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Magnetic Properties of Barium Ferrite Thin Films Grown Under Oxygen Pressure by Pulsed Laser Deposition.

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Introduction

M-type hexagonal barium ferrite (BaM) films have been studied extensively due to their potential applications in recording and microwave device. The present development of epitaxial BaM thin films has been exclusively focused on deposition onto various substrate and condition for application[1-4]. In this work, M-type hexagonal barium ferrite (BaM) thin films were deposited on Pt (111) substrate by pulsed laser deposition (PLD). We have studied crystalline structure and c-axis orientation of magnetization of the BaM thin films by controlling various oxygen pressures.

Experiment

The BaM thin films were deposited on 10×10 mm Pt (111) substrates by using a pulsed laser deposition (PLD). A base pressure in chamber was 9×10^{-7} Torr, and a substrate was located at a distance 3.5 cm from target. BaM target was ablated using a KrF (248 nm) excimer laser operated at 13 Hz during rotated target and substrate, and substrate temperature (T_S) was 710 ^oC. All deposition was carried out with oxygen pressure (PO_2) ranging from base pressure to 300 mTorr during 30 minutes. In these experiment conditions, thickness of the deposited BaM thin film was measured 200 nm. Crystalline structure was measured using x-ray diffraction (XRD), and surface morphologies and thicknesses of BaM film were measured atomic force microscope (AFM) and scanning electron microscope (SEM). Magnetic properties were measured by vibrating magnetometer (VSM) and conversion electron Mössbauer spectroscopy (CEMS).

Results and discussion

Fig. 1 shows XRD patterns of the BaM films deposited at oxygen pressure (PO_2) of base pressure, 10, 150, and 300 mTorr. We note that as oxygen pressure (PO_2) decreased from 300 mTorr to base pressure, diffraction peaks of (006) and (008) plane of the BaM c-axis orientation were developed pronouncedly, even if the peak of (200) plane appeared when oxygen pressure (PO_2) was on base pressure. Therefore, it is concluded that the c-axis oriented BaM thin film was well deposited in low oxygen pressure on the Pt (111) substrates. Fig. 2 shows SEM image of the BaM surface morphologies. An obvious hexagonal platelet grain can be seen apparently on the film surface. Also, AFM images confirmed that BaM thin film gradually grew a hexagonal platelet grain as oxygen pressure (PO_2) decreased from 300 mTorr to base pressure. Magnetic hysteresis loops for the perpendicular and parallel to the BaM thin films were measured using VSM with a maximum field 10 kOe. As oxygen pressure (PO_2) decreased, saturation magnetization (M_S) increased under the external field perpendicular to BaM thin films. The M_S was measured to be 260 ± 5 emu/cm^3 in and coercivity (H_C) was measured 1.0 kOe in base pressure. Conversion electron Mössbuaer spectroscopy was measured in which direction of γ-ray in perpendicular to the BaM thin films at room temperature.

Finally, we have successfully deposited c-axis oriented BaM thin films by controlling low oxygen pressure (PO_2). Magnetic properties have good quality in low oxygen pressure.

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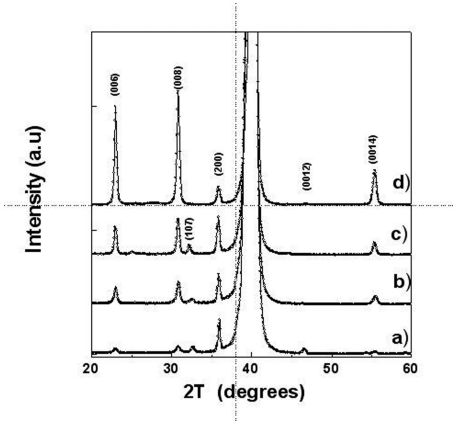

Fig. 1. XRD patterns for BaM thin films of oxygen pressure a) 300 mTorr, b) 150 mTorr, c) 10 mTorr, and d) base pressure.

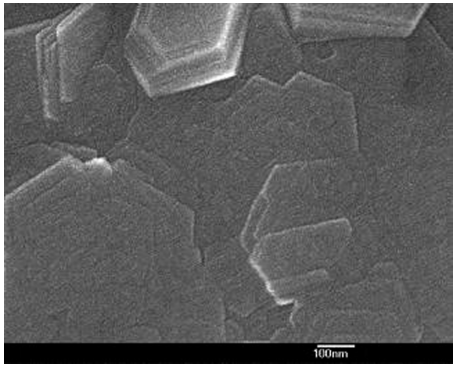

Fig. 2. SEM image of BaM thin films deposited on base pressure oxygen pressure.