Compositional dependence of $BaTiO_3$-x$BaSnO_3$ piezoelectric thin films prepared by combinatorial sputtering

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1. Introduction

Investigation of lead-free piezoelectric thin films has been of great importance to realize environmental-friendly piezoelectric MEMS. One of the promising lead-free piezoelectric materials is (1−x)$BaTiO_3$–x$BaSnO_3$ (BT-xBS) solid solution whose piezoelectric coefficient (d_{33}) is as high as 425 pC/N [1]. In this study, we tried to deposit BT-xBS thin films on Si substrates and examine the compositional dependence of piezoelectric properties.

2. Experimental procedure and results

BT-xBS perovskite thin films with one-directional graded composition were prepared on Pt/Ti/Si substrates by multi-target rf-magnetron sputtering as shown in Fig. 1. The combinatorial sputtering method enabled a wide range of Sn^{4+} concentration varying from 0 to 20 at% in polycrystalline BT-xBS thin films. The crystal structure of BT-xBS thin films were highly (101)-oriented and the maximum value of dielectric constant was 925 at around Sn^{4+} = 2.8 at%. The piezoelectric properties of these films were measured by the tip displacement of the BT-xBS/Si unimorph cantilevers. Fig. 2 shows the compositional dependence of the transverse piezoelectric coefficient $|e_{31,f}|$, which reached 1.91 C/m^2 at the same Sn^{4+} concentration of 2.8 at% as dielectric constant. These good piezoelectric performances indicate that BT-xBS solid solution is a promising substitute for lead-free piezoelectric thin films.

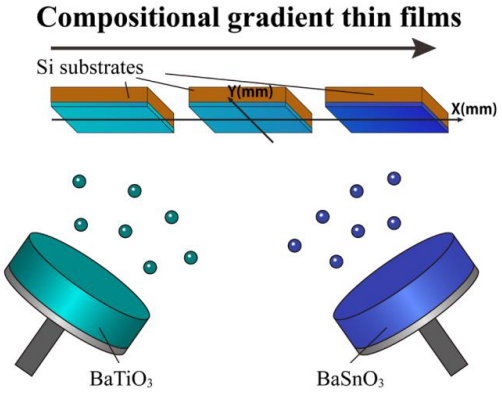

Fig.1 combinatorial sputtering setup for compositional gradient BZT-BCT thin films

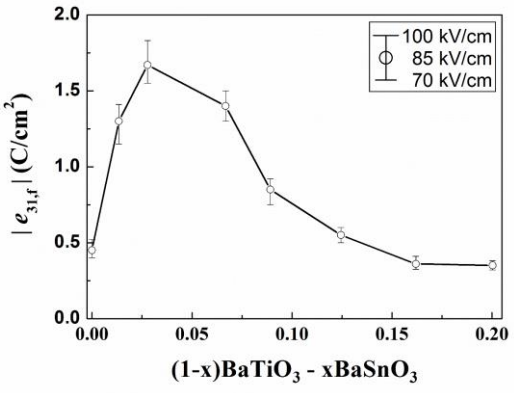

Fig.2 Piezoelectric coefficients | $e_{31,f}$| of BZT-BCT films as a function of composition ratio

[1] Kalyani, A. K.; Brajesh, K.; Senyshyn, A.; Ranjan, R., *Appl. Phys. Lett.* **2014**, *104* (25), 252906.