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Growth and characterization of  $\text{Bi}_{3.15}\text{Nd}_{0.85}\text{Ti}_{2.95}\text{Hf}_{0.05}\text{O}_{12}/\text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_3$  composite film with strong magnetoelectric effect by chemical solution deposition under moderate crystallization temperature

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## Abstract

Using chemical solution deposition method,  $\text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_3$  (LSMO) and  $\text{Bi}_{3.15}\text{Nd}_{0.85}\text{Ti}_{2.95}\text{Hf}_{0.05}\text{O}_{12}$  (BNTH) layers were successively fabricated onto (001)  $\text{LaAlO}_3$  (LAO) substrates, and then BNTH/LSMO ferromagnetic-ferroelectric composite films with a 2-2 layered type structure were obtained. The LSMO ferromagnetic layer was epitaxially grown on the LAO substrate and showed the low resistivity of  $5.0 \times 10^{-3} \Omega \cdot \text{cm}$ . It was not only used as a seed layer to induce the oriented growth of BNTH ferroelectric layers, but also as a bottom electrode to measure ferroelectric/magnetoelectric (ME) properties. The effects of crystallization temperature on the orientation degree, the surface morphology, and the dielectric and ferroelectric performances of the composite films were investigated. The composite film crystallized at 730 °C has the largest remnant polarization ( $P_r$ ) of  $35.0 \mu\text{C}/\text{cm}^2$ , the lowest leakage current density of  $1.35 \times 10^{-7} \text{ A}/\text{cm}^2$  and the high saturated magnetization ( $M_s$ ) of  $370 \text{ emu}/\text{cm}^3$ . The composite film also exhibits a strong ME

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