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Investigation Into The Effect Of Substrate On $Pb(Zr_{0.52}Ti_{0.48})O_3$ Films for MEMS Application

During the past several decades, $Pb(Zr,Ti)O_3$ (PZT) thin films were given extensive attention for their potential as sensors and actuators in microelectromechanical systems (MEMS) due to their excellent piezoelectric properties. However, for thin films deposited on much thicker substrate, the piezoelectric response is influenced by the substrate clamping, which deviates PZT properties compared with bulk materials. Therefore, to optimize the performance of PZT thin film for a MEMS device, a comprehensive understanding of the clamping effect of substrate on PZT thin films and devices is extremely pertinent.

The first part of this talk discussed the effects of the structural layer in substrates on the mechanical and electrical properties of PZT films for MEMS applications. The mechanical properties of PZT films were characterized by nanoindentation. Electrical properties as a function of film thickness and layer material were also investigated. A new model of film indentation was employed to decouple the effects of film orientation and structural layer type on the Young's modulus.

The other focus of the talk will be the influence of varying Si thickness on the electrical and piezoelectric properties of fabricated PZT cantilevers. PZT cantilevers with different thicknesses were designed and fabricated. The electrical and piezoelectric properties of the MEMS devices were measured and the Si thickness dependence of those properties was investigated. The obtained results indicated a smaller thickness of Si substrate resulted in higher polarization, dielectric and piezoelectric constants, probably due to the change of the residual stress condition. A model was developed to predict the residual stress in PZT cantilevers.

Dr. Liu received his B. S. and M. S. degree in Materials Science and Engineering from Huazhong University of Science and Technology, China, in 2000 and 2003 respectively. He received his Ph.D. degree in Materials Engineering from Auburn University in May 2011. His research interests include thin film materials focused on ferroelectric and piezoelectric materials to advance scientific understanding and to realize novel application; design, fabrication and characterization of piezoelectric MEMS devices.

Friday, August 5, 2011
1:30 pm - Room 149, Jorgensen Hall

Host:
Dr. Xia Hong
Department of
Physics & Astronomy

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