MEMS and NEMS
Room 3rd Floor Lobby - Session MN-TuP
Aspects of MEMS and NEMS Poster Session

MN-TuP1 Development of Accelerometer Using Multilayered Optical Bandpass Filter, ***H. Toyota**, M. Yaegashi, T. Ono,* Hirosaki University, Japan*; M. Shimada, Y. Jin,* NTT MI Labs, Japan

Accelerometer which is micro-electromechanical systems (MEMS) device has begun to be used with the cellular phone and the car, etc. In present, detection range of acceleration is limited by MEMS device structure and its range is very narrow. Therefore, it is necessary to develop the accelerometer which can be measured wide range of acceleration. We propose the accelerometer based on optical bandpass filter. The accelerometer has a membrane structure with Fabry-Perot (FP) resonator. The FP resonator is composed of air gap as cavity layer between multilayered dielectric thin films. Weight is also attached bottom layer. The input light from white light source is introduced into top surface of FP resonator. The output light is extracted from exit aperture of the weight. The output light was measured by monochromator and photo detector. When the displacement of weight is occurred by the acceleration, the thickness of air layer is changed. Then, the wavelength of output light is also changed. It is principle that acceleration can be measured by this wavelength displacement. To obtain the optical characteristics of newly accelerometer, theoretical calculation was carried out by the change of the thickness of air layer using optical simulator. The design wavelength was 780 nm. As the dielectric material, silicon oxide (SiO@sub 2@: n=1.5) and tantalum oxide (Ta@sub 2@O@sub 5@: n=2.1) were used. The peak intensity of 100% appeared at the wavelength of 780 nm. It was found that the change of output light wavelength was varied as the change of air layer thickness. Considering the linearity relation, the effective wavelength displacement was about 120 nm. Then, in order to detect gravity force from 0.1 to 100 G, the wavelength resolution of 0.1nm is required for spectroscopic measurement system, but it is easy to achieve by the use of the general spectroscopic measurement system.

MN-TuP2 Mechanical Quality Factor Measurement of Micro Structure According to Vacuum Range and Temperature Variation, ***J.S. Kim**,* Korea University*; W.B. Kim, K.D. Jung, M.S. Choi, K.W. Nam, I.S. Song,* Samsung Advanced Institute of Technology, Korea*; B.K. Ju,* Korea University, Korea

In this paper, the Mechanical quality factor of a micro gyro structure according to vacuum range at room temperature and 75°C is measured. On the SOI wafer, gyroscope structures with a comb drive are patterned with a photo-resist (PR) and vertically etched with the ICP-RIE. After the etching process, this micro structure wafer is diced into proper size and released by the oxide layer etching in BOE (buffered oxide etcher). The test circuit and diced micro structure wafer are placed in a chamber with heater that can control vacuum range and substrate temperature. The circuit board is connected with the signal analyzer(HP35670A) and the power supplier by using the feed-through of the chamber. The chamber is vacuated to the specific vacuum range, which can be controlled particularly by using the air release valve. When the vacuum is set to a specific range, the frequency and damping coefficient are read from signal analyzer and translated to the Q-factor. In this way, Q-factors as vacuum range of gyro structures are measured. The measured Q-factor and vacuum range are 3000 to 50000 and 1Torr to 50mTorr. Sample is measured at room temperature and 75°C of substrate temperature, and we found that Q-factor 4000 matched the Vacuum 740mTorr range. From these data, we can fabricate the wafer level package(WLP) gyro-chip that has the desired Q-factor range, controlled by the basic pressure of package bonding chamber.

MN-TuP3 Detection of Stimulated Proteins in KDR/VEGF-A165 System by Microcantilever Sensor, *F.S. Fiorilli, R.C. Ricciardi, P.R. Rivolo, M.S. Marasso, **B.S. Bianco**,* Politecnico di Torino, Italy*; N.L. Napione, B.F. Bussolino,* Universit@aa a@ degli Studi di Torino, Italy

