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Effect of Gd content on the magnetic properties of Gd-Fe thin films

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Abstract

Gd-Fe films with two compositions, $Gd_{48}Fe_{52}$ and $Gd_{54}Fe_{46}$, were produced at room temperature using dc magnetron sputtering and changing Ar gas pressure. The XRD plots revealed that both films are amorphous. Due to the increase in rare earth concentration, the film with a high transition metal content exhibited domain wall pinning along the in-plane magnetization direction, whereas the film with a low transition metal level exhibited substantial magnetic anisotropy.

Introduction

Because of their functional features, studies on the magnetic anisotropy of Gd-Fe thin films have gotten a lot of attention in recent decades [1]. These films' great magnetic anisotropy makes them appropriate for a wide range of applications, including micro-sensors, micro-actuators, magnetic optical switching, and so on [2]. Furthermore, material parameters such as composition, microstructure, film thickness, and annealing conditions are found to have a considerable influence on these properties [3]. However, there are few research on Gd-Fe films with in-plane magnetic anisotropy. In this connection, a study has been undertaken to develop Gd-Fe films by sputtering and investigate their magnetic characteristics as a function of composition.

Experimental Details

DC magnetron sputtering was used to deposit Gd-Fe thin films. The films were deposited at room temperature with a constant sputtering power of 100 Watt and changing Ar gas pressures (8 and 16 mTorr). Al was utilised as a capping layer to prevent the films from oxidising. Energy dispersive spectroscopy (EDS) coupled to scanning electron microscopy was used to determine the composition of the films (SEM). The X-ray diffraction (XRD) technique was used to conduct structural analyses. A VSM was used to measure room temperature magnetization along the plane of the film up to a magnetic field of 2 kOe.

Reults and Discussion

Tb-Fe-Co films with thicknesses of 300 and 400 nm were deposited at 8 and 16 mTorr gas pressures, respectively. The XRD patterns for the Gd-Fe films deposited with various Ar gas pressures, namely 8 and 16 mTorr, show that both films are amorphous. Images for films with compositions $Gd_{48}Fe_{52}$ and $Gd_{54}Fe_{46}$show compositions determined by EDS analysis. In-plane magnetization curves for Gd-Fe films with varying Gd to Fe ratios at room temperature. The films are discovered to be ferromagnetic in nature when tested at room temperature.Because of the rise in rare earth content in the film, the unsaturated magnetization curves for the film with high Gd content show an increase in anisotropy.

Summary:

Dc magnetron sputtering was used to deposit amorphous Gd-Fe films with two distinct

compositions, $Gd_{48}Fe_{52}$ and $Gd_{54}Fe_{46}$. The films' structural and magnetic characteristics were investigated. In-plane magnetic anisotropy is observed in films with a high transition metal content. Magnetic anisotropy is high in Gd-Fe films with high Gd concentration. The magnetization at room temperature plainly demonstrates this.

References

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