Friday, September 29, 2006 • 2:30 pm • Rogers Hall 226

THIN FILM DIELECTRICS FOR EMBEDDED APPLICATIONS

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Abstract

Numerous researchers have pursued the integration of high permittivity thin film dielectric materials in high volume application since the mid 1980s. Appreciation of this goal has been slower than anticipated for a variety of reasons, perhaps most importantly, the incredible complexity of ferroelectric materials under challenging physical, electrical, and mechanical boundary conditions. In this presentation, Dr. Maria will discuss recent efforts at NCSU to develop methods for preparing device quality ferroelectric thin film processes that overcome several cost and complexity issues. He will focus on compositions from the $(Ba,SrTi)O_3$ (BST) solid solution deposited on low cost substrates, specifically thin copper foil. This foil based embodiment is targeted towards the application where thin and flexible capacitor sheets are embedded into printed wiring board polymer packages.

The materials challenges associated with this work are centered upon achieving process compatibility as it pertains to thermal expansion, chemical reactivity, and interface formation. In all cases, the necessary pathways to success involve a fundamental understanding of processing science. Methods used by Dr. Maria's group for chemical solution deposition and sputtering of BST will be discussed, with specific attention to two recent advances: fluxed-assisted densification and grain growth for solution deposited $BaTiO_3$, and novel annealing methods that promote large area electrode formation in sputtered BST. Respectively, these advances have provided for (1) room temperature permittivity values in excess of 3000, and (2) near 100% capacitor yield for 800 nm thick dielectric layers with capacitor diameters of 25 mm in the absence of any clean room processing steps. Finally, Dr. Maria will discuss how these improvements are being exploited in a collaborative program between NCSU and Dupont Electronic Technologies, which is currently on track to commercialize mass-produced $BaTiO_3$ thin films.

Speaker's Bio

Jon-Paul Maria received his BS (1994), MS, (1996) and PhD (1998) degrees in Ceramic Science from the Pennsylvania State University. His thesis topics involved preparation and characterization of epitaxial ferroelectric thin film heterostructures, and specifically, an investigation of domain engineering for enhanced piezoelectric responses in relaxor-ferroelectric solid solutions. Dr. Maria was a research assistant professor at the North Carolina State University in the Department of Materials Science from 1998 to 2002, assistant professor from 2002 through 2005, and associate professor from 2006 to present. While at NCSU, Dr. Maria has managed the Electroceramic Thin Film Group which specializes in structure-property relationships, processing science, fundamentals of ferroelectricity, defect chemistry, and novel integration. Current topics of investigation include tunable dielectrics for microwave front ends, alternative gate dielectrics, embedded capacitors, piezoelectic thin films, nitride-oxide heterostructures, multiferroic oxides, and energy storage. The group comprises Dr. Maria, seven PhD students, and two undergraduate researchers. Collectively, the group has produced four MS graduates, four PhDs, about 100 publications, and five patents.

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