To reach new and relevant insight in biomolecular sciences it is necessary to develop new tools for fine and precise measurements. To this purpose, microcantilevers-based biosensors, which can trasduce a biochemical signal into a mechanical motion with extremely high sensitivity, represent an intriguing possibility.@footnote 1@ In particular, microcantilevers biosensors may represent a great improvement of the current detection techniques in regard of "signaling transduction pathways", which allow cells to respond to external stimuli. This contribution deals with the development of cantilever biosensors to measure in a quantitative and specific way key molecules involved in the activated tyrosine kinase receptor KDR in vascular endothelial cells (EC) stimulated by its ligand vascular endothelial growth factor-A165 (VEGF-A165). KDR/VEGF-A165 system is at the heart of a network that governs differentiation, survival, proliferation and migration of EC.@footnote 2@ The basis of these measurements is the antigen-antibody reaction. The cantilevers has been coated with Protein A or G, which specifically bind to the Fc fragment of the antibody, allowing the correct orientation of the Fab fragment, responsible for the antigen interaction. The coated surface will be bound to specific antibodies and hybridized with VEGF-A165 stimulated cellular lysates. The resonant frequancy response of cantilever to binding event permits to obtain data about protein analyte concentration. @FootnoteText@@footnote 1@Fritz.J., Baller M.K. Lang H.P., Rothuizen H., Vettinger P., Meyer E. Gerber C., Gimzewski, Science, 2000, 288, 316, @footnote 2@Zachary I., Gliki G., Cardiovasc Res, 2001, 49: 568-581.

MN-TuP4 Plasma Polymerised Biomaterial for Micro-Nano Device Bonding at Room Temperature, ***M. Dhayal**,* Rajasthan University, India

In this study the plasma polymerised acrylic acid (ppAc) biocompatible films has been shown potential usefulness to bond any types of two substrate materials without applying a load at room temperature (???25 oC). To understand the bonding mechanism of plasma ppAc film at room temperature the interfacial adhesion is an important factor in determining the performance and reliability of MEMS/NEMS systems. In this paper the effect of covalent bonding between two chemically activated surfaces has been discussed. It is also know that at small roughness values at interface the adhesion is mainly due to van der Waals forces acting across extensive non-contacting areas. Therefore, the contribution of both covalent bonding and van der Waals forces at contact and non-contact areas at the interface respectively has been also discussed in this paper. Advantages of this bonding technique in fabrication of recycled and reusable MEMS/NEMS, bio-MEMS/NEMS, organic micro/nano fluidic devices, lab-on-a-chip etc. has been also discussed.

MN-TuP5 Bulk Micromachining of High Index Silicon Wafers and Possible Applications in Diffractive Elements, ***W. Calleja-Arriaga**, F.J. De la Hidalga-Wade, C. Reyes-Betanzo, A. Torres-Jacome, C. Zuñiga-Islas, M. Linares-Aranda, P. Rosales-Quintero,* INAOE, Mexico

In this project we are evaluating new approaches to develop micromirror arrays and diffractive elements which have been fabricated using squared structures on (0 0 1) silicon wafers. In this project, n-type, 2-5 ohm-cm, two inch, 300 Î¼m-thick, high index (1 1 4) and (5 5 12) silicon wafers were used, which were produced from [1 1 2] ingots. Most micromachined structures compatible in Microsystems are fabricated on (0 0 1) silicon wafers, rarely using (0 1 1) wafers and of course more rarely using high index wafers. Several sophisticated microstructures maybe fulfilled by using substrates with different crystallographic orientations. Our etching mask was designed including several polygon-like structures to analyze the resulting morphology and crystallographic planes developed during a long-time etching. One of them, an array of 10 squared structures is arranged as follows: the first square is aligned parallel/perpendicular to the (0 1 1) main flat and then the next squares were slanted ranging from 5@degree@ till 45@degree@ in 5@degree@ steps. We have developed our experimental work using different KOH-H2O dilution at 40 @degree@C. All the experimental procedure was developed at the same time on (0 0 1) and (0 1 1) silicon wafers, which were used as control samples. Our etching mask containing several polygon-like structures was transferred parallel to the main (0 1 1) flat of the low and high index wafers. We are reporting the etching of concave squared structures, watching the roughness evolution of the walls and bottom surfaces, with the main purpose of developing microstructures for integrated optics applications. At this stage we have facing some problems to develop micromirrors because the bottom surfaces developed on both high index wafers show some roughness. On the other hand we have observed a very interesting structure whose very smooth walls could be used to develop a very simple fabrication procedure of blazed diffraction gratings for infrared applications.

