Poster Presentation

mne BERLIN 2011

Invited Posters

IP-1 – Nanoimprint Lithography with a Soft Roller and Focused UV Light for Flexible Substrates

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This paper is focused on the design, simulation, implementation and process of a new concept of a UV-RNIL system which can use a flat stamp or a roll stamp. The system uses an UV light source, like other systems, but it focuses the UV light in the shape of a line. Likewise, the length of the contact between the stamp and the substrate is also narrow, but it is made to become wider than the focused length of the UV light. The experiment for the nano-pattern transfer was executed by the system.

IP-2 – Mask Aligner Lithography Simulation – From Lithography Simulation to Process Validation

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We report on the recent progress in mask aligner lithography simulation. Our investigations span from the angluar spectrum of the illumination to the dynamics of photoresist development. Combining an accurate modeling of the optical setup with photoresist data obtained from a Dissolution Rate Monitoring (DRM) setup yields quantitative agreement between measurements and simulation, thus allowing to test novel approaches in mask aligner lithography using computers rather than test exposures.

IP-3 – Ultrafast Cantilever for High Speed Scanning Force Microscopy

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(nominated from EIPBN 2011)

High speed atomic force microscope imaging is important for many applications such as biological imaging, large area inspection and patterning. The sampling frequency is directly proportional to the resonance frequency of the cantilever. To achieve resonance frequencies in the MHz-range it is necessary to reduce the physical dimensions of the system. Such MHz cantilever with resonance frequency between 0.5–2MHz is fabricated in a bulk-silicon micromachining process.

IP-4 – Inkjet printing for fabrication of automated lab-on-paper on nitrocellulose membrane

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(nominated from MNC 2010)

Lab-on-paper have become increasingly popular as diagnostic device. These devices have also been developed for enzyme immunoassay. Despite of high sensitivity of ELISA, it takes relatively long time due to multistage procedure. Up to date, most of the lab-on-paper have the limitation of single step reaction by one-time sample loading, and multi-step reactions requires multi step handling. In this article, automated lab-on-paper based on nitrocellulose membrane was developed for one-step ELISA.

1. Lithography and Systems

1.1 Nanoimprint Lithography

P-LITH-001 – A novel thermal imprinting technique for forming through holes in polymers by using hollow microneedle array

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This paper presents a novel thermal imprinting technique for forming through holes in polymers by using an array of hollow silicon dioxide microneedles. The technique has the potential of enabling high-throughput and low-cost fabrication of through holes with a minimum feature of ten micrometers. Moreover, to improve the durability of the imprint tool, the microfabrication process of a nickel microneedle array has been established by employing site-selective electroless nickel plating.

P-LITH-002 – A PDMS Mold with Inserts and a Mechanical Apparatus for Easy Contact and Separation in Large Area UV Nanoimprint

GeeHong Kim [1], HyungJun Lim [1], JaeJong Lee [2], Kee-Bong Choi [1], Lee-Mi Do [1]

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This paper focuses on how to handle a flexible PDMS mold for uniform contact and easy separation in large area UV nanoimprint process. The key feature in the proposed process is to deform the mold in cylindrical shape before and after imprint, and for this purpose, we add mechanical blocks called inserts inside the PDMS mold and design a device which keeps the mold in prefered shape by using the inserts.

P-LITH-003 – Characteristic evaluation of antisticking layer by scanning probe microscopy

Makoto Okada [1], Kei Kuramoto [1], Masayuki Iwasa [1], Yuichi Haruyama [1], Shinji Matsui [1]

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The adhesion and friction between an antisticking layer and nanoimprint resin are occurred in demolding process. We measured adhesion and frictional forces of fluorinated self-assembled monolayers (F-SAMs) and polydimethylsiloxane (PDMS) thin layer by scanning probe microscopy. As the results, the adhesion forces of F-SAMs depended on the number of fluorine. In the case of the PDMS thin layer, the adhesion force was similar to that of FAS-17 and the frictional force was vanishingly low value.

P-LITH-004 – Defect study on mold releasing process in nanoimprint

Kohei Tomohiro [1], Hoto Norihito [1], Tomoki Nishino [1], Takahiro Shiotsu [1], Hiroaki Kawata [2], Yoshihiko Hirai [3]

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The defect yield in mold releasing process for high aspect ratio pattern fabrication in nanoimprint lithography is studied based on probability events. The breaking defects are induced by stretching force due to frictions between the mold and polymer, which is proportional to the aspect ratio of the pattern. The results fairly agree with experimental results.

P-LITH-005 – Distributed feedback lasers with highly uniform gratings fabricated by reverse-tone nanoimprint lithography

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A reverse-tone nanoimprint process has been applied to the grating fabrication of anti-reflection coated quarter-wavelength phase shifted distributed feedback (DFB) lasers. Highly uniform gratings were successfully fabricated. Yield exceeding 97% of DFB lasers having a sub-mode suppression ratio of more than 33 dB was achieved.

P-LITH-006 – Double patterning nanoimprint lithography

Makoto Okada [1], Hiroto Miyake [1], Shuso Iyoshi [1], Takao Yukawa [1], Tetsuya Katase [1], Katsuhiko Tone [1], Yuichi Haruyama [1], Shinji Matsui [1]

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In NIL, the imprint pattern resolution depends on the mold pattern resolution. This means that a high resolution mold is required to imprint a high resolution pattern such as 22 nm half-pitch pattern. Double patterning (DP) is developed for photolithography to enhance the feature size. In this study, we challenged to demonstrate a double patterning UV-nanoimprint. We confirmed from the results that the second patterns were imprinted on the first imprinted lines.

P-LITH-007 – Effect evaluation of fluorine additive in UV nanoimprint resin

Makoto Okada [1], Hiroto Miyake [1], Shuso Iyoshi [1], Takao Yukawa [1], Hidekazu Takeuchi [1], Yuichi Haruyama [1], Shinji Matsui [1]

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We evaluated the effect of the fluorine additive for UV nanoimprint resin by X-ray photoelectron spectroscopy (XPS), contact angle measurement, and scanning probe microscopy (SPM). XPS result indicates that the fluorine was present on the surface of cured fluorine additive-containing resin. We confirmed from the measurement results of contact angle and SPM that the resin has the release property by the addition of the fluorine additive.

P-LITH-008 – Enabling fast UV-NIL without anti-sticking layer on the mould

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In this contribution the full characterization of new UV-NIL resists will be presented, which can be imprinted using bare moulds like Si, quartz and OrmoStamp® without any anti-sticking layer (ASL). By using high concentrations of perfluoropolyether-based (PFPE) components the effect of the release forces were minimized to a negligible level. A resolution of 15 nm with ASL and 75 nm without ASL were achieved successfully without compromising from the substrate adhesion.

P-LITH-009 – Evaluation of liquid-phase HSQ resin for room-temperature nanoimprinting

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So far, we reported room-temperature nanoimprint lithography (RT-NIL) using liquid-phase hydrogen silsesquioxane (HSQ) with poly(dimethylsiloxane) (PDMS) mold. To improve this technique, it is necessary to examine the characteristics of liquid-phase HSQ. In this study, we evaluated the time dependence of characteristics of liquid-phase HSQ. The spin-coated HSQ was placed in the air, and the time dependence of FT-IR, force curve, and imprinted patterns were evaluated.

P-LITH-010 – Fabrication of metallic nanoring arrays for infrared wavelenghts by nanoimprint lithography and reactive ion beam etching

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Bragg reflector used in Fabry-Perot-Interferometer as a tunable infrared pass band filter. We will replace the typical used Bragg reflector layers by sub-micro metal ring resonator arrays. For the fabrication of these IR resonators the hot embossing nano imprint lithography and reactive ion beam etching are used. The hard mask masters were done by electron beam lithography and RIBE mask transfer. The polystyrol ring structures were transferred into the 100 nm AlMg3 layer by RIBE process.

P-LITH-011 – Fabrication of Metallic Wire Grid Polarizer using High Efficiency NIL and Lift-off Processes

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This study demonstrates the double-layer hybrid gratings that can be fabricated efficiently by using NIL and lift-off processes for the applications of flexible wire grid polarizers as well as the brightness enhancement films. The optical designs and process planning minimize the manufacturing difficulty while maintaining acceptable optical performance and at the same time make the continuous roll-to-roll process more feasible.

P-LITH-012 – Fabrication of MOSFETs by 3D soft UV-nanoimprint

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we report on a 3D UV-Nanoimprint process which allows the fabrication of a MOSFET in one lithography step. One single imprint step defines the MESA and gate layer. The complete 3D resist topography has been transferred into the substrate with only one reactive ion etching step. No alignment is needed and even typical mold distortion in soft UV-NIL is not issue anymore using this 3D imprint process. This 3D imprint reduced the process steps required for the fabrication of a MOSFET from 14 to 8.

P-LITH-013 – Fabrication of Moth-Eye Structures with Film with Silver Layer Deposited Antireflection by Nanoimprint Lithography

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In recent years, the s stainable energy becomes a focus point all people are striving toward. An effective method for sustainable energy is how to deal with the solar energy well. Hence, the development of high-efficiency solar photovoltaic energy has attracted increasing interest. In this study, we demonstrate moth-eye antireflection coatings fabricated by UV nanoimprint lithography.

P-LITH-014 – Fabrication of nanometer-scale periodic structures on semi-crystalline polymers by nanoimprint lithography

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We present the possibility to structure the surface of semicrystalline polymers, for example PET or PTT, by using thermal nanoimprint lithography. Semicrystalline polymers present great versatility in terms of mechanical performance, they can provide both high strength and high capacity for mechanical energy absorption. We have achieved the optimal conditions to imprint arrays of nanometric scale lines, which provides the possibility to use these polymers to fabricate stamps for soft lithography

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P-LITH-015 – Fabrication of optimized 3D microstructures with undercuts in transparent fused silica for replication

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The aim of this work is to develop a process for the fabrication for imprint master with undercuts in transparent materials. Such masers are needed for process development, optimization and for applications and should incorporate well-defined microstructures with a smooth surface and adjustable widths and depths of the undercuts. The fabrication of such masters in fused silica by pattern transfer of masks using RIBE at different inclinations and various etching parameters needs to be studied.

P-LITH-016 – Fabrication of Organic Thin Film Transistors with the Nano-Groove Al Gate Electrodes by Using UV Nano Imprint Technology

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The organic thin film transistors (OTFTs) have become the potential candidates for low-cost and flexible electronics applications. Using periodic groove patterns on organic dielectrics to improve the preferred orientations of organic molecules and device performances had been proposed. In this work, we introduce another option to improve the molecular orientations of pentacene with the nano-groove Al gate electrodes fabricated by UV nano imprint technology.

P-LITH-017 – Fabrication of roll mold using electron beam direct writing and metal liftoff process

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The roll-to-roll (RTR) technique is a high-throughput production method for NIL. However, the fabrication of the roll mold for RTR NIL is difficult because of the cylindrical shape of the mold. To obtain a seamless nanoscale mold, we have developed a technique for direct writing with an EB on a rotating cylindrical substrate. And, fabrication of metallic roll mold with EB direct writing and liftoff process was examined. Remained metal patterns by liftoff are protrusions of roll mold.

P-LITH-018 – Flow behaviours of a resist according to the different resist thicknesses and the increasing pressure during pressing step in NIL

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To find out major effects that affect flow behavior of resist in thermal-NIL. Experiments were conducted at 140 °C to oberve incomplete filling. For the simulation, Imprint velocity is considered as instantaneous velocities proportional to the pressure as a function of processing time and inversely viscosities. As a result, horizental single peak by pipe flow was appeared above 200nm-thick. At the 100nm-thick, horizental single peak by squeezed flow was observed by increasing pressure.

P-LITH-019 – Formation of a fine pitch nanohole array in AAO film on Si substrate by combination of the pattern transfer with IBE and the self-organizing anodic oxidation

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The 58 nm-pitch of ordered AAO nanohole arrays was prepared by a combination of IBE induced pattern transfer of 100 nm-pitch AAO mask and reduction of anodization voltage. It turned out that there was an adequate IBE condition for realizing good pattern transfer to produce reduction of nanohole array. This method suggests a possibility for fabrication of further finer pitch of nanoscale array with combination of top-down and bottom-up approaches.

P-LITH-020 – Gratings in metallic V-groove channel plasmon polariton waveguides

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We introduce high quality visible and IR gratings to metallic V-groove waveguides via nanoimprint lithography. By applying variable e-beam dosages transversally across the V-groove profiles etched into a Silicon stamp, we are able to account for changes in resist thicknesses that form due to contours of the groove. A corrugation pitch down to Λ= 265 nm is maintained in gold surface devices consisting of V-groove depths greater than 5 μm.

P-LITH-021 – Hybrid tri-layer stamps resolve critical issues in step-and-repeat imprint lithography

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State-of-the-art step-and-repeat templates are made from a 6025 photo-mask blank and undergo traditional back-end processes. Step-and-repeat is based upon superior flatness tolerances of both the quartz template and the substrate to obtain defect free and uniform imprints with highest resolution. Step-and-repeat soft stamps address critical parameters such as: uniformity and high resolution; critical stamp parameters like layer durability; as well as minimum stamp release force for multi-use.

P-LITH-022 – Immersion nanoimprint lithography using perfluoroalkyl liquid

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A bubble defect might occur because of the air trapped between a mold and a moldable substrate when a thin thermoplastic film spread on a hard substrate is imprinted at a high temperature. We proposed removing the bubble defect by inserting perfluorotributylamine between the mold and the molding material by which the kinematic viscosity is lowered at the imprinting temperature. This technique was applied to imprint a 450-nm-thick PMMA coated on a Si wafer, and it succeeded in a complete molding.

P-LITH-023 – Impact of Mold Material for Ultrasonic Nanoimprint Lithography

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We demonstrate that the impact of mold material is important for U-NIL and our system could use different materials of mold to imprint at room temperature, including silicon and nickel. We also found temperature is the most effective factor of different line width molds. The setting temperature should be decrease when the line width of pattern decreases form micrometer to nanometer. Besides, comparing the mold materials of silicon with nickel, the imprinting force is the most significant factor.

