MAR05-2004-004567

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Combined Surface Analytical Methods to Characterize Degradative Processes in Anti-Stiction Films in MEMS Devices

KEVIN ZAVADIL, Sandia National Laboratories

The performance and reliability of microelectromechanical (MEMS) devices can be highly dependent on the control of the surface energetics in these structures. Examples of this sensitivity include the use of surface modifying chemistries to control stiction, to minimize friction and wear, and to preserve favorable electrical characteristics in surface micromachined structures. Silane modification of surfaces is one classic approach to controlling stiction in Si-based devices. The time-dependent efficacy of this modifying treatment has traditionally been evaluated by studying the impact of accelerated aging on device performance and conducting subsequent failure analysis. Our interest has been in identifying aging related chemical signatures that represent the early stages of processes like silane displacement or chemical modification that eventually lead to device performance changes. We employ a series of classic surface characterization techniques along with multivariate statistical methods to study subtle changes in the silanized silicon surface and relate these to degradation mechanisms. Examples include the use of spatially resolved time-of-flight secondary ion mass spectrometric, photoelectron spectroscopic, photoluminescence imaging, and scanning probe microscopic techniques to explore the penetration of water through a silane monolayer, the incorporation of contaminant species into a silane monolayer, and local displacement of silane molecules from the Si surface. We have applied this analytical methodology at the Si coupon level up to MEMS devices. This approach can be generalized to other chemical systems to address issues of new materials integration into micro- and nano-scale systems.
* This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration.