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FMR Study on Single Crystalline Co_2MnAl Heusler Alloy Thin Films

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The discovery of the giant magneto-resistance (GMR) and the large tunnel magneto-resistance (TMR) effect at room temperature have attracted great attention to the spintronics studies. After understanding high spin polarization in some kinds of Heusler alloys such as Co_2MnSi, Co_2MnAl, etc., many scientists predict a large potential for applications of these alloys in spin-electronics devices, especially for producing magnetic random access memory (MRAM), and present-day communication industries. Therefore intensive experiments have been carried out to determine the magnetic properties of Heusler alloys in recent years [1].

Gilbert damping constant, $G = \alpha \gamma M_s$, (in here α and γ are, respectively, intrinsic damping parameter and gyro-magnetic ratio and M_s is saturation magnetization), of ferromagnetic materials is extremely important for achieving high-speed magnetization switching for MRAM and reduction of critical current density for spin-transfer-driven magnetic reversal [2].

Samples have been prepared using the magnetron sputtering technique on a MgO(100) substrate for single crystalline and than annealed at various temperatures to control the structure. The magnetic properties such as g-value, effective magnetization and magneto-crystalline anisotropy constants and intrinsic Gilbert damping constant were obtained from angular dependences of FMR spectra using the Landau-Lifshitz-Gilbert equation[3].

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ES04

Preparation and Characterization of NiFe Epitaxial Thin Films Grown on $SrTiO_3(100)$ and MgO(100) Single-Crystal Substrates

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NiFe multilayer films combined with thin insulator layers are widely investigated for devise applications such as TMR-heads and MRAMs. Theoretical calculations show that the tunneling magnetoresistance of magnetic sensor prepared using an epitaxial film is one order of magnitude greater than that obtainable with an amorphas film [1,2]. The crystallographic propertis of NiFe/insulator structure give strong influence on the tunneling magnetoresistance. In the present study, $Ni_{82}Fe_{18}$ films were prepared on $SrTiO_3(100)$ and MgO(100) single-crystal substrates by UHV-MBE. The growth process, the crystallographic quality, and the magnetic properties of these films were investigated.

NiFe epitaxial thin films were obtained on both $SrTiO_3(100)$ and MgO(100) substrates. A clear RHEED pattern reflecting fcc(100) structure was observed for an NiFe film grown on an $SrTiO_3(100)$ substrate throughout the course of deposition, as shown in Figs. 1(a) and 1(b). However, in early stage of NiFe film growth on an MgO(100) substrate, an NiFe($11\bar{2}0$) bi-crystalline epitaxial film with hcp structure was observed, as shown in Fig. 1(c). With increasing the film thickness, fcc-NiFe(100) phase appeared. The RHEED intensity of fcc phase increased and the RHEED pattern of fcc reflection overlapped with that of hcp reflection (Fig. 1(d)). Fig. 2 shows the magnetization curves. The magnetic properties of these epitaxial films reflect the magnetocrystalline anistropy of bulk fcc-NiFe crystal. The coercivities are less than 3.5 Oe for both films. The Gilbert's damping constants are investigated by using an FMR system.

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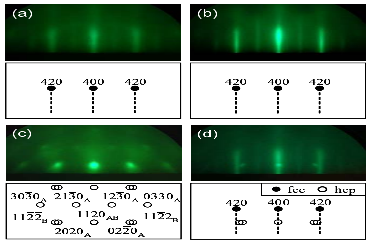

Fig. 1. RHEED patterns observed for NiFe thin films grown on SrTiO3(100) (a), (b) and MgO(100) (c), (d) deposited at 300 °C. The film thicknesses are 5 nm (a), (c) and 40 nm (b), (d), respectively.

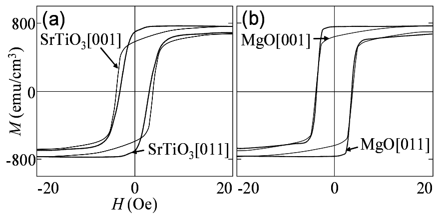

Fig. 2. Magnetization curves of 40 nm-thick NiFe thin films prepared on (a) SrTiO3(100) and (b) MgO(100) substrates.

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