P-LITH-024 – Improvement of efficiency for Si solar cells using double side nano/micro patterned glass

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In this report, in order to improve the conversion efficiency of Si solar cells, several kinds of double side nano and/or micro patterned glass were used. The efficiencies of Si solar cells were measured by means of solar cell simulator. In the case of non patterned glass, the efficiency of solar cell was decreased 0.45% compared to bare solar cell. In the case of 20um lens/glass/AR, the efficiency of solar cell was increased 0.58% compared to non patterned glass.

P-LITH-025 – In-situ material characterisation for thermal nanoimprint

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In-situ-characterisation of imprint polymers in a piezo-driven imprint system is reported. The system is fully characterised with respect to its mechanical response, experimentally and theoretically. We show polymer responses in this system under step load and under dynamic loading, the latter being provided by piezo-excitation up to cut-off frequencies of 60 Hz. The polymer time constants measured as well as their temperature dependence can be well understood by polymer theory.

P-LITH-026 – Integration of rotated 3-D structures into pre-patterned PMMA substrate using step & stamp nanoimprint lithography

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The present work explores a scheme for the manufacturing of three-dimensional stamps based on hybrid 3D nanofabrication processes. We used a poly(methyl methacrylate) (PMMA) substrate which was at first pre-patterned with a nanoscale binary line grating by thermal NIL. The second imprint was added into the linear surface-gratings by rotation controlled thermal imprinting using a nickel stamp with micron scale blaze gratings.

P-LITH-027 – Investigation for orientation of photoinduced liquid crystalline polymer imprinted by using mold with various patterns

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A polymethacrylate, which is hexamethylene spacer group terminated with a 4-oxycinnamic acid (P6CAM) in its side chain, exhibits a large photoinduced molecular reorientation with a high photoreactivity toward linearly polarized UV (LPUV) light. We proved from the imprinting results that P6CAM was reoriented parallel to the imprinted line. In this study, we fabricated a SiO2/Si mold with the line pattern in different directions and carried out thermal nanoimprinting on the P6CAM.

P-LITH-028 – Life Time Evaluation of PDMS Stamps for UV-enhanced Substrate Conformal Imprint Lithography

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In this work, results on the diffusion of an UV-curing material into h-PDMS and the life time of h-PDMS stamps for UV-SCIL are shown. 500 imprints could be performed without an obvious degradation of the h-PDMS stamp. But, also diffusion of UV-curing material into h-PDMS occured. This might be a reason that after 600 imprints the separation forces increased and the imprint quality decreased. Further work on different PDMS compositions to further improve PDMS stamp life time will be performed.

P-LITH-029 – Lifetime evaluation of release agent on UV-NIL

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NIL is very useful for fabrication of nanopattern. In UV-NIL, release coating of mold surface with release agent is very important because of prevention from UV curable resin. However, there is lifetime in the release agent and during repetition UV-NIL transfer, release layer becomes degradation. The reason of degradation of release agent is though as remove of release agent or resin's contamination. In this study, lifetimes of various release agents are evaluated by repetition UV-NIL.

P-LITH-030 – Metal nano pattern transfer technique from plastic replica mold using metal oxide release layer

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We have developed the three-dimensional metal pattern nanoimprint technique using metal oxide release layer with spin on glass (SOG) mold. In order to improve the mold fabrication throughput, the metal nano pattern transfer technique using plastic replica mold was examined in this study. As a result, the metal nano pattern was transferred onto PET substrate using a plastic replica mold with metal oxide release layer. This technique can save many steps related to a mold fabrication.

P-LITH-031 – Method for 3D Nanoimprint Lithography Stamp Fabrication

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Nanoimprint lithography (NIL) is capable of replicating 3D patterned templates with nanoscale resolution. We present a method for the manufacturing such high resolution 3D templates. Our method is capable of lateral resolution better than 50nm. Calculation shows that 7 clearly delineated height levels are obtainable.

P-LITH-032 – Molding Effect by Thermal Conductivity of Press Stage in Thermal Nanoimprint

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We are targeted for providing a simple way to enable the processing of trench patterns with a high aspect ratio onto a resin substrate in a short time, by the thermal nanoimprint technology with high selectivity for the molding material, in order to improve of production efficiency for a wiring of printable electronic devices. Also, we evaluated the molding effect of the thermal conductivity of the press stages used by thermal nanoimprint technology.

P-LITH-033 – Nano-Imprinting Lithography of P(VDF-TrFE-CFE) and Poly(dimethylsiloxane) (PDMS) for Integrated Polymeric MEMS Devices

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Thermoplastic Nano-Imprinting Lithography (T-NIL) has been used to create free-standing thin micron scale layers and to pattern periodic features that are 2 µm wide and 1.5 µm high from both P(VDF-TrFE-CFE) and poly(dimethylsiloxane) (PDMS). The critical advantage of T-NIL process for polymers is that the formation of the thin layers is simultaneous with the patterning as opposed to using separate processes for each step.

P-LITH-034 – Nanoimprint Working Stamp Fabrication by High Conformability Electroless Nickel (EN) Plating

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This study demonstrates the NIL working stamps with the critical dimension of 100 nm made by UVNIL and EN plating to achieve large-area patterning with excellent durability and uniformity. The fabricated EN stamp was adopted in thermal NIL for multiple times, and the stamp quality remained the same without any delamination or damage which showed good mechanical strength; meanwhile, the imprinted structures were formed faithfully.

P-LITH-035 – Nanostructured Protein Patterning using Reversal Microcontact Printing

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Microcontact printing is an interesting method to deposit proteins or antibodies in well defined µm sized patterns to analyse protein-protein interactions in vivo. In this work we use a relatively new method called reversal µCP to create protein patterns in the nanometer range. These patterns can be used to investigate protein-protein interaction in smaller cells like T-cells. Using reversal µCP we where able to create lines with 400 nm line width and dots with diameters down to 180 nm.

P-LITH-036 – Non-sticky Polyvinylsilazane stamp with high durability for UV-nanoimprint lithography

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We conducted comparing experiments with Ormostamp and PVSZ as a sustainable and reliable working stamp. For the comparing experiments, we prepared two types of stamp using Ormostamp and PVSZ. Using two types of working stamp, we carried out the nanoimprinting process within PUA resin repeatedly. when we use Ormostamp material and PVSZ mold as a working stamp, we should treat the stamp surface having an anti-sticky characteristic. we observed that contact angle after repeated imprinting process.

P-LITH-037 – Novel Polymers for UV-enhanced Substrate Conformal Imprint Lithography

Robert Fader [1], Holger Schmitt [1], Mathias Rommel [1], Ran Ji [2], Michael Hornung [2], Markus Brehm [3], Andreas Kraft [4], Marko Vogler [5]

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In this work, two kind of UV curing polymers are introduced as resists for UV-enhanced Substrate Conformal Imprint Lithography (UV-SCIL), an acrylate based resist and an epoxy based resist. With these at all organic polymers, the process time is reduced essentially because of their short curing times compared to commonly used resists for UV-SCIL. Imprints with these two materials are shown in this work and the results of an HBr dry etch process, where the materials served as etching masks.

P-LITH-038 – Optimized Inkjet Printed UV Resin for Sub-100 nm Nanoimprint

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In this study we proposed a discrete but uniform novel thin film inkjet deposition process for nanoimprint. Even with micrometer scale discrete 10 pico liter (pL) droplets inkjet printed on the 125 μm flexible substrate (PET), the nanoimprinted structure shows perfectly uniform linewidth (75 nm), pitch (230 nm), height (302 nm), and the remaining layer (50nm). This method provides not only precise positioning of pattern area, but also cost-saving and environmental-friendly solutions.

P-LITH-039 – Optimizing optical properties of single and multi-layer metamaterials fabricated by NIL

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We show the fabrication of large area single layer as well as multi-layer fishnet gratings using Nanoimprint Lithography (NIL) aiming at the visible frequency regime. To fabricate NIMs at visible frequencies we face with the following challenges: (a) achieving structure dimensions with line width around 100 nm (b) optimizing and minimize degradation of silver properties and (c) deal with the fact that the multi-layers are embedded in Ormocomp. We demonstrate approaches to solve these problems.

P-LITH-040 – Process modeling of curing characteristics for UV nanoimprint resist

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Kinetics of UV resist reaction is essential to optimize of UV nanoimprint processes and materials. In our previous study, curing behavior of the radical polymerization resist was investigated and the reaction speed is proven to be product of square root of UV light intensity I and irradiation time t . In this paper, process modeling for numerical simulation is proposed to estimate cross-linked initiation efficiency of the resist (Conversion ratio) and cured modulus of the cross linking.

P-LITH-041 – Reel-to-reel imprint system to form weaving guides on fibers

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We developed a reel-to-reel imprint system using a cylindrical mold to continually process a weaving guide with a uniform depth on the surface of a fiber at high speed. A press force control mechanism was built into this system, and a continuous pressing with a constant force was enabled that suppressed the installation error margin of the mold. We successfully demonstrated an imprinting of rectangle and arc shaped weaving guides on a 250-um-diameter fiber at a sending speed of 5 m/min.

P-LITH-042 – Research on fabrication of mould with bulk metallic glass based on hot embossing

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Hot embossing is a technique by which features on moulds can be transferred to the thermoplastic materials, which makes possible for fabrication of nanodevices.As a mold bulk metallic glasses break through the finite grain size limitation and display attractive mechanical properties . Lacking crystallites, grain boundaries and dislocating in the amorphous structure of such alloys lead to homogeneous and isotropic materials, hence they exhibit high strength, hardness and corrosion resistance.

P-LITH-043 – Reversed order hybrid lithography of T-NIL and UVL

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Hybrid lithography (T-NIL and UV-L in one single resist layer) is performed in reversed order: (1) exposure (2) imprint and (3) development. This avoids damage of the resist during imprint and formation of parasitic patterns due to exposure over topography. The results, based on detailed characterisation of the lithographic performance of AZ-1505 after thermal loading during imprint, show a substantial improvement of the transition region between imprinted and lithographically defined patterns.

P-LITH-044 – Role of confinement on material flow in nano-structured geometry

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In nanoimprint lithography viscous flow in polymeric thin films is the primary mechanism for the generation and the relaxation of the structures. Here we quantify the impact of confinement on the flow rate. Pattern relaxation experiments were carried out above the glass transition temperature as a function of film thickness. The results are adequately fitted by a simple expression (based on Newtonian viscosity) for the flow rate valid at all confinements.

P-LITH-045 – Roll to roll pilot nanoimprinting process for backlight devices

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[1] VTT Microsystem and nanotechnology, Espoo/Finland, [2] VTT Nanoelectronics, Espoo/Finland

In this work result of a pilot production of 30 mm x 30 mm size planar diffractive optical elements for backlight applications is reported. For piloting more than 1000 devices were manufactured by roll to roll nanoimprinting process into PMMA web. Processing parameters such as temperature, pressure and printing speed were kept as low as possible to make a good replication but also to make long run possible.

P-LITH-046 – Scatterometry analysis of sequentially imprinted patterns: influence of thermal parameters

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Scatterometry is well adapted to the characterization of nanoimprint processes, since this technique is fast and non destructive. It is shown how it can be used to control step and stamp processes for stamp up-scaling for day-lighting applications. The influence of thermal parameters on the polymer reflow is demonstrated.

P-LITH-047 – Sidewall-angle dependent mold filling of three-dimensional microcavities in thermal nanoimprint lithography

Mirco Altana [1], Arne Schleunitz [1], **Helmut Schift** [1]

[1] Paul Scherrer Institut, Villigen PSI/Switzerland

We report on a filling study of 3-D microcavities using stamp structures with vertical and sloped sidewalls but constant cavity volume. For all sidewall structures an intermediate state of pre-filling can be found, which is completely independent of the applied imprint pressure. In addition, the filling process is strongly influenced by surface effects. Although the volumes of the microstructures are identical, large differences in the filling speed can be observed.

P-LITH-048 – Simulation of the resist filling process in condensable gas for UV nanoimprint

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[1] Osaka Prefecture University, Sakai/Japan, [2] National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba/Japan, [3] Osaka Prefecter University, Sakai/Japan

Resist filling process is simulated under condensable gas in UN nanoimprint lithography. Resist filling time for nano scale pattern is investigated for various pattern sizes. surface tension and viscosity of the resist. For wide pattern over 100nm in line width, the filling time is restricted pattern size. In narrow pattern below around 100 nm in line width, the filling process is affected by resist viscosity, surface tensions.

P-LITH-049 – Soft roll stamp fabrication using a magnetic roll and microbeads for a roll imprint process

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In this paper, we propose and fabricate soft roll stamps using permanent magnetic (NdFeB) rolls and ferromagnetic microbeads (Fe). The present soft roll stamps suggest not only easy fabrication of roll stamps for imprint process, but also an easy stamp replacing method. We can easily attach and detach another soft master to the permanent magnetic rolls. The repeatable and cheap method for fabricating roll stamps, therefore, is one of potential issues for next advances.

P-LITH-050 – Stamp deformation during nanopattern thermal imprinting on double-curved substrates

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We explore method to create nanopatterns on double-curved polymer surfaces with very low radius. We used very small (1.0 and 0.5 mm) to demonstrate feasibility and to facilitate observation of bending and stretching of the employed soft stamp, while transferring submicron pattern. We tested and compared 2 stamps, PDMS and Zeonor COP foil. We worked with 2 different substrates, PMMA and PS. Imprinted substrates have been characterized using confocal microscopy, AFM and SEM.

P-LITH-051 – Step&Repeat UV Nanoimprint for high precision mastering of diffractive optic elements

Florian Schlachter [1], Christoph Nowak [1], Ulrich Plachetka [1], Christian Moormann [1], Heinrich Kurz [1], Jérémie Teisseire [2], Elin Sondergard [1]

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Development of a modified innovative UV soft nanoimprint process to provide a scalable low-cost solution for the recombination of micro- and nanoscale structures to a much larger area to enable economic mastering. Within this work, attempts to develop this technique for the fabrication of large diffraction gratings for in-room daylighting management are reported.

P-LITH-052 – Strength Enhancement of High Aspect Nano Patterns Fabricated by Edge Lithography and Its Application to Thermal Nanoimprint Lithography

Junji Sakamoto [1], Hayato Noma [1], Norihiro Fujikawa [1], Hiroaki Kawata [1], Masaaki Yasuda [1], Yoshihiko Hirai [2]

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NIL is a powerful process for a nano-pattern fabrication. In the previous report, a fabrication method of high aspect ratio nanostructure has been presented using edge lithography. SiO2 line with 25 nm width, whose aspect ratio exceeded 10, was obtained. However the SiO2 pattern strength was insufficient for an imprint mold. In this report, process for enhancement of the nano pattern strength is proposed and a pattern of 25 nm in width and 250 nm in height can be transferred to PMMA by T-NIL.

P-LITH-053 – Study and Development of Polymer Destabilization by Capillary NIL: Effect of Charges

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Nano-Imprint Lithography techniques are presented as an alternative to current lithography techniques. The objective of this paper is to study a variant of printing techniques: nano-structuring by spontaneous destabilization of a polymer film due to capillary forces. Using a mold with nano-scale patterns can lead to nano-structuration of the polymer. We will present a study on the effect of charges on this spontaneous destabilization, which is one of the two pathways that can promote it.

P-LITH-054 – SU-8 ridge waveguide with holographic grating embedded in nanoimprinted groove

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Fabrication of an SU-8 ridge waveguide with a holographic grating for DFB lasers, effectively utilizing nanoimprint (NIL), is presenetd. Rhodamine-6G-doped SU-8 ridge waveguide was embedded in a groove defined by NIL in UV curable resin. Utilization of NIL made it easier to form such a 3D micro structure consisting of ridge stripe and fine corrugation grating. A 594nm TE-polarized light emission was observed from the waveguide, when the waveguide was irradiated by 532nm Nd:YAG green laser.

P-LITH-055 – Temperature effect of Vapor-phase self-assembled monolayer for anti-sticking layers used in UV-embossing

Peng Jin [1], Nan Liu [1], Jie Lin [1], Jiubin Tan [1], Philips Prewet [1]

[1] Harbin Institute of Technology, Harbin/China

An optimizing method of depositing anti-sticking layers through vapor-phase self-assembled monolayer based on temperature controlling was proposed. From the contact angle, surface free energy, and chemical composing experiment results, it can be seen that, with the increasing of temperature, the property of anti-sticking layers decreases. When the deposition condition is below the room temperature, the property of anti-sticking layers is close to the theoretical value.

P-LITH-056 – Thermal nanoimprint lithography using fluoropolymer mold

Celal Con [1], Mustafa Yavuz [1], Bo Cui [1]

[1] University of Waterloo, Waterloo/Canada

We studied fluoropolymer as mold material for thermal nanoimprint lithography. The fluoropolymer mold was duplicated by thermally curing a pre-polymer mixture onto a silicon master mold. Its adhesion to the silicon support is poor due to its low surface energy, but can be improved by using a silane surfactant. We were able to imprint into poly (vinyl phenyl ketone) using the fluoropolymer mold with high resolution.

P-LITH-057 – Three-dimensional measurements of UV-imprint process by micro-digital Holographic-PTV

Shin-ichi Satake [1], Jun Taniguchi [1], Takahiro Kanai [1], Noriyuki Unno [1]

[1] Tokyo University of Science, Noda, Chiba/Japan

We evaluate the capability of the system to measure a press process and a UV photo-curing after the press process in UV-imprint system. We report on a technology of detecting 3-D particle position during the processes. The particle tracking is carried out by digital hologram technique. The 3-D displacement from the tracking was primarily found to be the press process not but the UV-photo curing process. The press procedure is dominant physics for the fluidics on an imprint process.

P-LITH-058 – UV enhanced Substrate Conformal Imprint Lithography (UV-SCIL) for LED applications

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Substrate Conformal Imprint Lithography (SCIL) [4,5], a revolutionary NIL technique developed by Philips Research and SUSS MicroTec, bridges the gap between UV-NIL using rigid stamps for best resolution and soft stamps for large-area patterning. The application of UV-SCIL technology in PSS, NPSS and PC structures for LED devices are briefly described. Additionally, the business potential of integration of SCIL in high volume manufacturing (HVM) of high brightness LED (HB LED) is discussed.

P-LITH-059 – Wetting properties of patterned surfaces for slip length control in micro-fluidic devices.

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Surfaces with well-ordered micro- and nanotextures have been one of the most attractive fields last decade on various fields ranging from optics to wetting or liquid flow. Here we study the wetting properties of patterned surfaces made by nanoimprint lithography and we examine the stability of these surfaces by using the evaporation test. Our results demonstrate the nanoimprint lithography on silica sol-gel materials is a promising technique for rapid prototyping of surfaces for fluid control.

P-LITH-060 – µCP 4.0 – A new GeSiM NIL/µCP Platform for Research and Fabrication in Biotechnology and Material Science

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We advanced our current NIL/µCP platform, µ-CP3.0, to the fourth generation, the µ-CP4.0, by combining it with a robotic stage, our Nano-Plotter. A membrane stamp using PDMS with different formats is used to perform the NIL and µCP process either on a flat surface or on a 3D-shaped object such as micro well plates. The deposition of imprint resists or inking materials for microcontact printing is carried out with a piezoelectric microdispenser enabling subnanoliter droplets.

P-LITH-061 – A new nano probe facility for proton beam writing

Jeroen Anton van Kan [1], Piravi Malar [1], Armin Baysic de Vera [1]

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A 2nd generation proton beam writing (PBW) beam line has been installed at the Centre for Ion Beam Applications at the National University of Singapore. This new system for PBW is able to focus MeV proton beams down to a spot size of 20 nm. PBW is a promising technique for proximity free structuring of high aspect ratio, high density 3D nano structures. PBW of high aspect ratio metallic nanowires as well as NIL mold fabrication through PBW and Ni electroplating will be presented.

P-LITH-062 – A Simple Air Bridge Technology for mm-Wave Applications

Ata Khalid [1]

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We describe a new air-bridge fabrication technology using electron beam lithography. This novel technique greatly simplifies the lithographic process, eliminating the requirement for complex writing control procedures used in established electron-beam lithography based processes. The new technique is demonstrated using single-dose per layer electron beam lithography and is applied to the fabrication of microwave and millimeter-wave waveguide structures.

P-LITH-063 – Analysis on probe-sample interaction for scanning near-field photolithography (SNP)

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[1] University of Nottingham, Nottingham/United Kingdom, [2] University of Sheffield, Sheffield/United Kingdom, [3] University of Glasgow, Glasgow/United Kingdom

Experimental force measurements are carried out to analyse interaction between probe and sample in scanning near-field photolithography. The theoretical influences of the medium The theoretical influences of the medium on van der Waals forces, electrostatic forces, pull-off forces and hydrodynamic forces are discussed. Experimental results lead to the conclusion that liquid environment can decrease adhesion force significantly and hence improve SNP and benefit its application.

P-LITH-064 – Automated Scanning Tunneling Microscope Image Analysis of Si (100) 2X1 Surfaces

John Randall [1], James Von Ehr [1], Joshua Ballard [1], James Owen [1], Ehud Fuchs [1]

[1] Zyvex Labs, Richardson, Texas/United States

Automated image analysis of scanning tunneling microscope images of the Si (100) 2x1 H passivated surface is being developed to identify the individual surface atoms in their dimerized form, as well as different atomic terraces, dangling bonds, Si atom vacancies, and other surface features. This automated surface feature recognition will permit manufacturing processes such as H depassivation lithography for patterned Si atomic layer epitaxy where subsequent patterns must be precisely aligned.

P-LITH-065 – Benchmark of Monte Carlo simulation for high resolution electron beam lithography

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Proximity Effect Correction (PEC) in EBL requires a Point Spread Function (PSF). We compared two different Monte Carlo methods (CSDA and DACS) to compute the PSF. The results coincide in the long-range part, but they show high discrepancy in the short-range and mid-range part. We validated the differences by using PEC and test exposures. The exposure results with DACS correction show better uniformity and prove that the mid-range energy of the PSF influences the lithographic result.

P-LITH-066 – Charging process simulation of a resist film on Si substrate by electron beam irradiation

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The specimen simulated is 300-nm thick PMMA on Si substrate and it is irradiated by EB with acceleration voltage (Vacc) of 0.8-20kV and the beam current is 50 pA. Surface potential is obtained for various Vacc. At low and high Vacc's, the surface charges positively with a small time constant (TC). However, if Vacc is between 1.3 kV and 3 kV, it charges negatively with a large TC. The saturated surface potential as a function of Vacc is quite similar to the one obtained by our experiment.

P-LITH-067 – Chemical Routes to High Resolution Electron Beam Lithography on Ge & Bi2Se3

Richard Hobbs [1], Nikolay Petkov [2], Ciara Bolger [1], Yordan Georgiev [2], Faxian Xiu [3], Kang L. Wang [3], Ran Yu [2], Jean-Pierre Colinge [2], Justin Holmes [1]

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Aqueous HSQ developers such as NaOH and TMAH have thus far prevented the fabrication of high-resolution structures via the direct application of HSQ to Ge and Bi2Se3, due to the solubility of components of their respective native oxides in these strong aqueous bases. We report a chemical process to remove the native oxide on Ge and Bi2Se3 crystals, thus facilitating high-resolution electron beam lithography (EBL) on their surfaces using a hydrogen silsesquioxane (HSQ) resist.

P-LITH-068 – Close packing of gold nanoparticles site-selectively arranged on nanolines prepared by scanning probe lithography on ITO surface

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[1] Kyoto University, Kyoto/Japan

Extensive research on the physical properties of nanoparticles domains has been undertaken for the fabrication of optical and electronic devices. And the use of nanoparticles in device requires precise control with their ordered aggregation and organization for potential applications. We provide a convenient method for fabricating highly controlled arrays of gold nanoparticles on optically transparent ITO substrate by combining scanning prove lithography and self-assembled monolayers.

P-LITH-069 – CVD grown graphene lithography by AFM local anodic oxidation

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[1] Czech Technical University in Prague, Prague 6/Czech Republic, [2] Academy of Sciences of the Czech Republic, Prague 8/Czech Republic

Results of local anodic oxidation (LAO) process on the graphene monolayers prepared by CVD growth on copper are presented. The AFM microscope Ntegra NT-MDT has been used for the scanning and lithography. The properties of LAO oxide lines for different negative voltages applied on the tip and different tip velocities were analyzed. The lithography is capable of producing small features down to 20 nm, allowing in situ monitoring of the device parameters and easy tuning of the fabrication.

P-LITH-070 – Direct E-beam Lithography of PDMS

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Poly-(dimethylsiloxane) (PDMS) is a versatile material frequently used in the fabrication of micro and nano scale devices. Here we introduce the use of e-beam lithography (EBL) as a method of directly patterning liquid PDMS. EBL is a lithographic technique that is widely used to define nanoscale features and while it is a serial method, the ease of design and resolution means it has great potential in being used to generate a great variety of PDMS-based structures.

P-LITH-071 – Enhancing 3-D structural variety by combination of electron-beam and nanoimprint lithography with thermal reflow

Arne Schleunitz [1], Vitaliy A. Guzenko [1], Christian Spreu [1], Marko Vogler [2], Hakan Atasoy [2], Gabi Grützner [2], Helmut Schift [1]

[1] Paul Scherrer Institut, Villigen PSI/Switzerland, [2] micro resist technology GmbH, Berlin/Germany

We present a new way to simplify the generation of complex resist topographies in PMMA which combine stepped contours with vertical and inclined sidewalls in close vicinity. The process is based on the combination of nanoimprint and (grayscale) electron-beam with a molecular weight (Mw) dependent thermal reflow. A major advantage over previous work is the generation optimized slope contours due to a homogeneous Mw distribution as well as a further process simplification.

P-LITH-072 – Fabrication of GaN nanorods by focus ion beam

Javier Martinez [1]

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Nanofabrication of GaN nanocolumns by focus ion beam. In this paper we demostrate a single step processing for the fabrication of GaN nanocolumns. This technology is very efficient because there is no need of a resist layer and the system can pattern large areas and one can control the geometry of the nanocolumns, from single ones to circular ones.

P-LITH-073 – Focused Ion Beam Fabrication of Spintronic Nanostructures

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Focused Ion Beam Fabrication of Spintronic Nanostructures The presented work studies the influence of the thin film deposition process (ion beam sputter deposition with and without assisting ion beam, epitaxial growth by pulsed laser deposition) on the quality of FIB patterned structures.

P-LITH-074 – High molecular weight polystyrene as very sensitive electron beam resist

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We studied the exposure property of 170 kg/mol polystyrene as negative electron beam lithography resist. It was exposed at 5 keV and developed using tetrahydrofuran. We found that, compared to 2 kg/mol polystyrene resist, the sensitivity for 170 kg/mol polystyrene (12 uC/cm2) is two orders higher, though its contrast is significantly lower. We were able to achieve 48 nm-wide polystyrene line array patterning.

P-LITH-075 – High resolution and high density Ion Beam Lithography employing HSQ resist

Lars Bruchhaus [1], **Sven Bauerdick** [1], Lloyd Peto [1], Ulli Barth [1], Axel Rudzinski [1], Jonas Mussmann [1], Jacques Gierak [2], Heinz Hövel [1]

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In the early ages of FIB development, IBL employing resists has shown pot. advantages over EBL. However, EBL has always been more popular due to various reasons. We will present and detail our results obtained with a Ga-LMIS nanofabrication system studying the resolution limits related to Ga-IBL. We will show that minimum feature sizes below 10 nm and 30 nm period are possible in HSQ. Due to the performance level and ease of use of this IBL process, we believe this opens promising perspectives.

P-LITH-076 – High resolution and high density nano-patterning in HSQ using proximity correction

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This work demonstrates that 100 kV electron beam lithography of dense features in HSQ is not possible without proximity effect correction. Dot arrays with diameters of 20 nm and pitches from 40 to 80 nm are studied. The effect of beam current is analyzed. It observed that there are additional process effects beyond forward and backscattering of electrons which must be compensated for to achieve maximum uniformity across the dot array.

P-LITH-077 – Investigating the Resolution Limits of 200 keV Electron-Beam Lithography with an Aberration-Corrected STEM

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We investigated the resolution limits of electron-beam lithography (EBL) with an aberration-corrected scanning transmission electron microscope at 200 keV. This system provides 1.5 Å spot size and smaller electron scattering cross section than lower energy EBL systems. We fabricated 5-nm-half-pitch dot arrays in hydrogen silsesquioxane (HSQ) resist. We also fabricated features with minimum dimension of 1 nm in HSQ. To analyze these results, we measured the point-spread function at 200 keV.

P-LITH-078 – Ion Beam Lithography for direct patterning of high accuracy large area X-ray elements in gold on membranes

Achim Nadzeyka [1], Sven Bauerdick [1], Lloyd Peto [1], Corinne Grevent [1], Marcel Mayer [2], Kahraman Keskinbora [2], Markus Weigand [2], Michael Hirscher [2], Gisela Schütz [2]

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Ion beam lithography was used to fabricate zone plates on silicon nitride membranes. 100 µm zone plates with 100 nm outermost zone width were successfully produced by milling of 500 nm gold within a 15 hours process including automatic drift compensation by mark recognition on a mark outside the 500 µm x 500 µm membrane area. The quality of the zones has been analyzed by SEM imaging and lens functionality has been proven by first X-ray measurements.

P-LITH-079 – Lifetime improvement of cantilever during scanning probe lithography

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Scanning probe lithography (SPL) is a very simple and flexible lithography method to offer resolution below 100 nm. Electron beam (EB) resist is delineated by scanning of the fine needle (cantilever) on resist surface with applying voltage. However, cantilever of SPL wears during SPL because of contact process. And the wearing of cantilever causes line widths change. To improve this issue, effect of low friction layer and protection of cantilever apex are examined.

P-LITH-080 – Nano- and Micro-fabrications of Polystyrene Having Atactic and Syndiotactic Structures using Ion Beam lithography

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Micro and nano fabrications of polystyrene (PS) with atactic and syndiotactic structures were carried out with direct etching using focused ion beam (FIB) lithography. Micro and nano structures without any solid debris were obtained. Etching rates were different between atactic and syndiotactic. The rate of syndiotactic shows higher than atactic. The FIB direct etching proceeds through two steps of decomposition and desorption. Both process are influenced by conformation and configuration.

P-LITH-081 – Optimised marker definition for high overlay accuracy e-beam lithography

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A thorough investigation of the dependence of the overlay displacement of a Vistec EBPG 5000+ on marker distance and marker definition procedure is given. Markers are holes of 10µm width and 500nm depth defined by e-beam lithography with perpendicular incident beam. It is possible to achieve overlay displacements better than 5nm in the middle of the die defined by the distance of the markers. At the rim the mean value still is better than 5nm, but the standard deviation increases to 7.7nm.

P-LITH-082 – Parallel Electron-Beam-Induced Deposition using a Multi-Beam Scanning Electron Microscope

Cornelis Wouter Hagen [1], **P. Chris Post** [1], Ali Mohammadi-Gheidari [1], Pieter Kruit [1]

[1] Delft University of Technology, Delft/Netherlands

We present the first results of parallel electron-beam-induced deposition in a multi-electron beam scanning electron microscope. Arrays of dots are deposited from a Pt-precursor gas with 196 electron beams simultaneously.

P-LITH-083 – Periodic tilted structure fabrication by electron beam exposure

Jian Zhang [1]

[1] University of Waterloo, Waterloo/Canada

We demonstrate that 2D periodic array of tilted nanostructure can be conveniently fabricated using SEM exposure of e-beam resists in imaging mode. During the exposure of the resist on a tilted wafer, we utilized the dynamic focus function to maintain focus over millimeter scale. Tilted holes and pillars were achieved using ZEP-520A positive resist and SU-8 negative resist with the substrate tilted at 45 degree.

P-LITH-084 – Point and Line Spread Function of Primary Electrons Approximated by Power Law

Leonid Litvin [1], Ulrich Barth [1], Guido Piaszenski [1], Mark Levermann [1], Michael Kahl [1]

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The point and line spread function for primary beam were measured by Rishton's method. Our goal was to investigate the distribution of secondary electrons, when forward scattering is negligible. We found the PSF that obeys power law with exponent near 2.5, and proposed a formula for fitting experimental results. The LSF is a derivative of PSF; its shape can be inferred from PSF. However the experiment shows unexpectedly the LSF with a kink at which the power exponent changes from 1.6 to 2.8.

P-LITH-085 – PPF – Explorer: Advantages of a new Pointwise Proximity Function Calibration Method

Reinhard Galler [1], Michael Krueger [1], **Martin Suelzle** [1], Ulf Weidenmueller [2], Luis Ramos [2]

[1] EQUIcon Software GmbH Jena, Jena/Germany, [2] Vistec Electron Beam Lithography Group, Jena/Germany

This paper describes the newly developed PPF-explorer method for point-wise proximity function calibration which is based on the exposure and evaluation of new calibration layouts. Further, first very promising calibration results obtained by test exposures are presented. They show some accordance with the process proximity function calibrated using an available PPF-calibration tool but also some systematic differences indicating potential PPF-calibration improvements by the new method.

P-LITH-086 – Precision assembly of a miniaturized wire deflector for electron-beam lithography

Stefan Risse [1], Matthias Mohaupt [1]

[1] Fraunhofer IOF, Jena/Germany

Fast and precise deflection of electron-beams is necessary for common electron beam tools and next generation multi-beam lithography systems. This paper will discuss the design and the manufacturing of a new wire-based electrostatic deflector for electron-beam lithography and describes the novel alignment, assembly and solderjet bumping fixation technology. Accuracy and long term stability results will be illustrated by X-ray CT measurements.

P-LITH-087 – Proximity effect correction for fabrication of high-efficiency grating couplers

Jens Bolten [1], Christel Manecke [1], Thorsten Wahlbrink [1], Matthias Karl [1], Heinrich Kurz [1]

[1] AMO GmbH, Aachen/Germany

We report on the application of a recently presented proximity effect correction technique for the fabrication of high efficiency grating couplers for integrated silicon photonics. We demonstrate that, without a proximity effect correction, deviations of the gap width of the gratings lead to unstable coupling conditions and therefore hinder the optical characterization of devices. Applying an efficient PEC, those deviations can be significantly reduced, offering stable coupling conditions.

P-LITH-088 – Room Temperature Inductively Coupled Plasma Etching of InAs in BCl3/Cl2/Ar

Jian Sun [1], Jurgen Kosel [1]

[1] KAUST, Thuwal/Saudi Arabia

Most dry etching processes for In based III-V semiconductors are chloride-based. However, due to the low volatility of InCl3 etch products compared to the one of group-V chlorides, the surfaces of In-containing materials etched with chloride-based environments at room temperature are typically rather rough.In this work, we report on a process to obtain ultra-smooth surfaces, for both InAs and InSb using inductively coupled plasma (ICP) etching in a BCl3/Cl2/Ar gas atmosphere at room temperature.

P-LITH-089 – Sensitivity analysis for accurate determination of PSF parameters

Tortai Jean Herve [1]

[1] LTM/CNRS, grenoble/France

Point Spread Function (PSF) determination is a key issue in order to achieve dense patterns of high resolution byE-beam lithography. Short range and long range proximity effects have to be taken into account to adress sub 22 nm node. This paper deals with the analysis of the sensitivity of a layout to the PSF parameters in order to obtain accurate values. It is shown that the presented layout is sensitive to long range Gauss function of the PSF, parameter the most difficult to obtain.

P-LITH-090 – Simple and efficient method to fabricate nanocone arrays by FIB milling demonstrated on planar substrates and on protruded structures

Mathias Rommel [1]

[1] Fraunhofer IISB, Erlangen/Germany

A simple and processing time efficient strategy is presented for the fabrication of regular arrays of silicon nanocones using focused ion beam (FIB) processing. Optimized processing parameters for arrays with different periodicities (i.e., 150 nm, 300 nm, and 600 nm, respectively) are presented resulting in nanocones with tip radii below 30 nm. The patterning approach is very simple for planar samples whereas the patterning of protruded structures needs some more effects to be accounted for.

P-LITH-091 – Single-step 2.5D nanolithography using plasmapolymerized hexane films

Rasmus Haugstrup Pedersen [1], Kiryl Kustanovich [1], Nikolaj Gadegaard [1]

[1] University of Glasgow, Glasgow/United Kingdom

We present two approaches to obtain a 2.5D nanopatterned surface, using a single conventional lithography and etch step. This is accomplished by utilizing plasmapolymerized hexane films (ppHex). In method A, a pre-etched substrate is structured by a single e-beam lithography step on both top and bottom, using ppHex as a resist. In method B, a predefined pattern is etched to various etch depths in a single step, using a ppHex film deposited with a thickness gradient as a sacrificial etch mask.

P-LITH-092 – Time Efficient Fabrication of Ultra Large Scale Nano Dot Arrays using Electron Beam Lithography

Jochen Grebing [1], Jürgen Faßbender [1], Artur Erbe [1]

[1] Helmholtz-Zentrum Dresden-Rossendorf, Dresden/Germany

Many applications in plasmonics or sensorics require large scale arrays of nano-sized dot structures with rather high surface coverages, leading to extremely high numbers of objects to be handled by both the software and the lithography system. An astonishingly simple alternative method for the creation of ultra large scale nano dot arrays is presented here utilizing that in electron beam lithography, exposure is based on single pixels with defined distances.

P-LITH-093 – A Novel Lloyd Mirror Type Laser Interference Lithography Framework for the Fabrication of Large Area Periodic Nano Structures

Chien-Chung Fu [1]

[1] National Tsing-Hua University, Hsinchu/Taiwan

We present a novel configuration of Lloyd mirror type laser interference lithography system. The system can be promoted to fabricate periodic nanostructures with an area much larger than the mirror used. We introduce the design concepts and ideas for the construction, not only to re-configure the mirror stage itself, but also to introduce a sliding reflective mirror to enable pitch tuning. Periodical nano structures with an area up to 36 cm2 have been successfully demonstrated.

P-LITH-094 – Bilayer extreme UV diffraction grating fabricated by nanoimprint lithography

Chun-Hung Lin [1], Yi-Ming Lin [1], Chia-Ching Liang [1], Yin-Yu Lee [2], Hok-Sum Fung [2], Bor-Yuan Shew [2], Szu-Hung Chen [3]

[1] National Cheng Kung University, Tainan/Taiwan, [2] National Synchrotron Radiation Research Center, Hsinchu/Taiwan, [3] National Nano Device Laboratories, Hsinchu/Taiwan

Simple two-step processes were proposed to fabricate the EUV transmission grating. The grating structure is formed by nanoimprinting the SU-8 resist film. The bilayer grating is then obtained by evaporating Cr on the imprinted SU-8. No additional lift-off step is required in this process.

P-LITH-095 – Contact Edge Roughness: Effects of dose and the role of CD reduction

Vijaya Kumar Murugesan Kuppuswamy [1]

[1] Institute of Microelectronics, Aghia Paraskevi, Attiki/Greece

In recent years it has been proposed that contact edge roughness (CER) may be one of the origins of variation in device characteristics. In this work, we analyze the effects of dose on CER parameters such as RMS, correlation length and critical dimension (CD) for two different EUV resists. In which one of the resist is treated with different sensitizer concentrations. We conclude our paper with partial explanation of metrological effects on the influence of process conditions on CER.

P-LITH-096 – Design, Fabrication and Characterization of Split Ring Resonators using X-Ray Lithography

Valentina Giorgis [1], Filippo Romanato [2], Michele Massari [2], Giuseppe Parisi [2], Marta Carli [2], Davide Sammito [1], Enrico Sovernigo [1]

[1] IOM CNR, Istituto Officina dei Materiali, Basovizza (Trieste)/Italy, [2] LaNN Laboratory for Nanofabrication of Nanodevices, Padova/Italy

In this work we present a SRR fabrication process based on X-Ray Lithography (XRL). The XRL fabrication of SRRs offers the possibility to obtain large area sample with high aspect ratio and a good lithographic quality. In XRL high energy x-radiation is used to transfer a pattern from a mask to a photoresist. The x-ray mask has been produced on a silicon nitride membrane by EBL (at LaNN, Padua) and subsequent electrochemical gold growth; XRL has been performed at ELETTRA synchrotron.

P-LITH-097 – Development of a nondeforming chuck for EUV lithography

Atsunobu Une [1], Nagahisa Ogasawara [1], Kenichiro Yoshitomi [1], Masaaki Mochida [1]

[1] National Defense Academy, Yokosuka-shi/Japan

A EUV mask is usually clamped by a chuck using electrostatic force. However, the electrostatic force deforms the mask. Therefore, we developed a new nondeforming chuck that does not use the electrostatic and does not damage the contact surface. This paper describes the principle and features of the nondeforming chucking technique and clarifies the cooling temperature for the pin chuck system, the shear peeling force, and the deformation of the quartz wafer due to chucking.

P-LITH-098 – Extension of the Domain Decomposition Method for Modeling Through-Slit Variations of Mask Shadowing

Kostas Adam [1]

[1] Mentor Graphics, Fremont/United States

In this paper, the extension of DDM for modeling through-slit variations of mask shadowing is presented. Specifically, the procedure to derive continuously varying DDM signals that are suitable for specific mask coordinates is discussed in detail. By construction, these continuously varying signals allow the variations of mask shadowing to be modeled without discontinuities in the imaging simulations across boundaries on the slit of the EUV exposure tool.

P-LITH-099 – Fabrication of Complex Shape Micro Component with Porous Existence by Sintered Steel Nanopowder Formed by Direct X-Ray Lithography

Andy Tirta [1], Eungryul Baek [2], Suksang Chang [3], Jonghyun Kim [3]

[1] Yeungnam University, Gyeongsan-si, Gyeongbuk/Republic of Korea, [2] Material Science and Engineering, Yeungnam University, Gyeongsan-si, Gyeongbuk/Republic of Korea, [3] Pohang Accelerator Laboratory, Pohang/Republic of Korea

P-LITH-100 – Fabrication of double-slits-grating for high resolution Microspectrometers

Zhang Zhiyou [1]

[1] Sichuan University, Chengdu/China

In order to improve the performance of microspectrometer, we present a double-slits-grating (DSG) in this paper, and united lithography methods with interference lithography, localized surface plasmon imaging lithography and ion etching techniques are used to fabricate DSG. It can enhance the spectral resolution of microspectrometers reached 0.1nm and has rich spectral characteristics and spectral sensibility that provide a well potential application in biomedical sensors.

