Preparation and Ferroelectric Properties of $BaTiO_3$ Related Thin Films

Yoichiro MASUDA*, Shigetaka FUJITA* and Hirofumi KAKEMOTO**

Abstract

$BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ thin films on Pt/SiO_2/Si(100), Nb doped $SrTiO_3$ (100) and (111) substrates were synthesized by pulsed laser deposition method using fourth harmonic generated light of Nd^{3+} : YAG laser beam under low O_2 partial pressure.

The *in-situ* observation of $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ film deposition on Nb doped $SrTiO_3$ (100) substrate was performed using reflection high energy electron beam diffraction method. The $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ thin films deposited on Nb doped $SrTiO_3$ (100) and (111) substrates showed a preferential [100] and a preferential [111] orientation, respectively.

The ferroelectric properties of $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ thin films were investigated by electrical measurements. The frequency dependence of the dielectric constant of $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ thin film was influenced by low dielectric phase, and it analyzed by the Debye model. The remanent polarization and coercive electric field of $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ thin film on Nb doped $SrTiO_3$(111) substrate were measured at room temperature, and those values were 3.1 μC/cm^2 and 3.6 kV/cm, respectively.

Keywords: $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$, pulsed laser deposition method, thin film, RHEED, ferroelectric properties, hysteresis loop

INTRODUCTION

$BaTiO_3$ (BT) is well known as a fundamental ferroelectric perovskite oxide (ABO_3). By substituting small portion of the B(Ti)-site of $BaTiO_3$ with ($Hf_{0.5}$, $Zr_{0.5}$) cations, namely, $BaTi_{0.91}(Hf_{0.5}, Zr_{0.5})_{0.09}O_3$ (BTHZ) appears rhombohedral structure (C_{3v}, $a=b=c=3.99$ Å, $\alpha=\beta=\gamma=89.5°$) at room temperature (RT). BTHZ shows large remanent polarization ($P_r=15$ μC/cm^2) and small coercive electric field ($E_c=350$ V/cm) in comparison with those of BT ($P_r=7.0$ μC/cm^2, $E_c=3.5$ kV/cm) [1, 2]. BTHZ has been noticed for its potentials as electronic device applications for ferroelectric random access memories (FeRAMs) and infrared sensors. In addition, BTHZ is attracted for microactuators, because of a quadratic strain function on an ac electrical field above 1 kV/cm [2]. Hence, investigations about BTHZ thin film's growth conditions and its ferroelectric properties are very important study.

Many attempts have been made on ferroelectric thin films has been grown on Pt deposited SiO_2/Si substrate. Recently, the buffer layer and substrate which possesses perovskite structure such as $SrRuO_3$ and $SrTiO_3$ (STO) have been attracted for an epitaxial growth of ferroelectric thin films [3].

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* 電気電子工学科・教授
** 電気電子工学科・研究員