Materials Science and Engineering Master's Defense

Growth and Characterization of Thin Films of High Performance Microwave Dielectrics

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abstract

Microwave dielectrics are widely used to make resonators and filters in telecommunication systems. The production of thin films with high dielectric constant and low loss could potentially enable a marked reduction in the size of devices and systems. However, studies of these materials in thin film form are very sparse.

In this work, Pulsed Laser Deposition (PLD) has been used to synthesize $Ba((Co,Zn)_{1/3}Nb_{2/3})O_3$ (BCZN) dielectric thin films on MgO(001) substrates. The BCZN films are epitaxial and have an orientation of (001)//MgO(001) and (100)//MgO(100) when deposited at substrate temperatures above 500°C. In-situ annealing at growth temperature in 200 mTorr oxygen pressure was found to enhance the quality of the films, reducing the peak width of the X-ray Diffraction (XRD) rocking curve to 0.53° and the χ_{min} of channeling Rutherford Backscattering Spectrometry (RBS) to 8.8% when grown at 800°C. Atomic Force Microscopy (AFM) was used to study the topography and found a monotonic decrease in the surface roughness when the growth temperature increased. Optical absorption and transmission measurements were used to determine the energy bandgap and the refractive index respectively. A low-frequency dielectric constant of 33.8 was measured using a planar interdigital measurement structure. The resistivity of the film is $\sim 3.4\times10^{10}$ Ω·cm at room temperature and has an activation energy of thermal activated current of 0.66 eV.

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