Pulsed-Laser Deposited 35 Bi(Mg1/2Ti1/2)O-3-65 PbTiO3 Thin Films-Part I: Influence of Processing on Composition, Microstructure, and Ferroelectric Hysteresis

C. Morandi, J.L. Gray, W. Auker, S. Trolier-McKinstry

35 Bi(Mg1/2Ti1/2)O-3 - 65 PbTiO3 (35 BiMT-65 PT) is a potential candidate material for a high-temperature nonvolatile ferroelectric memory. For pulsed-laser deposited 35 BiMT-65 PT films with the perovskite structure, it was found that as the chamber pressure during deposition decreased, the Mg and Pb contents in as-deposited films drop, while the concentration of Bi increases. Concurrently with the change in composition, the remanent polarization Pr increases 64% to approximate to 21 μC/cm² and the polarization-electric field loops rotated counterclockwise as the deposition pressure increases. Decreasing the seed layer thickness from 36 to 16 nm led to a decrease in Pr to approximate to 14 μC/cm². Adjusting the target composition allowed the deposition of films which had near-stoichiometric Bi and Mg concentrations, but in all cases, the grown films were lead deficient. These films had remanent polarizations of 18-20 μC/cm². If the lead content of the target was increased too far, the remanent polarization decreased, possibly due to the need to evolve more PbO from defective growth layers. Finally, the deposition rate showed no substantial effect on the film composition, but did have a significant impact on the ferroelectric properties. As the deposition rate decreased, the Pr increased to approximate to 22 μC/cm² due to enhanced crystalline quality. At laser frequencies of 5 Hz, a Mg-rich pyrochlore phase begins to form and films showed a maximum Pr approximate to 22 μC/cm². The processing-composition behavior is explained via preferential adsorption of Bi on the A-site, which results in lead vacancies.