P-LITH-101 – Fabrication of nanopore array based on the nanometer silver pore-mirror device

Zhang Zhiyou [1]

[1] Sichuan University, Chengdu/China

we present a new device for plasmonic lithography to enhance the exposure depth by using the plasmonics resonance between the silver nanopore and nano-mirror. The feature size of the lithography patterns can be decreased by the SP interference excited by silver pore array, and the exposure depth can be increased by the nano-mirror. In this paper, the characteristics of optical energy distribution in the resist are discussed with FDTD method and some nanopore arrays are experimentally obtained.

P-LITH-102 – Hexagonal gold nanoparticle arrays fabricated using anodic porous alumina mask

Jeonghyeon Yang [1], Takashi Ichii [1], Kuniaki Murase [1], Hiroyuki Sugimura [1], Toshiaki Kondo [1], Hideki Masuda [1]

[1] Kyoto University, Kyoto/Japan

Vacuum ultra-violet (VUV) light of 172 nm wavelength has attracted much attention for patterning organic thin films by irradiating through a mask. An anodic porous alumina membrane formed by anodizing Al can be a useful mask because of its ideally ordered hole structure. We demonstrate the arrangements of gold nanoparticles by controlled functionalization in a regular fashion, on the basis of the self-assembly and VUV lithography approaches through anodic porous alumina mask.

P-LITH-103 – Influence of dynamic sub-pixelation on exposure intensity distribution under diffraction effects in mask-less lithography using binary spatial light modulator

Manseung Seo [1], **Haeryung Kim** [1]

[1] Tongmyong University, Busan/Republic of Korea

In lithography using binary spatial light modulators, the irradiance is influenced by diffraction effects. Dynamic sub-pixelation, a method of dividing an image pixel reflected off a single mirror on to a translating substrate into equal-sized sub-pixels by the superposition of the image pixel, is presented to enhance resolution. The influence of dynamic sub-pixelation on exposure intensity distribution under diffraction effects is investigated through lithography simulations and experiments.

P-LITH-104 – Method for various patterning by light source change in Attenuated Phase Shift Mask

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[1] Sungkyunkwan University , Samsung Electronics Co. Ltd, Suwon/Republic of Korea,
[2] Sungkyunkwan University, Suwon/Republic of Korea

When an ArF attenuated PSM with line & space type patterns is used under KrF light source scanner, we can observe that original L&S patterns are changed to reverse S&L patterns and also, original L&S patterns are changed to double pattern under moderate dose. In this study, we investigate the pattern reversal effect, double patterning effect which is induced by the mismatch between attenuated PSM and light sources, and have an effort to understand the mechanism of the phenomenon.

P-LITH-105 – Origination of nano- and microstructures on large areas by interference lithography

Andreas J. Wolf [1]

[1] Fraunhofer ISE, Freiburg/Germany

We present large area nano- and microstructure origination by interference lithography. Unique and tailored profiles and shapes as well as combined multifunctional structures can be manufactured. Subsequent replication is considered and a route via UV nanoimprint lithography is chosen. An industrially feasible process is developed and shown by the generation of light trapping structures via the texturization of multicrystalline silicon wafers.

P-LITH-106 – Superlens-based interference nanolithography

Xiaowei Guo [1]

[1] University of Electronic Science and Technology, Chengdu/China

In this paper, we propose a superlens-based interference lithography which provides potential to obtain a lithography resolution at least two times the mask used. The Finite Difference Time Domain method has been performed to analyze the performance of lithography pattern. Waveguide theory is used for the design of enhancing the interference intensity.

P-LITH-107 – Application of gravimetric controlled infrared drying system in thick layer processes for fabrication of cantilever sensors for environmental monitoring

Maik Schönfeld [1], Heiko Aßmann [1], Manfred Cappek [1], Bernd Löchel [2], Ulrich Wöhrl [1], Jens Saupe [1], Jürgen Vogel [1], Jürgen Grimm [1]

[1] Westsächsische Hochschule, Zwickau/Germany, [2] Helmholtz-Zentrum Berlin, Berlin/Germany

Epoxy-based photoresists are widely used in MEMS technology. In addition to utilization within LIGA processes, photoresists are also used for the direct production of micro-mechanical devices. An innovative IR-drying method for the processing of thick photoresist coatings will be presented. This system is an alternative to the conventional resist drying methods, but with a remarkable ability to determine, in-situ, the mass loss of the coating layer due evaporation of the solvent while drying.

P-LITH-108 – Development of an adhesive testing method for two-dimensional fine patterns on Silicon substrate using a photoresist column

Chiemi Ishiyama [1], Chiaki Miyasaka [1], Ik Keun Park [1]

[1] Tokyo Institute of Technology, Yokohama/Japan

The adhesive testing method for circular shape of two-dimensional fine patterns on substrate has been newly developed and demonstrated for the purpose to reveal the relationship between the effective delamination factors and the adhesive strength. Photoresist columnar jigs with the same diameter of the circular pattern have been fabricated on the patterns and the adhesive strength of micro-sized circular pattern on substrate is measured by applying the bending force using the columnar jig.

P-LITH-109 – Direct Photo-Etching of Fluorocarbon Polymers Induced by High Energy Synchrotron Radiation

Hideki Kido [1]

[1] University of Hyogo, Hyogo/Japan

Fluorocarbon Polymers is very attractive material for various fields, because of its chemical resistance and hydrophobic property, etc. However, it is difficult to fabricate Fluorocarbon Polymers microstructures with conventional techniques such as semiconductor process or micro machining. We had succeed in the fabrication of high-aspect-ratio micro fluidics parts of poly-tetrafluoroethylene (PTFE) by direct in-vacuum photo-etching using synchrotron radiation (SR) with energy from 2 to 12keV.

P-LITH-110 – Dose control by scan step for high volume manufacturing maskless lithography

So-Yeon Baek [1]

[1] Hanyang University, Ansan/Republic of Korea

A simulation package has been developed for predicting the influence of the point array maskless lithography with a digital micromirror device (DMD) system. The maximum overlaying intensity with respect to various feature sizes as well as scan step were analyzed. We found a correlation between scan step and overlaying intensity to predict new dose when new scan step is applied. Also, simulation performed the development process to obtain the photoresist profiles for the desired pattern size.

P-LITH-111 – Effects of tensile stress on electrical parameters of thin film conductive wires fabricated on a flexible substrate using stencil lithography

Milos Frantlovic [1], Ivana Jokic [1], Veronica Savu [2], Shenqi Xie [2], Jürgen Brugger [3]

[1] ICTM – University of Belgrade, Belgrade/Serbia and Montenegro, [2] Ecole Polytechnique Federale de Lausanne, Lausanne/Switzerland, [3] EPFL, Lausanne/Switzerland

We report for the first time the results of stretching tests of thin film conductive structures patterned on a PI substrate using stencil lithography. The change in resistance and resistivity was measured under gradually applied strain and after a large number of stretching cycles. Electrical parameters, structure and functionality of the samples are preserved. Stencil lithography proved to be a promising technique for fabrication of interconnects at the micrometer scale in flexible electronics.

P-LITH-112 – Environment Treatment for Perfect Spray Photoresist Morphology

Laddawan Supadee [1], **santi chatruprachewin** [1], Wisut Titiroongruang [1]

[1] King Mongkut's Institute of Technology Ladkrabang, Bangkok/Thailand

A homogeneous resist film requires a certain flowing of the resist film on the substrate for at least few µm, thus defining certain minimal resist viscosity for the remaining solvent concentration. If photoresist is too much solvent evaporates during flight (between spray nozzle and substrate), this prevents the droplets from sticking to the substrate or at least causes a rough surface.

P-LITH-113 – Evaluation of inorganic directly patternable spin on hardmask materials using electron beam lithography

Xaver Thrun [1], Kang-Hoon Choi [1], Martin Freitag [1], Andrew Grenville [1], Manuela Gutsch [1], Christoph Hohle [1], Jason K. Stowers [1]

[1] Fraunhofer CNT, Dresden/Germany

In this paper, the evaluation of inorganic resists from Inpria and its feasibility will be discussed. The resists were evaluated in terms of contrast, sensitivity, resolutions and pattern quality. The process characteristics required for CMOS manufacturing such as shelf life, vacuum stability, post coat and post exposure delay will be examined. Furthermore, it will be demonstrated the exposure of real application pattern, for example large SRAM layer shrink down to the design CD of 22 nm.

P-LITH-114 – Fabrication of 3D asymmetric gold electrodes for ac-electroosmotic micropumps

Hamza Rouabah [1]

[1] University of Southampton, southampton/United Kingdom

In this paper the fabrication process of making 3D gold electrodes for asymmetrical set of electrodes on a single plating process is presented, problems encountered during the fabrication were presented along with the appropriate solutions.

P-LITH-115 – Functionalized silsesquioxane resists for UV nanoimprint lithography

Olivier Lorret [1]

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Multi-functional POSS polymers were synthesized and used as resist for UV nanoimprint lithography. The presence of epoxy groups allows the resists to solidify within seconds under UV exposure at RT, while the presence of phenyl groups enhances the material toughness and patternability. Finally, fluoro groups contained in the POSS resists provide a low surface energy that allows easy demolding after the curing. In addition, they possess the desired properties of epoxy-silicon resists.

P-LITH-116 – Highly inorganic titania based sol-gel as directly patternable resists for micro- and nano- structured surfaces

Erika Zanchetta [1], Gioia Della Giustina [1], Vaida Auzelyte [2], Jürgen Brugger [3], Giovanna Brusatin [1]

[1] Mechanical Engineering Department – Materials Sector, University of Padova, Padova/Italy, [2] École Polytechnique Fédérale de Lausanne (EPFL), Lausanne/Switzerland, [3] EPFL, Lausanne/Switzerland

High refractive index films have attracted much attention for applications in a large number of devices. We report on the synthesis of titania hybrid sol-gel films, obtained using Ti-isopropoxyde or loading the system with ex-situ synthesized titania nanoparticles. The films were patterned by NIL at different temperatures and further treated by UV irradiation (exploiting the titania photocatalytic effect) to produce high refractive index (over 2.1@400nm) micro- and nano- patterned surfaces.

P-LITH-117 – Negative hybrid sol-gel resist as hard etching mask for pattern transfer with dry etching

Gianluca Grenci [1], Gioia Della Giustina [2], Alessandro Pozzato [1], Erika Zanchetta [2], Massimo Tormen [1], Giovanna Brusatin [2]

[1] CNR-IOM, Laboratorio TASC – Lilit beam line, Basovizza/Italy, [2] Mechanical Engineering Department – Materials Sector, University of Padova, Padova/Italy

Hybrid organic-inorganic sol-gel systems are a versatile class of materials, as their physical and chemical properties can be widely tailored and they can be directly written by different lithographic techniques. In this work we present a new Al-based system, designed as high resolution resist and highly resistant etch mask in fluorine-based plasmas. We used X-ray lithography to write patterns with resolution down to 200 nm in a 30 nm thick film, which showed selectivity of 100:1 to Si

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P-LITH-118 – Negative Resists for Ultra-Tall, High Aspect Ratio Microstructures

Stephanie Lemke [1], Philipp Göttert [1], Ivo Rudolph [1], Jost Goettert [2], Bernd Löchel [3]

[1] Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin/Germany, [2] Louisiana State University, CAMD, Baton Rouge. LA/United States, [3] Helmholtz-Zentrum Berlin, Berlin/Germany

High resolution, high aspect ratio micro-optical and micromechanical components can be patterned into PMMA resist with extreme precision using X-ray lithography. New alternative negative tone resist materials, namely mr-X and SUEX, have recently been developed and are currently being introduced into the market. This paper will discuss typical process parameters and present first results comparing these new resist materials with PMMA for the fabrication of high aspect ratio microstructures.

P-LITH-119 – Novel Resin Mold for UV Nanoimprint: A Demolding Agent Free System

Masamitsu Shirai [1]

[1] Osaka Prefecture University, sakai , Osaka/Japan

The fouling of the mold is a serious issue in UV nanoimprint lithography (UV-NIL). It is essential to use the fluorine-containing compounds as a mold-release layer on the surface of the quartz mold. In this study, we have developed a novel resin mold which does not need to modify the surface of the mold with fluorine-containing compounds. ΛUV-NIL was successfully accomplished using the resin mold prepared.

P-LITH-120 – Off-Axis Illumination for the 16 nm Node in Extreme Ultra-Violet Lithography

Eun-Jin Kim [1]

[1] Hanyang University, Ansan, Gyunggi-do/Republic of Korea

Over the years, extreme ultra-violet lithography has made a lot of progress. So, we studied the optimized EUV parameters for 16 nm node with some comparison to 22 nm node. First, we changed the incident angle for a possible high NA. We calculated the incident angles for the various illumination pole conditions. Secondly, we checked the flare, horizontal-vertical line width. We might need more complex optical proximity correction in EUV to make 16 nm patterns.

P-LITH-121 – Optical characterization of a new photopolymer for 3D holographic lithography

Tina Sabel [1], Susanna Orlic [1], Alexander Schlösser [1], Karl Pfeiffer [2], Ute Ostrzinski [2], Gabi Grützner [2]

[1] Institut für Optik und Atomare Physik der TU Berlin, Berlin/Germany, [2] micro resist technologies GmbH, Berlin/Germany

We present a promising photopolymer material system for three-dimensional holographic recording, newly developed by micro resist technologies GmbH. We perform the optical characterization of photopolymer samples and studies on the material's dynamic response upon light illumination.

P-LITH-122 – Photolithographic patterning of PFPE for microfluidics

Alessandra Vitale [1], Marzia Quaglio [2]

[1] Politecnico di Torino, Torino/Italy, [2] Italian Institute of Technology, Torino/Italy

In recent years polymers have assumed a leading role as substrate materials for the fabrication of microfluidic devices. Polydimethylsiloxane (PDMS) has rapidly become a reference material, but its extensive application is limited by its low chemical resistance. Perfluoropolyethers (PFPEs) can be an interesting alternative to PDMS. In the present work we demonstrate a novel, simple photolithographic approach to control the pattern transfer into the PFPE polymeric film.

