Fine-Tuning the Microwave Transport Properties of Ferroelectric Thin Films Using the Pulsed Laser Deposition Technique

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Ferroelectric thin films offer great potential as active and passive components in microwave devices because their dielectric constant can be changed under the influence of an applied electric field. Traditionally, ferroelectric materials have been overlooked for microwave applications because of the intrinsically high coercive fields required to induce changes in their dielectric constant and the high dissipation losses typically observed in bulk polycrystalline materials. The ability to fabricate ferroelectric thin films by the pulsed laser deposition technique (PLD) obviates these drawbacks of bulk, polycrystalline ferroelectrics to a large extent because the films are typically epitaxial, have relatively low loss tangents (10^{-1} to 10^{-3}) and require small coercive voltages (5 to 10 volts). Furthermore, the PLD process can be easily used for the in situ deposition of both the substrate (or ground plane) as well as the ferroelectric material. Ferroelectric thin films of $(Sr,Ba)Nb_2O_3$, $(K,Ta)Nb_2O_3$, and $Pb(Zr,Ti)O_3$, or SBN, KTN, and PZT, respectively, have been successfully deposited by PLD onto a variety of substrate materials, including metal and high-temperature superconducting thin films and some of their electrical properties have been measured. Successful integration of ferroelectric materials into microwave heterostructures will require knowledge of their DC and microwave transport properties as a function of the ferroelectric film thickness, composition, and structure, as well as the substrate/film interface. This talk will focus on how PLD film growth conditions affect the composition, structure, and optical properties of PZT, SBN, and KTN thin films and how this can be used to fabricate thin films with desired microwave and DC transport properties, such as high dielectric constant, low loss tangent, and low coercive voltages.