The ferroelectric and leakage current properties of Sm-Ta co-doped $Bi_4Ti_3O_{12}$ Ferroelectric Thin films

H. Z. Chen[a], M. C. Kao[a], S. L. Young[a], B. N. Chuang[b], W. W. Jiang[a], and J. S. Song[b]

[a]Department of Electronic Engineering, Hsiuping Institute of Technology, Taichung, Taiwan
[b]Center for Measurement Standards, Industrial Technology Research Institute, Hsinchu, Taiwan

The Sm-Ta co-doped $Bi_4Ti_3O_{12}(Bi_{4-x}Sm_xTi_{2.92}Ta_{0.08}O_{12}, BSTTO)$ thin films were fabricated on $Pt(111)/Ti/SiO_2/Si(100)$ substrates by sol-gel technology. The effects of various processing parameters, including Sm content (x = 0 − 0.08) and annealing temperature ($500 - 800^oC$), on the microstructure and ferroelectric properties of thin films were investigated. The measured $2P_r$ of the highly (117)-oriented BSTTO thin film is larger than that of the $Bi_4Ti_3O_{12}$ thin film. The leakage currents of Sm-Ta co-doped $Bi_4Ti_3O_{12}$ films are lower than those of Ta doped specimens. The leakage current of $Bi_{4-x}Sm_xTi_{2.92}Ta_{0.08}O_{12}$ and $Bi_{3.98}Sm_{0.02}Ti_{2.92}Ta_{0.08}O_{12}$ films are 1.25×10^{-3} and 1.47×10^{-5} A/cm^2, respectively, at 500 kV/cm. The reason is that the improvement of ferroelectric and leakage current properties in these films can be attributed to the enhanced stability of the oxygen in the Ti-O octahedron layer, which is caused by the substitution of stable rare-earth ions (Sm) for the volatile Bi ions located near the Ti-O octahedron layer. Furthermore, the substitution with high-valent cations (Ta) for Ti^{4+} in BTO thin films assisted the elimination of defects such as oxygen vacancy and vacancy complexes.