P-LITH-123 – Processing SUEX Dry Film for Microfluidic Applications

Don Johnson [1], Jost Goettert [2], Varshni Singh [2], Dawit Yemane [2]

[1] DJ DevCorp, Sudbury, MA/United States, [2] Louisiana State University, CAMD, Baton Rouge. LA/United States

The paper will discuss SUEX TDFS characterization and optimization studies for the lithographic preparation of the fluidic structures and ultimate SUEX capabilities. We will show processing details as well as typical microfluidic applications and illustrate some initial results. We will also demonstrate the utility of SUEX TDFS by the fabrication of all polymer, multi-level fluidic devices for gases and liquids, e. g. a GC separation column and a Linear Displacement Array .

P-LITH-124 – Super-resolution lithography using a novel calixarene-based photoresist

Mikkel Schøler [1], Richard J. Blaikie [1], David J. Garrett [1]

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A novel calixarene-based UV photoresist has been developed and characterised. The resist is a chemically amplified, negative tone, molecular glass resist based upon tetramethyl calix[4]resorcinarene. This resist is shown capable of sub-micrometer resolution with low line edge roughness through interference lithography and evanescent near-field optical lithography (ENFOL) and may have superior characteristics for future high-resolution UV imaging studies in such fields as superlensing and ENFOL.

P-LITH-125 – The ZrO/W(100) Schottky Cathode: Morphological Modification and Its Effect on Long Term Operation

Alan Bahm [1], G. A. Schwind [1], L. W. Swanson [1]

[1] FEI Company, Hillsboro/United States

Understanding and controlling the time-dependant shape modifications is essential to improving the stability and life time of ZrO/W(100) Schottky cathodes. An investigation of the change in various geometric and emission parameters over the life cycle of nine ZrO/W(100) Schottky cathodes was performed. Change in geometric parameters were measured at the beginning and after 10,000 to 18,000 hrs. of cathode operation and are correlated with emission behavior.

P-LITH-126 – TiO2 high refractive index structures fabricated via multiphoton absorption lithography

Giovanna Brusatin [1], Carlo Liberale [2], Gioia Della Giustina [1], Gobind Das [3], Vijayakumar Rajamanickam [1], Enzo Difabrizio [2], Erika Zanchetta [1]

[1] Mechanical Engineering Department – Materials Sector, University of Padova, Padova/Italy, [2] Italian Institute of Technology, genoa/Italy, [3] Italian Institute of Technology, Genova/Italy

Multiphoton absorption polymerization using ultrashort laser pulses is a promising micro/nano fabrication method, for the realization of highly complex 3D structures. In this work we demonstrate as highly titania (up to 90%) loaded hybrid sol-gel films, obtained from Titanium alkoxide, can be directly patterned by TPP. As a result of the TiO2 photocatalytic effect, TPP allows to produce almost totally inorganic structures. High refractive patterns have been realized with values up to 2.2 @400nm.

P-LITH-127 – UV-patternable polymers with selective spectral response

Andreu Llobera [1], Anja Voigt [2], Victor J. Cadarso [3], Sandra de Pedro [1], Jordi Vila-planas [1], Jürgen Brugger [4], Stephanus Büttgenbach [5], Gabi Grützner [2]

[1] Institut de Microelectrònica de Barcelona (IMB-CNM, CSIC), Bellaterra/Spain, [2] micro resist technology GmbH, Berlin/Germany, [3] Microsystems Laboratory, EPFL, Lausanne/Switzerland, [4] EPFL, Lausanne/Switzerland, [5] Institut für Mikrotechnik, Braunschweig/Germany

In this work, we have characterized Epocore- modified polymers in which three commercially-available dyes have been mixed. Lithographic process parameters are identical to that of non-doped Epocore, as well as its resolution. The second characterization consisted on determining the optical properties of the modified Epocore polymers. Such materials present present significant stop-bands at concrete regions of the visible spectra and a negleglible bleaching (4% after 40.00 mJ/cm2).

1.5 Directed Self-Assembly

P-LITH-128 – A kind of Silicon Hierarchical Structure With Super-hydrophobic Property

Shibing Tian [1]

[1] Chinese Academy of Sciences, Beijing/China

In this paper, we report a kind of synthesis hierarchical structures with super-hydrophobic property. It has the skeleton with 30 um high and 5 um diameter pole arrays fabricated through photolithography and cryogenic deep etching process and has the decoration on the pole top with nano-structures fabricated by the same etching process but self-assembly PS balls as mask. This hierarchical structure shows very pretty hydrophobic property with water droplet contact angles above150°.

P-LITH-129 – Direct capillary-driven self-alignment on micronscales for cm-sized systems-in-foil

Gari Arutinov [1], Edsger Smits [2], Jeroen van den Brand [2], Herman Schoo [2], Andreas Dietzel [1]

[1] Holst Center/TNO, TU/e, Eindhoven/Netherlands, [2] Holst Center/TNO, Eindhoven/Netherlands

We report on the development of novel concepts of fast-alignment of smaller functional foils to large area carriers using capillary-driven self-alignment principle. We show that mm- and cm-sized foil dice can be aligned on a patterned foil and glass carriers with a very high accuracy (below 30 µm) and showed that assembling systems such as separately manufactured sensors, paper batteries and RFIDs is feasible with this direct capillary-driven self-alignment approach.

P-LITH-130 – Direct patterning and ordering of diblock copolymers through nanoimprint lithography

Mathieu Salaun [1], Nikolaos Kehagias [1], Marie Le Gallic [2], Clivia M. Sotomayor Torres [3], Marc Zelsmann [2]

[1] Catalan Institute of Nanotechnology, Bellaterra/Spain, [2] CNRS / LTM, Grenoble/France, [3] Catalan Institute of Nanotechnology (CIN2-CSIC), Bellaterra (Barcelona)/Spain

Thermal nanoimprint lithography is used to imprint a PS-b-PMMA layer. It is shown that the copolymer can self-organize during the imprinting step and that this organization is guided by the mold's features. Influence of the mold material, treatment and design on the self-organization process is studied.

P-LITH-131 – Fabrication of sub-10 nm L&S on Si substrate using organic-inorganic hybrid diblock copolymer

Naoko Kihara [1], Hiroyuki Hieda [1]

[1] Toshiba Corporation, Kawasaki/Japan

We report the fabrication process of sub-10 nm L&S Si pattern using hybrid material, composed of PS-b-PEO and silsesquioxane. The 16 nm pitch L&S of silsesquioxane was formed by the self-organizing phenomenon of PS-b-PEO. The silsesquioxane lines were transferred to Si substrate to form 8 nm lines with around 8 nm depth. Trench pattern was applied to align the self-organized pattern. The relationship between the width of the guide trench and the pitch size of cylinder was also investigated.

P-LITH-132 – Functionalization of focused electron beam induced deposits by molecular self-assembly

Willem van Dorp [1], **Jacob Hoogenboom** [1]

[1] Delft University of Technology, Delft/Netherlands

We present a novel combination of top-down lithography with bottom-up molecular self-assembly to create fluorescent glass nanopatterns. Silica patterns are created in a single step using focused electron beam induced deposition (FEBID). After activation, fluorophores are attached to the nanopatterns via the linker molecule (3-aminopropyl)triethoxysilane. Fluorescence recording of features currently with a size down to 80 nm is demonstrated.

P-LITH-133 – Kinetic Studies of Quantum Dot Attachment to DNA Origami

Seung Hyeon Ko [1], Gregg Gallatin [1], **J. Alexander Liddle** [1]

[1] Center for Nanoscale Science and Technology, Gaithersburg/United States

The kinetics of streptavidin-functionalized quantum dots binding to biotinylated DNA origami are quantitatively evaluated and parameters controlling the reaction rate and binding efficiency are investigated.

P-LITH-134 – Nanostructuring of silicon substrates for the growth of III/V quantum dots

Muhammad Usman [1], Tariq Alzoubi [1], Mohamed Benyoucef [1], Johann Peter Reithmaier [1]

[1] Institute for nanostructure technologies and analytics, Kassel/Germany

Si (100) substrates were patterned with sub-100 nm holes for the MBE growth of III/V material. The holes were fabricated with optimized electron beam lithography and dry etching processes. The MBE overgrowth with In0.15Ga0.85As QDs embedded in thin GaAs matrix has shown highly localized formation of GaAs/ In0.15Ga0.85As /GaAs dome like nanostructures in the fabricated holes on the patterned substrate. These localized nanostructures are useful to address optical properties of single QDs.

P-LITH-135 – Selectivity optimisation of biomimetic molecularly imprinted polymer thin films

Reinhard Boysen [1], Shuyan Li [1], Jamil Chowdhury [1], Lachlan Schwarz [1], Milton Hearn [1]

[1] Monash University, Melbourne/Australia

This study addresses existing challenges in the design, synthesis and selectivity optimization of biomimetic molecularly imprinted polymer (MIP) thin film surfaces. The design of new MIP thin films involved molecular modeling of monomer template interactions. Film thickness and topography was characterized with atomic force microscopy. Selectivity optimization was performed with a photolithographic patterned MIP/NIP thin film using fluorescence microscopy with fluorescent amino acids as probes.

P-LITH-136 – Two dimensional assembly of gold colloids using focused ion beam

Miroslav Kolibal [1], Filip Ligmajer [1], David Skoda [1], Jakub Zlamal [1], Tomas Vystavel [2], Tomas Sikola [1]

[1] Brno University of Technology, Brno/Czech Republic, [2] FEI Company, Brno/Czech Republic

We report on the assembly of sub-100 nm gold colloids from solution utilizing focused ion beam implanted charge into a conductive silicon wafer with no need of an electret. The method consists of only two steps: (1) implantation of the charge and (2) deposition of colloids from a solution. We have achieved a single-line resolution using 20 nm gold particles and will also present results for smaller colloids. We will discuss and explain the physical principles of the method.

2. Nanodevices/Nanoelectronics

2.1 Novel Fabrication Methods

P-NANO-001 – a Diffusion Limited Aggregation Model Can Explain the Growth Mechanisms of Silver Nanoparticles Clusters for SERS Applications

Francesco Gentile [1], Maria Laura Coluccio [1], Andrea Toma [1], Eliana Rondanina [1], Marco Leoncini [1], **Francesco de Angelis** [2], Gobind Das [1], Patrizio Candeloro [3], Enzo Di Fabrizio [4]

[1] Italian Institute of Technology, Genova/Italy, [2] Istituto Italiano di Tecnologia, Genova/Italy, [3] BioNEM – University Magna Graecia (Cz), Catanzaro/Italy, [4] IIT, Genova/Italy

Electroless growth is a process whereby metal ions are reduced and deposited as metals upon a silicon surface. Understanding the mechanisms by what means metal ions combine to yield structures may be of valuable help for designing efficient SERS devices. Here, a model is introduced that gives an explanation of the electroless growth dynamics. Founding on a diffusion limited aggregation (DLA) framework, the experimental growth was reproduced. The model was confirmed by direct observations.

P-NANO-002 – A study on the fluorine effect of direct contact process in high doped BPSG

Hyungjoon Kim [1]

[1] Samsung Electronics Co, Suwon-City/Republic of Korea

As the device design rule of semiconductor rapidly shrank, the contact space of device decreased and the high doped boron phosphorus silicate glass (BPSG) was applied to increase a gap-fill margin of interlayer dielectrics. In this study, we proposed the solution and root cause of sidewall wiggling profile during contact process and discussed the effect of interaction between fluorine gas and BPSG layer. At the same time, we revealed the effect of n+/p+ plug ion dopant species with fluorine ions.

P-NANO-003 – Atomic Resolution Size Reduction with Low-current Focused-ion-beam Thinning

Wuxia Li [1], Ajuan Cui [1], Changzhi Gu [1], Paul Warburton [2]

[1] Institute of Physics, Chinese Academy of Sciences, Beijing/China, [2] London Centre for Nanotechnology, London/United Kingdom

When the diameter of a superconducting nanowire is reduced to a critical value, quantum phenomenon could be observed. Thus is it of great importance to explore a reliable technique with scalable capability for fabricating nanometer scale wires, which may be used as building blocks for quantum devices that could find applications in quantum information-processing. In this work, we explored a method to locally thin objects by low current focused-ion-beam milling with atomic resolution.

P-NANO-004 – Characterizations of electrospun ultra-fine Pb(Zr0.3, Ti0.7)O3 nanofibers

Meng Fan [1], ran Liu [1], Yifang Chen [2]

[1] Department of Microelectronics, ASIC & System State Key Lab, Fudan University, Shanghai/China, [2] Rutherford Appleton Laboratory, Didcot/United Kingdom

Ultra-fine Pb(Zr0.3Ti0.7)O3 (PZT) nanofibers have been synthesized by sol-gel process and electrospinning. The morphology and crystalline structure of the obtained PZT nanofibres have been studied by SEM, XRD, FT-IR and micro-Raman spectroscopy, and the ferroelectronic and piezoelectric properties investigated by PFM. Excellent ferroelectric and piezoelectric characteristics observed suggest it is promising to provide new alternatives for the realization of nano-scale ferroelectronic devices.

P-NANO-005 – Comparison of GaP and InGaP Insertion Layers Effect on the Structural and Optical Properties of InP Nanostructures

Somchai Ratanathammaphan [1]

[1] Chulalongkorn University, Bangkok/Thailand

InP self-assembled quantum dots (SAQDs) were grown by utilizing the thin GaP and InGaP insertion layers (ILs) in order to reduce the dots diameter, increase density and improve the photoluminescence (PL) emission. It was observed that the thickness of the two ILs had an effect on the size distribution of InP QDs. Comparison between the GaP and InGaP ILs, the latter gives the smaller QD size. These two ILs led to tuning the emission wavelength and narrowing of full width at half maximum (FWHM).

P-NANO-006 – Controllable Three-dimensional Deformation of Platinum Nanopillars through Focused-ion-beam Irradiation

ajuan cui [1], Zhe Liu [1], Wuxia Li [2], qiang Luo [1], Changzhi Gu [2]

[1] Institute of Physics, Chinese Academy of Sciences, beijing/China, [2] Institute of Physics, Chinese Academy of Sciences, Beijing/China

Three-dimensional nanostructures/devices have attracted tremendous interest due to their special physical properties as well as potential applications in optoelectronic devices, nanosensors, biological information detectors, plasmonics, quantum devices and etc. In order to develop a reliable technique for metallic 3D nanostructure fabrication, in this work, focused-ion-beam was used to deform platinum nanopillars to produce free-space 3D nanostructures with high-precision shape controllability.

P-NANO-007 – Definition of micron-submicron regions of silicon nanowire arrays and porous silicon through metal assisted chemical etching

mohammad zahedinejad [1], mahdi khaje [1], shahin begheri [1], alireza erfanian [1], farshid raissi [1], **payam Heydari** [1]

[1] Islamic Azad University, Tehran/Islamic Republic of Iran

A simple and efficient method for selective formation of porous Si and Silicon Nanowire arrays regions throught metal-assisted chemical etching (MaCE) using platinumis, palladium and silver nanoparticles is presented. Reproducible porous and nanowire arrays regions with feature size of 5 µm were produced on Si wafers. By combining of interference lithography and MaCE, micron and submicron patterning of porous areas on Si wafers with minimum feature size of 600nm were achieved.

P-NANO-008 – Effect of hydrogen plasma on growth of Ir thin film by plasma enhanced hybrid atomic layer deposition

Moo Ryul Kim [1], Bum Ho Choi [1], Jong Ho Lee [2], Young Baek Kim [1]

[1] Korea Institute of Industrial Technology, Gwangju/Republic of Korea, [2] Korea Institute of Industrial Technology, Gwangju/Republic of Korea

In this study, effect of hydrogen plasma on growth of 3 nm thick Ir layer using plasma enhanced ALD (PEALD) on TaN/Si substrate and nano-patterned trench.

P-NANO-009 – Electrical and optical properties of index matched transparent conducting oxide layers for liquid crystal on Si projection display

Cheol Young Park [1], Young Baek Kim [1], Jong Ho Lee [1], Bum Ho Choi [1]

[1] Korea Institute of Industrial Technology, Gwangju/Republic of Korea

In this study, we studied electrical and optical properties of IMTCO layer such as ITO, AZO, and GZO for the application to LCoS projection display.

P-NANO-010 – Electron and Ion Beam Fabrication Using Positive-Negative Inversion of Chlorinated Resist Materials

Tomoko Gowa Oyama [1], Hidehiro Tsubokura [2], Akihiro Oshima [3], Seiichi Tagawa [4], Masakazu Washio [1]

[1] RISE, Waseda University, Tokyo/Japan, [2] RISE, Waseda University, Tokyo-to Shinjuku-ku/Japan, [3] Osaka University, Ibaraki, Osaka/Japan, [4] ISIR, Osaka University, Osaka/Japan

It has been known that chlorinated resist materials ZEP520A and ZEP7000 (ZEON) change from positive-tone to negative-tone by high dose irradiation of electron beam (EB) and ion beams. The present study shows the novel micro/nano fabrication techniques using EB and ion beam, by applying the positive-negative inversion in ZEP resists. Various structures were successfully obtained, including nano membranes and sub-millimeter-length wires/fibers with desired length and diameter.

P-NANO-011 – Fabrication of 35-nm wide nanochannels based on SU-8 using sacrificial resist etching method

jian jin [1], xudi wang [2]

[1] Hefei University of Technology, Hefei/China, [2] Hefei University of Technology, Hefei/China

Currently, Nanochannels canbe fabricated by different approaches, but all have their shortcomings or challenges. In this paper, we propose and demonstrate a new method for fabricate the enclosure of large-area, micron to nanometer size channel by spin coating and sacrificial resist developing method, in which the positive photoresist AZ1350 patterns were used as sacrificial layer. The technique avoids some shortcomings of the traditional nano/micro-channel manufacturing technology.

P-NANO-012 – Fabrication of Bottle-Shaped Nanochannels in Quartz Using a Self-Closing Effect

Ivan Maximov [1], **Mariusz Graczyk** [1], Martina Balaz [1], Heiner Linke [1]

[1] Lund University, Lund/Sweden

We present a novel method of fabrication of nanochannels. The method is based on high-resolution electon beam lithography patterning, selective reactive and wet etching and a controllable oxidation of the top Si layer. Due to increase of volume during the Si oxidation, it is possible to create a well-controlled slits in the upper part of nanochannels thus producing bottle-shaped channels.

P-NANO-013 – Fabrication of ultrasmooth complementary split ring resonators by an improved template stripping method

Zhe Liu [1], Xiaoxiang Xia [1], **Haifang Yang** [1], Junjie Li [1], Changzhi Gu [1]

[1] Institute of Physics, Chinese Academy of Sciences, Beijing/China

In this paper, we fabricated an ultrasmooth complementary split ring resonators (CSRRs) sample by an improved template method. By an additional baking and cooling process, the success rate for this method can be highly increased. The properties of the ultrasmooth CSRR were characterized by SEM, AFM and transmission spectra. More details will be reported in the paper.

P-NANO-014 – Facile fabrication of 1-D nanochannels based on crystallinity-dependent anisotropic etching of silicon

Youngsup Song [1], Min-Ook Kim [1], Dae-sung Kwon [1], Jongbaeg Kim [1]

[1] Yonsei University, Seoul/Republic of Korea

The proposed fabrication method for 1-D nanochannels provides simplified and facile process utilizing the crystallinity-dependent anisotropic wet etching of silicon. The nanochannels are formed in bulk (111) oriented single-crystalline silicon by single step of microscale lithography and sealed by thin film deposition. Hence the massively parallel and wafer scale nanochannel fabrication is easily achieved without the necessity of nanolithography or complicated process.

P-NANO-015 – Filling of nanoscale holes with high aspect ratio by Cu electroplating using suspension of supercritical carbon dioxide in electrolyte with Cu particles

Nao Shinoda [1], Masato Sone [1]

[1] Tokyo Institute of Technology, Yokohama/Japan

We propose a novel electroplating method with supercritical CO2 (scCO2) suspension to obtain pinhole-free, metal wiring. In this study, Cu electroplating is conducted in scCO2 emulsion of the electrolyte and suspension formed by addition of Cu particles in order to inhibit dissolution of Cu seed layer. We electrodeposited Cu into nanoscale holes with aspect-ratio of 5 on Si substrate. The complete filling of all the holes with deposited Cu was observed, because scCO2 has low viscosity.

P-NANO-016 – Gold nanoparticle patterned assembly based on block copolymer self-organizing films

Angela Evelyn Di Mauro [1], Lucia Curri [1]

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Self-organized films of a diblock co-polymer (BCP), poly(styrene–b-methyl methacrylate) have been used as a template for self assembly of Au nanoparticles (NPs). The assembling has been tested on self-assembled BCP both onto bare silicon and onto lithographically patterned surface. The results point out a preferential dispersion of Au NPs in the PS nanodomains, confirming the efficiency of the proposed strategy to fabricate periodic NP arrays, with a high control on size and spacing.

P-NANO-017 – Growth of (0001) GaN films on polycrystalline diamond substrates

Adikimenakis Adam [1], K.E. Aretouli [1], G. Tsiakatouras [1], A.O. Ajagunna [1], L. Tóth [2], B. Pécz [2], E. Dynowska [3], E. Kaminska [4], K. Tsagaraki [1], M. Androulidaki [1], A. Georgakilas [1]

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The heteroepitaxial growth, by PA-MBE, of GaN on polycrystalline diamond substrates has been investigated. Various nucleation conditions and layers have been examined, in order to obtain the best possible GaN thin film structure. Compact (0001) oriented GaN films were obtained, as evidenced by FE-SEM, HR-XRD and TEM/HR-TEM investigations. The results are very promising for the potential of applying GaN-on-poly-diamond heteroepitaxial material in the development of sensors and high power devices.

P-NANO-018 – Integration of two-photon polymerization with UV lithography for the fabrication of functional 3D Micro/Nano-electrodes

Mohammed Al- Abaddi [1], Luigi Sasso [1], Maria Dimaki [1], Winnie E. Svendsen [1]

[1] Technical University of Denmark, Kgs. Lyngby/Denmark

In this presentation we report a novel fabrication method that consists of combining a two-photon polymerization (2pp) technique with conventional photolithography-based microfabrication. This work describes the fabrication, integration and characterization of three dimensional (3D) micro- and nanoelectrodes with the goal of using them as technological platforms developed for biological cell analysis.

P-NANO-019 – Laterally grown ZnO nanorods arrays on obliquely deposited seed layers and its UV photocurrent response

Myoung-Soo Kim [1], Jang-Hwan Han [1], Da-Hyeok Lee [1], Jong-Geun Lee [2], Beom-Hoan Oo [1], Seung-Gol Lee [1], El-Hang Lee [1], Se-Geun Park [1]

[1] Inha university, Incheon/Republic of Korea, [2] Bucheon college, Incheon/Republic of Korea

We describe a method that ZnO nanorods can be laterally grown in one direction on oblique seed layers. In our experimental results, ZnO nanorods were grown from one sides of the Cr line edges as seed layer deposition angles are increased. These results suggests that one side of ZnO seed layer films has lower surface energy that the other. And also, we measured I-V characteristics both in the dark and under UV. The sample with PDMS passivation has a higher photocurrent than no passivation.

P-NANO-020 – Low cost polymeric microcantilever sensor with titanium as piezoresistive material

payam Heydari [1], Ali Shokuhfar [1]

[1] K. N. Toosi University of Technology, Tehran/Islamic Republic of Iran

This paper presents the design and fabrication of a polymeric microcantilever sensor with accessible fabrication method. To avoid self heating of the microcantilevers designers are enforced to reduce the dimensions of metal piezoresistors to 2µm. In this paper titanium thin film has been chosen as a metallic piezoresistive material which results in a resistivity of 1320 Ωnm. So the minimum size can be increased to 40µm and the lithography step does not require access to an ultraclean room.

P-NANO-021 – Micro-/Nano-fabrication of Crosslinked Poly(L-lactic acid) Using EB-Nanoimprint Lithography

Satoshi Okubo [1], Akinobu Kobayashi [1], Tomohiro Takahashi [1], Tomoko Gowa Oyama [1], Naotsugu Nagasawa [2], Mitsumasa Taguchi [2], Akihiro Oshima [3], Seiichi Tagawa [4], Masakazu Washio [1]

[1] RISE, Waseda University, Tokyo/Japan, [2] JAEA, Gumma/Japan, [3] Osaka University, Ibaraki, Osaka/Japan, [4] ISIR, Osaka University, Osaka/Japan

EB nanoimprint lithography was proposed for fabricating micro-/nano-structures of poly(L-lactic acid) (PLLA), which is one of the most typical biodegradable polymers. PLLA with 5 wt% Triallyl isocyanurate solution was dropped on the silicon molds and EB shower was irradiated to 60 kGy. As the results, the micro-/nano-patterns of crosslinked PLLA were successfully obtained. Furthermore, these structures were hardly deformed though heated at 70°C for 24 h due to high thermal stability of RX-PLLA.

P-NANO-022 – Morphological and optical properties of naturally textured Al-doped ZnO film on flexible substrate by DC magnetron sputtering

Kankan Prosad Mandal [1], Young Baek Kim [1], Jong Ho Lee [1], Bum Ho Choi [1]

[1] Korea Institute of Industrial Technology, Gwangju/Republic of Korea

In this study, naturally textured AZO layer was formed during sputtering step on flexible substrate by controlling process parameters and their morphological and optical properties are investigated.

P-NANO-023 – MOSFET gate structure formation by phase separation

Alexander Rogozhin [1], Ivan Khorin [1], Alexander Orlikovsky [1], Andrew Vasiliev [2]

[1] IPT RAS, Moscow/Russian Federation, [2] Scientific & Product Enterprise "Pulsar", Moscow/Russian Federation

Recently investigations of the technologies using self-organization and phase layering occur more frequently. In this work we present results of computer simulation and experimental study of CoSi2/TiO2/SiO2/Si gate structure formation process. The technology which was investigated in this work allows to form such a gate structure during the sole annealing process. Simulation and experimental results show that the technology can be used for gate structure formation.

P-NANO-044

P-NANO-024 – On-site fabrication of conducting polymer nanowire in field effect transistor device

Jihye Lee [1], Wan Doo Kim [1], Hyun-Eui Lim [1]

[1] Korea Institute of Machinery and Materials, Daejeon/Republic of Korea

One dimensional nanostructures such nanowires of semiconductor, metal, and conducting polymer have been researched to be applied as a chemical or bio sensor. We demonstrated on-site fabrication of conducting polymer nanowire in field effect transistor device platform using sacrificial layer. This method gives controlled and high-yield on-site fabrication of nanowire on the device directly.

P-NANO-025 – One Step Fabrication of Hierarchical Silicon Surfaces and Modification of its Morphology using Sacrificial Layer

Seong Jin Cho [1], Se Yeong Seok [1], Taechang An [1], Geunbae Lim [1]

[1] POSTECH, Pohang/Republic of Korea

One-dimensional nanostructures have received great interest because of their unique functionalities such as anti-reflection property. Here, we demonstrate the simple fabrication method to control the morphology of nanostructures using a sacrificial layer. We could fabricate patternable hierarchical structures and control the shape of nanostructure and its density. The nanograss surface fabricated by the sacrificial layer method had excellent anti-reflective property over a broad band range.

P-NANO-026 – Optimized process of metal assisted silicon wet etching for antireflection layer

Bo-Soon Kim [1], Won-ki Ju [1], Min-woo Lee [1], Seung-gol Lee [1], Beom-hoan Oo [1]

[1] INHA University, Incheon/Republic of Korea

In this paper, the silicon wet etching process using Au nano particles as a catalysis was optimized. Silicon was etched using various formation of Au nanoparticles fabricated by thermal annealing. Depending on process parameter, average radius of single particle was changed from 7 to 70 nm. As a result, reflectance of silicon substrate which was just 2 minutes etching was reduced to below 2 % in wide wavelength region, and even change the incident angle, reflectance was less than 5 %.

P-NANO-027 – Preparation of the Ge(001) surface towards fabrication of atomic-scale germanium devices

Wolfgang Klesse [1]

[1] UNSW – CQC2T, Sydney/Australia

We demonstrate a four step preparation procedure to achieve clean, atomically flat and defect free Ge(001) surfaces based on ex situ wet chemical processing, epitaxial Ge buffer layer growth and in situ thermal anneal treatment. Using scanning tunneling microscopy, we investigate the effect on the surface morphology of using different chemical reagents, concentrations as well as substrate temperatures during growth.

