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FMR studies of CrO_2 epitaxial thin films

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Abstract

Epitaxial (100) thin films of CrO_2 of various thickness were fabricated by chemical vapor deposition (CVD) at atmospheric oxygen pressure onto (100) TiO_2 single-crystal substrates. Ferromagnetic resonance (FMR) measurements were performed at the X-band (9.5 GHz) at room temperature. The angular dependencies of the FMR spectra in both ''in-plane'' and ''out-of-plane'' geometries were measured. The directions of easy and hard axes of magnetization were determined from the in-plane measurements, when the DC magnetic field was rotated in the film plane. It was established that, at room temperature, the easy axis of magnetization is parallel to the *c*-axis of the CrO_2 rutile structure. Splitting of the FMR signal into surface and bulk modes was observed due to surface pinning of magnetization at interfaces of the CrO_2 films. The magnetoelastic anisotropy was observed to be enhanced with decreasing film thickness. The values of the room temperature effective magnetization and parameters of the anisotropy field were obtained from analysis of the FMR data.

Keywords: Thin films; Half-metallic materials; Magnetic anisotropy; Ferromagnetic resonance

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1. Introduction

A unique property of half-metallic ferromagnets is a completely spin-polarized conduction band, making them ideal candidates for applications in tunnel junctions and other spintronic devices. One such material is ferromagnetic chromium dioxide (CrO_2), which is used in powder form as a storage medium in commercial magnetic tapes. It has been predicted theoretically by band structure calculations that CrO_2 has a very high spin-polarization of the conduction band [1–3]. Experimental evidence for this has been provided recently by spin-polarized photoemission [4] and point-contact Andreev reflection measurements [5–8]. Epitaxially grown single-crystalline CrO_2 films have been synthesized very recently [9], and there are a few papers on the electric and magnetic properties of this material [6–13].

In this article we report preliminary results of a ferromagnetic resonance (FMR) study of the magnetic properties of epitaxial chromium dioxide films. The magnetic parameters (effective magnetization,

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