Ferroelectric $Sr_xBa_{1-x}Nb_2O_6$ Synthesized by YAG Laser Deposition

Ken-ichi KAKIMOTO*, Shigetaka FUJITA** and Yoichiro MASUDA**

Abstract

Tungsten-bronze type tetragonal $Sr_xBa_{1-x}Nb_2O_6$ (SBN) ceramics have been synthesized by pressure-less sintering at 1,250°C through a mixed-oxide route. With increasing x value in the range from 0.3 to 0.6, the Curie temperature shifted to lower temperature, but the corresponding maximum dielectric constant increased. Further, $Sr_{0.3}Ba_{0.7}Nb_2O_6$ thin films have been formed by pulsed YAG laser deposition (PLD) technique using a selected SBN bulk target with various choices of the deposition parameters. When Pt-coated Si substrates were used for PLD, a preferential c-axis-ordered structure was observed in the films deposited with the energy density above 2.0 J/cm², at substrate temperature above 650°C, and in oxygen partial pressure below 7 Pa. The thin film demonstrated a rhomboidal P-E hysteresis loop, and showed a remanent polarization (P_r) of 3.1 μC/cm² and coercive field (E_c) of 1.28 kV/cm.

Keywords: thin film, niobates, tungsten bronze structure, YAG laser ablation, crystal orientation, ferroelectric properties, P-E hysteresis loop

1. Introduction

Strontium barium niobate $Sr_xBa_{1-x}Nb_2O_6$ (SBN, $0.25<x<0.75$) is believed a solid solution in the $SrNb_2O_6$-$BaNb_2O_6$ pseudobinary system[1] and exhibits a crystal structure closely related to the tetragonal tungsten bronze structure (4 mm) with a unit-cell formula of $[(A1)_4(A2)_2C_4B_{10}O_{30}]$.[2] This structure consists of a framework of NbO_6 octahedra including different types of interstitial sites: A1 site for a coordination number of 15, A2 site of 12, C site of 9 and B site of 6. Two of such interstitial sites A1 and A2 are generally occupied by Sr/Ba cations, while C site is vacant. However, Sr/Ba cations in actual SBN materials are considered to be not distributed regularly at those sites, but seems to form various local coordination depending on the x value.

SBN is well known in particular that it exhibits an extremely high electro-optic coefficient[3] and strong photorefractive effects[4,5] as a similar degree to $BaTiO_3$, since the crystal is transparent over a wide wave length range. Further, SBN should demonstrate excellent ferroelectric properties due to the fact that spontaneous polarization occurs along the c-axis of the tetragonal structure and the Curie temperature can be continuously shifted in the range from 50 to 250°C by controlling the x value.[6] Various fabrication techniques can be used for successful synthesis of SBN. The methods reported so far include the Czochralski method

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* 日本学術振興会未来開拓学術研究プロジェクト・研究員
** 電気電子工学科・教授