Thin Films
Room 326 - Session TF+MM-WeA
Sensors, Smart Films and Functional Materials
Moderator: C.H. Stoessel, Consultant

2:00pm **TF+MM-WeA1 CMOS-Based Microsensors***, **O. Brand**,* Georgia Institute of Technology **INVITED**

CMOS-based microsensors combine, on a single chip, the necessary transducer elements and integrated circuits. This way, the microsensors benefit from well-established fabrication technologies and the possibility of on-chip circuitry. Besides sensor biasing and signal conditioning, added on-chip functionality, such as calibration, self-testing, and digital interfaces, can be implemented. A number of microsensors, including magnetic field and temperature sensors, are completely fabricated within the regular CMOS process sequence. A far larger number of microsystems can be realized by combining CMOS or BiCMOS technology with compatible micromachining and thin film deposition steps. These additional fabrication steps are performed either before, in-between, or after the regular CMOS process sequence. Commercially available examples include pressure sensors, accelerometers, gyroscopes, humidity sensors, mass flow sensors, and imaging devices. In the first part, the paper summarizes major technological approaches to CMOS-based sensors. In the second part, a packaged CMOS-based chemical microsystem, developed at ETH Zurich, Switzerland for the detection of volatile organic compounds in air is highlighted. On a single chip, the microsystem combines a sensor array featuring three different sensing principles with circuitry for sensor biasing, signal read-out, analog-to-digital conversion, and digital interfacing. The chemical microsystem is fabricated using an industrial CMOS technology in combination with post-processing bulk-micromachining to release the micromechanical sensor structures. After packaging the microsystem using flip-chip technology, the three sensor structures are coated with chemically sensitive polymer films. Absorption of volatile organic compounds in the polymer films results in a change of the (physical) film properties, such as the mass, dielectric constant, or temperature, which is then recorded by the underlying sensor structure.

2:40pm **TF+MM-WeA3 Behavior of Thin Ionic Liquid Films Studied with Atomic Force Microscopy***, **J.J. Nainaparampil**, B.S. Phillips,* AFRL/MLBT*; K.C. Eapen,* University of Dayton Research Institute*; J.S. Zabinski,* AFRL/MLBT

Ionic liquids (IL's) represent a new class of solvents having the character of molten salts. They have no detectable vapor pressure, are moisture, air and temperature stable and therefore are excellent solvents. Most of these IL's consists of cations such as different alkyl imidazolium or alkyl pyridinium ions and anions such as BF@sub 4@, PF@sub 6@, N (CF@sub 3@SO@sub 2@)@sub 2@, CF@sub 3@SO@sub 3@. In this work, crystals of alkyl imidazolium+ PF@sub 6@ are dissolved in water or acetonitrile to form 0.2% to 0.5% solutions and deposited on Si surface to form thin films. Atomic force microscope working in non-contact mode capable of providing biased tip lithography is used to characterize these films. It is observed that scanned films give rise to certain geometrical structures that are repeated in recrystallized surfaces. A biased AFM tip is used to mobilize these structures to form other complex structures. It is noted that the same solution, when used as a lubricant in sliding contacts gives rise to drastic friction reduction compared to other lubricants. These IL's were used to lubricate a micro electro mechanical system (MEMS) electro static output motor. Results from MEMS endurance tests and an interface model that is based on the AFM study will be presented. Electro-migration of crystallites and adhesion of transfer films affect the friction and durability significantly.

3:00pm **TF+MM-WeA4 Bilayer Transition-edge Sensors for X-ray Calorimeter and Infrared Bolometer Arrays***, **J.N. Ullom**, J.A. Beall,* National Institute of Standards and Technology*; J. Beyer,* PTB, Guest Researcher NIST*; S. Deiker, W.B. Doriese, G.C. Hilton, K.D. Irwin, C.D. Reintsema, L.R. Vale,* National Institute of Standards and Technology **INVITED**

Microcalorimeters and bolometers made from thin superconducting films cooled to temperatures near 100 mK have made dramatic progress in recent years. These devices provide an order of magnitude improvement in energy resolution over existing semiconductor x-ray sensors and are likely to be used in upcoming astronomical instruments spanning the spectrum from x-ray to millimeter wavelengths. The sensitivity of these devices is derived from the low heat capacities and thermal conductivities possible near 100 mK and from the strong dependence of resistance on temperature in the superconducting-to-normal transition. Our devices are made from bilayers of a normal metal and a superconductor. Use of a bilayer allows the transition temperature and resistivity of the sensors to be precisely controlled. In this talk, we describe recent progress towards kilopixel sensor arrays using multiplexed SQUID readout. We are building arrays of x-ray microcalorimeters for two applications: energy-dispersive x-ray spectroscopy on scanning electron microscopes and for the upcoming NASA satellite Constellation-X. We are building arrays of submillimeter bolometers for the SCUBA-2 camera on the James-Clerk Maxwell Telescope on Mauna Kea. At this time, the measured noise in both microcalorimeters and bolometers approaches but does not equal the value predicted from simple thermodynamics. We will present measurements of this excess noise and describe recent mitigation efforts.

Author Index

Bold page numbers indicate presenter