Microelectromechanical Systems (MEMS)
Room 320 - Session MM-WeM

New Frontiers in Microsystems: NEMS and BioMEMS
Moderator: R. Ghodssi, University of Maryland

8:20am **MM-WeM1 The Science and Technology of Nanomechanical Resonant Structures***, **L. Sekaric**,* Cornell University **INVITED**

The development of nanometer-scale mechanical structures into sensitive and integrated devices has enabled us to envision applications such as cell phones the size of a wrist watch, fast and sensitive pathogen detectors, and ultra-sensitive field and force gauges. An exact understanding of the physical phenomena affecting NEMS behavior should aid in the successful application of these systems. Several important achievements in this field will be described - from fabrication of ultra-small and ultra-high frequency resonant structures in a variety of materials to understanding their behavior and improving their performance. Some of the topics to be discussed include the time scales of nanoscale dynamics, the operation of NEMS in vacuum and in air, the sources of energy dissipation, and the effects of thin film mechanics in NEMS.@footnote 1@ @FootnoteText@ @footnote 1@In collaboration with: M. Zalalutdinov, K. Aubin, A. T. Zehder, J. M. Parpia, and H. G. Craighead, Cornell Center for Materials Research, and J. E. Butler, Naval Research Labs.

9:00am **MM-WeM3 Investigation of Nanostructuring by Use of Focused Ion Beam Fine Milling***, **Y. Fu**,* Nanyang Technological University, Singapore

Micro-pillars with nano-sizes for application of molecular controlling were fabricated by use of focused ion beam (FIB) fine milling on substrate of silicon. The nano-pillars can realize cell/molecular adhesion, and movement control by its high-density contact dots and tiled cone angle of the pillars, which can be obtained by means of FIB directly fine milling with a stage in a certain tilted angle. The milling process was investigated under different beam current and the stage-tilting angle, which determines an aspect ratio and the tilted angle of the pillars. Chemical assistant etching (GAE) with chemical gas of XeF2 was used for the purpose of deviating the pillars with higher aspect ratio. With these features, the pillars can realize cell/molecular movement in only one direction and cannot be backward. It will be helpful for DNA and protein analysis, such as molecule separation and purification, molecular detection, and DNA hybridization, etc.

9:20am **MM-WeM4 Electron Interactions in Nanoscale Focused Electron Beam Processing***, **P.D. Rack**, J. Kim, J.D. Fowlkes, S.J. Randolph, D.C. Joy,* University of Tennessee

Focused electron beam induced processing has recently been demonstrated to be a viable technique for selective nanoscale processing. The technique is similar in principle to focused ion beam processing, however, the electron-stimulated reactions have been shown to have a smaller effective beam width (~ 50nm) and do not suffer the collateral damage associated with gallium implantation. In this presentation, we will show our recent progress in electron beam stimulated deposition and etching. Particular attention will be given to the effects that secondary and backscattered electrons have on the deposited or etched structure. Electron-solid and electron-gas Monte Carlo simulations will be correlated to the observed deposition and etching profiles profiles. Beam energy and current density effects will also be shown and explained. Finally, application of the process to several nanoscale devices will be demonstrated.

9:40am **MM-WeM5 BioMEMS-Based Platforms for Drug Delivery: Implantable, Ingestible, and Beyond***, **T.A. Desai**,* Boston University **INVITED**

Microfabrication techniques, which permit the creation of multifunctional platforms that possess a combination of structural, mechanical, and electronic features, may surmount several challenges associated with the conventional delivery of therapy. In this talk, in vivo delivery concepts are presented which capitalize on the strengths of micro and nanofabrication. Current work on micromachined nanoporous implantable biocapsules for the immunoisolation of pancreatic islet cells - as a possible treatment for diabetes -- will be described. In addition, asymmetrical, reservoir-containing microfabricated particles and arrays with specific biorecognition ligands will be discussed for improving the oral delivery of peptides and drugs. Such microengineered interfaces may be optimized for biomolecular selectivity and surface bioactivity. With the capability to design components spanning from the millimeter down to the nanometer range, few other engineering technologies can so closely parallel the multidimensional size scale of the living cells and tissues, with control and reproducibility, in the same fabrication process. Micro/Nanotechnology can add flexibility to current practices while becoming an enabling technology leading not just to new therapies and laboratory techniques, but to new models for delivering healthcare to the patient.

10:20am **MM-WeM7 Flexible, Polyimide-Based Microfluidic Devices for BioMEMS***, **S. Metz**, A. Bertsch, Ph. Renaud,* Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland

We present flexible, polyimide-based microfluidic devices for a wide range of applications in the field of BioMEMS. Fluidic microchannels are manufactured by a modified lamination technique or a sacrificial layer method. For the lamination technique a layer of uncured polyimide is irreversibly bonded to open channel structures of semi-cured polyimide, which yields very high bond strengths. The sacrificial layer technique implies the use of a heat-depolymerizable polycarbonate sacrificial material. The material is embedded in two layers of polyimide and diffuses through the channel cover layer during the last fabrication step leaving empty microfluidic channel networks behind. The microchannels can be combined with metallization layers for the integration of microelectrodes inside the microchannels, which is a major requirement in the field of miniaturized bio-chemical analysis. The electrodes inside the channels can be used for fluid actuation or detection of substances. The embedded layers of metal can also be used as microelectrodes for the recording or stimulation of bio-electric activity. This results in devices, which are capable of selectively delivering fluids to cells and at the same time enable electrophysiological monitoring. Additionally, the channel walls can be made porous by ion track technology, which yields sub-micron, high aspect-ratio pores perpendicular to the fluidic structure with a pre-defined pore density. The pores can be generated in the top and/or bottom channel walls of the microfluidic device and the pore size is adjustable down to tens of nanometers. These devices can be used for the separation of particles by cross-flow filtration.

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