Investigation of BZT Thin Films for Tunable Microwave Applications

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Abstract

BZT thin film has been investigated as a perspective candidate for tunable microwave applications. Thin films were deposited by RF magnetron sputtering from a $Ba(Zr_{0.3}Ti_{0.7})O_3$ ceramic target on MgO single crystal substrates. By means of Rutherford backscattering (RBS), scanning electron microscopy (SEM) and x-ray diffraction (XRD), the composition, thickness and crystallinity of the thin films were analyzed, respectively. Using interdigital capacitors (IDC) with Au electrodes on thin films, the dielectric constant and loss tangent were measured as a function of bias electric field (0 – 7 kV/mm) and temperature (-140 °C to +160 °C) at low frequencies up to 1 MHz. The influence of post-annealing on the tunable dielectric properties of the thin films was studied. Tunability {defined as $\tau = [\varepsilon(0) - \varepsilon(E_{max})] / \varepsilon(0)$} can be significantly increased by increasing the annealing temperature. A tunability of 76 % at E_{max} = 7 kV/mm and a loss tangent of 0.0078 have been achieved for the sample annealed at 1100 °C, measured at 1 kHz and room temperature. In addition, BZT thin films were also characterized at microwave frequencies up to 26 GHz by measuring coplanar waveguide (CPW) resonators. The frequency dependence of losses and tunability is also discussed.

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