UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF TUNABLE BARIUM STRONTIUM TITANATE THIN FILMS ON SAPPHIRE SUBSTRATE

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ABSTRACT

With the recent rapid development of communication systems, there has been strong demand towards smaller scaled, lighter-weight and low-cost devices with the ability to be more adaptable and reconfigurable. These characteristics present significant hurdles to conventional systems, prompting the development of new advanced technologies. The introduction of ferroelectric materials such as Barium Strontium Titanate (BST) has aroused research interest in the last 20 years. BST thin film has been a preferred choice material throughout the previous decades due to its numerous applications in microwave devices. BST is seen as a viable candidate due to its high dielectric constant, which enables for continuous shrinkage of integrated circuits and device miniaturisation for RF and microwave components. BST is chosen as the material for room-temperature-based voltage device because of its unique microwave properties like high tunability and low electrical loss. Since its electrical behaviour is heavily influenced by the choice of material, therefore successfully incorporating BST into integrated circuits will necessitate the ability to control their physical and chemical properties. The primary objective of this study is to synthesize and characterize RF magnetron sputtered Barium Strontium Titanate ($Ba_{0.5}Sr_{0.5}Ti_{O3}$) thin film. The focus of the research is to investigate the correlation between processing condition, material and microwave characterization of the BST. In this study, there were 2 batches of deposited samples. The first batch of samples (Batch One) were deposited for 2, 3 and 4 hours with pre-sputtering process for 10 minutes, while for the second batch (Batch Two) the time varies from 1 to 5 hours with pre-sputtering process for an hour. These deposited samples were then annealed at 900℃ for 2 hours and structurally characterized using Field Emission Scanning Electron (FESEM), Energy Dispersive X-Ray (EDX), Atomic Force Microscopy (AFM), surface profilometry and X-Ray Diffraction (XRD). Tunable capacitors (varactors) were fabricated by patterning interdigital electrode structures on top of BST films. Tunability of 49% and 39% were achieved for the films grown at 4-hour and 3-hour respectively, at 40V biasing voltage. The results from these analytical techniques were then analysed, where the crystal structure, surface roughness and surface thickness were found to be dependent on the deposition time, annealing effect and pre-sputtering process.

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