P-NANO-028 – Pure, rapid and localized deposition of platinum by spontaneous reaction of Pt(PF3)4 with XeF2 in a scanning electron microscope

Aurelien Botman [1], Steven Randolph [1], Milos Toth [2]

[1] FEI Company, Hillsboro/United States, [2] University of Technology, Sydney, New South Wales/Australia

We report a new method of obtaining pure platinum patterns on a substrate in an SEM, in a manner similar to EBID, using mixing of the gaseous precursors in the vacuum chamber. Localized patterns, as small as tens of nanometers or as large as hundred of microns can be created by scanning the electron beam in the appropriate way. Growth speeds up to 50 um3/s can be obtained if desired, and the process can be performed at room temperature.

P-NANO-029 – Rapid fabrication of single crystalline silicon nano wires using self-assembled peptide nanostructures

Kasten B. Andersen [1], Martin B. Larsen [1], Winnie E. Svendsen [1], **Jaime Castillo-León** [1]

[1] DTU Nanotech, Technical University of Denmark, Lyngby/Denmark

Our work presents an alternative method to fabricate single crystalline silicon nanowires using self-assembled peptide nanotubes as etching mask material . The peptide nanotubes were immobilized on clean silicon wafers and then exposed to an reactive ion etching process. This fabrication method proved to be simple, fast and low-cost compared to traditional techniques used to fabricate silicon nanowires and has the potential to be used in the fabrication of other nanostructures at the clean-room.

P-NANO-030 – Remote Plasma Atomic Layer Deposition of ZnO for Thin Film Electronic Applications

Suhana Mohamed Sultan [1]

[1] University of Southampton, Southampton/United Kingdom

This work describes a systematic approach to analyze the simultaneous impact of various reactant plasma parameters of remote plasma ALD on the ZnO thin film properties (stoichiometry, C impurities) by utilizing the Design of Experiment (DOE) method. Results show the stoichiometry and C impurities could be improved by decreasing the plasma time and increasing the pressure. Based on the optimized condition of this deposition, thin film transistor is fabricated with highest mobility is 2.1 cm2/Vs.

P-NANO-031 – SU8 based microcantilever sensors chemically functionalized with organic-capped oxide nanocrystals for vapour detection

Chiara Ingrosso [1], **Lucia Curri** [1]

[1] CNR-IPCF, Bari/Italy

The surface of microcantilever sensors in SU-8 has been functionalized with oleic acid (OLEA)-capped oxide NCs. The role of the OLEA ligand molecules at the NC surface has been demonstrated fundamental to effectively chemically immobilize the NCs on the surface of SU-8. The immobilization protocol can be integrated in the UV-lithography fabrication of the cantilevers, without affecting the micromachining process. The NC functionalized cantilevers have been used for real time sensing of vapours

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P-NANO-032 – The Optimization of NOR Flash Cell Threshold Voltage Distribution

Youngho Kwon [1]

[1] Samsung Electronics Co. Ltd, Yongin City/Republic of Korea

We have improved a conventional diffused Self-Aligned Source line in NOR Flash architecture. In order to obtain uniform and low source resistance in SAS(Self Aligned Source) topography, SAS etch recess is optimized as well as an angled, lightly doped implantation condition. And then program speed and Cell threshold voltage distribution in erase status are improved considerably.

P-NANO-033 – Toward 10 nm resolution Fesnel zone plates in tungsten by one-step electron beam lithography with a fine dry etch process

Yifang Chen [1]

[1] Rutherford Appleton Laboratory, Didcot/United Kingdom

This paper describes a novel nanofabrication method of one-step electron beam lithography followed by a fine dry etch on metal film (Au, W and Cr), using ultrathin HSQ as etch mask for achieving 10 nm resolution Fresnel zone plates, which are applied in X-ray microscopy. This technique avoids two-step electron beam lithography, and has great prospect for even 5 nm resolution zone plates when the HSQ is patterned into zone plate shape with the outmost ring width as 5 nm.

P-NANO-034 – Trench width dependant deeply etched surface-defined InP gratings for low-cost high speed DFB/DBR lasers

Sohaib Afzal [1], Florian Schnabel [1], Wenzel Scholz [1], Johann Peter Reithmaier [2], Marco Vallone [3], Paolo Bardella [3], Ivo Montrosset [3]

[1] INA, University of Kassel, Kassel/Germany, [2] Institute for nanostructure technologies and analytics, Kassel/Germany, [3] Torino University, Torino/Italy

Trench width dependant etching process was developed for the fabrication of high speed DFB/DBR laser for telecommunication application. The improved design results in higher coupling coefficients, lower capacitance and very rectangular grating profile. The developed process is based on surface defined lateral grating which is compatible with nanoimprint lithography allowing high-throughput fabrication of high-performance low-cost DFB/DBR lasers for future high-speed data-com applications.

P-NANO-035 – Ultra-thin ALD layers of HfO2 for silicon micromachining

Marta Duch [1], Marta Gerbolés [2], Maria Cruz Acero [2], Oihane Beldarrain [2], Miguel Zabala [2], Francesca Campabadal [2]

[1] Institut de Microelectrónica de Barcelona (IMB-CNM,CSIC), Barcelona/Spain, [2] Institut de Microelectrónica de Barcelona (IMB-CNM,CSIC), Bellaterra/Spain

In this work, a study on the feasibility of using ultra-thin hafnium oxide layers grown by atomic layer deposition as a mask layer for the anisotropic wet etching of silicon is presented. The behavior of as-deposited and annealed HfO2 layers in front of two silicon anisotropic etchants (TMAH and KOH) has been studied. The results have shown that these films are highly resistant to anisotropic silicon etchants, so they are an excellent material as a mask for silicon micromachining.

2.2 Nanoelectronic Devices

P-NANO-036 – E-beam nanopatterning for the selective area growth of III-V nitride nanorods

Francesca Barbagini [1]

[1] ISOM/UPM, Madrid/Spain

III-V nitrides nanorods are ideal candidates for the fabrication of high efficiency opto-electronic devices. The efficiency of these devices is notably increased when the nanorods grow in pre-defined surface sites. In this work, we use e-beam lithography to pre-pattern a metal mask on GaN substrate with nanoholes. Using these hole-patterned masks, highly ordered arrays of excellent crystal quality GaN/InGaN nanorods are selectively grown by plasma-assisted molecular beam epitaxy.

P-NANO-037 – Edge free N-MOSFET structure for Shallow Trench Isolation edge effect elimination

Kwang-Soo Kim [1]

[1] Sungkyunkwan University, Suwon/Republic of Korea

Various phenomenons occurring at STI edge region are giving various effect to MOSFET qualities. Edge effects bring about off-state leakage and reliability decrease. If we use MOSFET without STI edge of channel, like this poor characteristics won't occur. We report new MOSFET structure that doesn't use channel of STI edge region for edge effect elimination. We will name this "Edge Free MOSFE".

P-NANO-038 – Effects of nanoparticle shell layer on the electrical properties of nonvolatile organic memory based on CdSe nanoparticle/ PMMA blend as a tunnelling layer

Jung-Min Kim [1], Ik Soo Shin [2], Dong-Hoon Lee [1], Jun-Ho Jeun [1], Jin Ho Bang [3], Yong-Sang Kim [1]

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Semiconductor NPs possess many intriguing properties and are a powerful tool for the development and fabrication of materials with novel functions in the floating gate organic memory devices. However, the electrical properties for these semiconductor NPs are not completely understood but could be sensitive to the NP's structure. In this work, we have experimented for the effects of NP shell layer by comparing with CdSe NPs and CdSe-ZnS NPs in the gate insulator.

P-NANO-039 – Experimental Study and Modeling of Double-Surrounding-Gate and Cylindrical Silicon-on-Nothing MOSFETs

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An experimental study and modeling of double-surrounding-gate (DSG) and cylindrical silicon-on-nothing (SONSG) MOSFETs using an analytic model is presented. The manufacturing issues of several sub-10nm multiple-gate MOSFETs are discussed, and DSG and SONSG devices are proposed as potential solutions to solve these fabrication challenges. The (analytic) general solution to cylindrical nonlinear Poisson's equation is obtained and applied to analyze the DSG and SONSG device performance.

P-NANO-040 – Force deflection spectroscopy of top down fabricated silicon nanowires

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Measurements of electromechanical properties of nanostructured materials is very challenging. A suitable measurement procedure, based on Atomic Force Microscopy and on four contact electrical measurements that can be performed simultaneously to the application of the mechanical stress, has been developed. Measurements of mechanical and electrical properties performed on top down fabricated silicon nanowires (SiNW), embedded in silicon dioxide, will be reported and discussed.

P-NANO-041 – Gate oxide properties in nMOSFET with (100) and (110) plane orientation

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In this study, the reliability of gate oxide in nMOSFET with (100) flat zone (FZ) and (100) surface wafer was evaluated. This paper showed that the gate oxide tolerance about Fowler-Nordheim (FN) stress in sub-100nm nMOSFET was worse in (100) FZ than in (110) FZ, even if the gate-induced drain leakage (GIDL) current in nMOSFET with (100) FZ was low compared to (110) FZ. We found that these results came from side-wall thickness variation of radically grown gate oxide.

P-NANO-042 – High resistivity Czochralski-silicon using a deep level dopant compensation process

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The resistivity of Cz-Si wafers was successfully increased by deep level dopant compensation using gold ion implantation. Hall measurements indicate that the increased resistivity is due to a reduction in free carriers. The temperature dependence of the free carrier concentration in the range of 350-200K indicates that the Fermi-level is virtually pinned at the intrinsic level. Coplanar waveguides fabricated on the wafers show strongly reduced microwave attenuation.

P-NANO-043 – High-performance dual-gate Field Effect Transistor Based on ZnO Nanowire with high-K gate dielectrics

Zong-ni Yao [1], Jun-jie Li [1], Wei-jie Sun [1], Hai-fang Yang [1], Chang-zhi Gu [1]

[1] Chinese Academy of Sciences, Beijing/China

In this paper, dual-gate ZnO nanowire field-effect transistor with high-k Al2O3 or HfO2 gate dielectrics was configured, which shows a good performance in on/off ratio, operation voltage, peak transconductance, field effect mobility and leakage current. These results indicated that the ZnO nanowire FET in top-gate mode provided a better device performance than that in bottom-gate mode. Moreover, the effects of Al2O3 and HfO2 gate dielectric layers on enhancing the FET performance were discussed.

P-NANO-044 – Improved Cell Tr characteristics by Double Trench Isolation

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When shrinking DRAM cells, the channel width of a cell transistor (Cell TR) is becoming small. This causes the cell current to decrease such that it becomes necessary to improve Cell TR characteristics in order to meet device performance. This paper presents the requirements and challenges to improve Cell TR characteristics by using Double Trench Isolation (DTI) technology. The DTI technology consists of two additional steps: a dry etching step and a medium thermal oxide (MTO) step.

P-NANO-045 – Investigation on electrical characteristics of Cr doped SrTiO3 films as a switch material in ReCTF device

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We created a new fusion charge-trap flash structure, named ReCTF (ReRAM + CTF). We introduced Cr-SrTiO3 a well-known resistance-switching material into the SONOS structure which consists of Metal/Cr-SrTiO3/Nitride/Oxide/Silicon to make use of the electrical transport phenomena in the Cr-SrTiO3 tunnel layer. In this paper, we investigate an effect of electrical properties of resistive switching material Cr-SrTiO3 influencing to a device performance of the ReCTF.

P-NANO-046 – Isolation leakage current induced by plasma damage depending on the layout in Dynamic Random Access Memory

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The plasma-etching technique is widely used in VLSI manufacturing. However, unnecessary leakage current paths can be occurred by plasma charging damage during the plasma-etching process. Most of the studies about plasma charging damage on dynamic random access memory (DRAM) were conducted about damage to gate oxide of MOS transistor. In this paper, we studied about isolation leakage current which is induced by plasma charging damage to shallow trench isolation (STI) surface.

P-NANO-047 – Nitrogen Concentration and Profile Optimization in Plasma Nitrided Oxides for the Gate Leakage Current Reduction

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High nitrogen concentrations in plasma nitrided oxide for gate leakage current reduction cause device performance degradation such as threshold voltage shift and trans-conductance degradation. However we found it is possible the gate leakage current reduction without mobility degradation when both plasma nitridation process time and PNA pressure increase. The re-oxidation by PNA pressure increase results in lower interface trap and non-mobility degradation.

P-NANO-048 – Raman Spectroscopy and Electrical Characterisation of Reactive Ion Etched Multilayer Graphene

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Fabrication of graphene device by thinning of multilayer graphene (MLG) using Reactive Ion Etching (RIE) is presented. Atomic Force Microscopy and Raman spectroscopy as well as electrical characterisations of the thinned MLG are also studied. Electrical device made by etched graphene is still little explored and there is a considerable interest utilizing graphene as a channel for electronics devices.

P-NANO-049 – Resistive switching characteristics of NiO/Ni nanostructure

Shintaro Otsuka [1], Saeko Furuya [2], Ryouta Takeda [2], Tomohiro Shimizu [3], Shouso Shingubara [4], Tadataka Watanabe [2], Yoshiki Takano [2], Kouichi Takase [2]

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We have fabricated the voltage-induced resistive switching device which consists of NiO/Ni nanostructures, prepared by AAO templates, with the typical diameter of 70 nm. Ni nanowires are ferromagnetically-ordered and indicate magnetic anisotropy. This device shows the resistive switching phenomena with large variability under the monopolar operation. Spin dependent phenomena from ferromagnetic Ni nanowires is expected.

P-NANO-050 – Resistive switching characteristics of S-doped GeOx thin films on flexible substrates

Isaac Chung [1]

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Flexible resistive random access memory (ReRAM) devices have attracted considerable attention as promising memory devices. Solution process is a valuable technique for fabricating electronic devices on flexible plastic substrates. As resistive materials, impurity-doped oxides are emerging materials. Therefore, in this study, we attempt to fabricate solution-processable ReRAM devices with high performance by utilizing S-doped germanium oxide as a resistive material.

P-NANO-051 – