capacity of the film to higher frequencies [2].

In this work, we have carried out a systematic investigation of the soft magnetic properties of Co-Fe-Hf-O soft magnetic films with varying thicknesses (t) in the range of 20 - 2500 nm. The $Co_{19.35}Fe_{53.28}Hf_{7.92}O_{19.35}$ films were deposited by the reactive rf sputtering method using an $Ar+O_2$ atmosphere with a base pressure of less than 2.0×10^{-7} torr, onto Si(100) substrates at ambient temperature, and in an applied dc magnetic field of 100 Oe to induce an in plane uniaxial anisotropy. It has been shown that the magnetic characteristics are strongly dependent on the film thickness. As the film thickness increases, the easy axis coercivity (H_c) decreases drastically, reaching a minimum value $H_c \sim 1.2$ Oe at a thickness of 240 nm, and then varies slightly at higher thicknesses, whereas the hard axis anisotropy field, H_k, and the saturation magnetization, $4\pi M_s$, changes considerably from 69.74 to 44.51 Oe, and 12.89 to 18.44 kG, respectively. Among the samples investigated, the films with thicknesses ($t \sim 240$ - 600 nm) show the excellent magnetic properties of low coercivity ($H_c \sim 1.2$ - 2.4 Oe), high hard axis anisotropy field ($H_k \sim 87.87$ - 74.54 Oe), and high saturation magnetization ($4\pi M_s \sim 17.72$ - 18.37 kG). These results indicate that the prepared films are very promising for technological applications.

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