MEMS and NEMS
Room Exhibit Hall C&D - Session MN-MoP
General Aspects of MEMS and NEMS Poster Session

MN-MoP1 AFM Studies of Conditioner Thickness Distribution and Binding Interactions on Hair Surface*, B. Bhushan, N. Chen,* The Ohio State University

How common hair care products, such as conditioner, deposit onto and change hair properties are of interest in beauty care science, since these properties are closely tied to product performance. The binding interaction between conditioner and hair surface is one of the important factors in determining the conditioner thickness distribution, and consequently the proper functions of conditioner. In this study, AFM is used to obtain the local conditioner thickness distribution, adhesive forces and effective Youngâ?Ts modulus mapping of various hair surfaces. The conditioner thickness is extracted by measuring the forces on the AFM tip as it approaches, contacts, and pushes through the conditioner layer. The effective Young's moduli of various hair surfaces are calculated from the force distance curves using Hertz analysis. The binding interactions of different silicones on the hair surface, as well as their effect on the effective Young's modulus of the hair are also discussed.

MN-MoP2 Plasma Enhanced Chemical Vapor Deposition of Low Stress Silicon Nitride Using Diethylsilane as Precursor*, L.M. Fischer, S. McColman, B. Szeto, K. Westra, S. Evoy,* University of Alberta, Canada

The stable surface and high stiffness-to-density ratio of silicon nitride offer interesting advantages over regular silicon for the production of high-frequency and high-quality nanoelectromechanical (NEMS) resonators. Such machining however requires a mechanical material possessing very low residual stress. Silicon-rich low-stress silicon nitride is typically produced using silane/nitrogen or silane/ammonia as precursors. Silane is however highly flammable and thus poses significant safety hazard. In addition, typical low-stress films produced by these methods may still contain residual stress levels exceeding 100 MPa. We here report the PECVD of silicon nitride using the relatively safer diethylsilane (DES) as precursor. We also report the control and reduction of residual stress in the films through post-deposition anneal. Compressive residual stress in the as-deposited material ranged from 555 MPa to 1GPa as the NH3:DES ratio varied from 1:1 to 16:1, while nitrogen content increased and carbon content decreased over the same range. This correlation is related to the increased formation of N-H radicals within the films. Compressive residual stress also increased from 558 MPa to 849 MPa as the deposition temperature was varied from 240 C to 315 C. Such temperature dependence is in turn attributed to an increased densification of the deposited films. A post-deposition anneal in inert nitrogen at temperatures of 500 to 600 C however relieves the stress and enables its control from the compressive to the tensile range. Tensile stresses as low as 50 MPa have been achieved. While hydrogen desorption is believed to be responsible for this change, XPS analysis also provided evidence of the formation C-N bonds in the annealed films. We will report a complete analysis of the formation, stochiometry, and stress relief in these films. We will also present the machining and characterization of NEMS resonators in this low-stress material.

MN-MoP3 DNA Detection System using a Microcantilever*, K.-A. Yoo,* Myongji University, Korea*; K.-H. Na,* Lite-on Technology Corp. Korea*; S.-R. Joung, C.J. Kang, Y.S. Kim,* Myongji University, Korea

We propose a novel detection system for analysis various biotinylated DNAs effectively with a microcantilever. The microcantilevers were fabricated employing surface micromachining technique that has attractive advantages in terms of cost efficiency, simplicity and ability of fabricating in array. The fluid cell system for injection of bio-molecular solution is fabricated using a polydimethylsiloxane (PDMS) and a fused silica glass. The microcantilever is deflected with respect to the difference of the surface stress caused by the formation of self-assembled bio-molecules on the gold coated side of the microcantilever. It can detect various biotinylated DNAs according to the specific interactions between the streptavidin and individual DNA sequencing of biotinylated DNA. We confirm that the deflections of bending-up or bending-down of individual microcantilevers are occurred by the bio-molecule adsorption. The microcantilever detected protein A and DNA due to the specific interaction between protein A and DNA. The principle of the interaction is a self-assembly between the bio-molecules. The microcantilever can be widely used to detect various bio-molecules including specific DNA and can be utilized as a bio-sensor.

MN-MoP5 Novel Fabrication Method of a Master Structure for Replicating an Optical Device Including Vertically Curved Structures*, M.W. Lee, K.J. Lim, C.H. Choi, S.B. Jo, S.G. Lee,* Inha University, Korea*; S.G. Park,* Inha University, Korea, Korea, Republic of*; B.H. O,* Inha University, Korea

Replication process is a good way to fabricate a passive optical device. Silicon based fabrication technology provides an efficient way to fabricate a master structure with optically smooth surface roughness. As silicon based technologies are often 2 dimensional processes, replication process requires a sophisticate fabrication steps for a master structure. For that reason, a vertically curved structure which is essential for a passive optical device is hard to fabricate. Some special processes, such as x-ray lithography, laser ablation, and gray-scale mask can overcome the conventional 2-dimensional fabrication process. But the processes need additional process steps, machines and masks. This study demonstrates easy way for fabricating a silicon master structure with vertically curved mirrors. This fabrication method is roughly divided into two steps. At the first step, a silicon wafer was deeply etched by using ICP system, to form the waveguide structures in the master structure. The vertically curved mirror structures at the each ends of the waveguides, are formed by using photoresist reflow process of the second step. After the master fabrication, the master shape was transferred to a PDMS mold. Replication process was carried by using UV curable polymers, and successful vertical redirection of lights at the curved structure was observed with a CCD device. The surface roughness of the replicated structure was also measured, and an optically smooth surface roughness was observed. Detailed fabrication steps and the fabricated device characteristics will be discussed.

MN-MoP6 CO Gas Sensor based on a Doped ZnO Film with a Microhotplate/Floating-Gate MIS Structure*, W. Calleja-Arriaga,* Inaoe Mexico, MEXICO*; J. De la Hidalga-Wade,* Inaoe Mexico*; A. Heredia-Jimenez,* Upaep Puebla-Mexico*; G. Rosas-Guevara, I. Juarez-Ramirez, C. Zuñiga-Islas, N. Carlos-Ramirez, P. Alarcon-Peña, L. Tecuapetla-Quechol, M. Escobar-Aguilar, J. Silva,* Inaoe Mexico*; J.L. Gonzalez-Vidal,* Citis-Uaeh Mexico*; M.A. Reyes-Barranca, M.L. Olvera, A. Maldonado,* Cinvestav Mexico

Doped and undoped zinc oxide (ZnO) single thin films, used as the active element in a gas microsensor, is presented in this work. The gas sensor arrangement is based on a double polysilicon micro-hotplate (MHP) and a polysilicon floating gate MIS transistor (FG-MIS). The ZnO films were doped with 6% of either copper, chromium, or gallium. The ZnO film, with an active area of 80x80 microns, was deposited onto a polysilicon plate that forms the gate of the MIS transistor. This sensing section is heated by a U-shaped polysilicon stripe, which is located beneath the polysilicon plate and electrically isolated from it by nitride/oxide films. The microhotplate is thermally isolated using a deep cavity micromachined in the silicon substrate, and mechanically supported by four polysilicon arms. The sensing film induces a charge in the floating-gate in such a way that the channel conductance is modulated. The sensor structure was characterized by detecting carbon monoxide (CO) at 300 ÂºC. Finally, a complete procedure of fabrication of this sensor structure will be presented at the conference.

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