MN-TuP6 In Situ Characterization of Passivation Layer for Silicon Cryogenic Etching, *X. Mellhaoui, **C. Duluard**, L. Pichon, R. Dussart, P. Ranson, T. Tillocher, P. Lefaucheux,* GREMI/CNRS - Université d'Orléans, France

The cryogenic etching process that uses SF@sub 6@/O@sub 2@ plasma chemistry offers an attractive alternative to the Bosch process for etching high aspect ratio patterns into silicon, both for its high etch rate and its cleanliness. Today its use in industry is still limited primarily due to a need for more robustness, in particular a slight shift in temperature can affect the process reproducibility. Understanding the passivation mechanisms is therefore crucial to improve the passivation efficiency at low temperature and to control silicon deep etching perfectly. Previous studies have shown that a SiO@sub x@F@sub y@ passivation layer forms at low temperature and is removed when the substrate is heated back up to room temperature.@footnote 1@ Other experiments prove that this layer can also be constructed using a SiF@sub 4@/O@sub 2@ plasma, so sulphur does not seem to participate in the formation of a passivation layer.@footnote 2@ The thickness and physical-chemical properties of the passivation layer can only be known by in situ analyses. An inductively coupled plasma reactor was equipped with a spectroscopic ellipsometer to perform this characterization. In SF@sub 6@/O@sub 2@ etching plasma conditions the passivation layer is hardly observable. Nonetheless in SiF@sub 4@/O@sub 2@ chemistry a depositing regime can be achieved, which better facilitates ellipsometric measurements. Ellipsometric spectra were acquired and analyzed while varying several experimental parameters (e.g. plasma source power, substrate temperature). This parametric study will be presented. @FootnoteText@ @footnote 1@ R. Dussart, M. Boufnichel, G. Marcos, P. Lefaucheux, A. Basillais, R. Benoit, T. Tillocher, X. Mellhaoui, , H. Estrade-Szwarckopf, P. Ranson, J. Micromech. Microeng. 14, 190 (2004)@footnote 2@ X. Mellhaoui, R. Dussart, T. Tillocher, P. Lefaucheux, P. Ranson, M. Boufnichel, L. J. Overzet, J. Appl. Phys. 98, 104901 (2005)

MN-TuP8 Controlling the Silicon Micro-grass in Fabrication of Deeply Etched Silicon Structures using Adaptive Bosch Process*, **M.W. Lee**, B.S. Kim, J.H. Sung, S.B. Jo, C.H. Choi, E.H. Lee,* INHA University, South Korea*; S.-G. Park,* INHA University, South Korea, Korea*; S.G. Lee,* INHA University, South Korea*; B.H. O,* INHA University, South Korea, Korea

A deeply etched silicon structure provides an easy way to realize an embossing master, compared with a conventional Ni master. But, the silicon micro-grass which usually occurs during silicon deep etch process have to be suppressed for subsequent embossing process. We tried to control the silicon micro-grass by changing etching conditions of our silicon deep etching method, named adaptive bosch process. Etch/passivation time ratios, bias powers and other process parameters are varied, and the fabrication results are compared. Mainly, etch/passivation time ratio variation showed good control of the silicon micro-grass, and other parameters also have effect to control the micro-grass. Detailed discussions will be presented.

MN-TuP9 The Adhesion Analysis of Multi Layered Hierarchical Structure of Gecko Feet*, **T.W. Kim**, B. Bhushan,* The Ohio State University

Several creatures including insects, spiders, and lizards, have a unique ability to cling on ceiling and wall that utilizes dry adhesion. Geckos, in particular, have developed the most complex adhesive structures capable of smart adhesionâ?"the ability to cling on different smooth and rough surfaces and detach at will. The gecko feet are comprised of a complex fibrillar structure of ridges called lamellae that are covered in microscale setae that branch off into branches with nanoscale spatulae. This hierarchical structure enables the gecko the adaptability to create a large real area of contact with rough surfaces. van der Waals attraction between the large numbers of spatulae in contact with rough surface is responsible for high adhesion. In order to investigate the effect of geckoâ?Ts hierarchical structure, we consider single and multi layered hierarchically structured spring models for simulation of seta contacting with random rough surfaces. Single contact (spatula) was assumed as spherical. Rough surfaces with various roughness parameters are generated, which is a common range of most of natural and artificial rough surfaces at the scale size of gecko seta. The simulation results show that multi layered hierarchy structure has higher adhesive force than single hierarchy structure, due to better adaptation and attachment ability.

Author Index

Bold page numbers indicate presenter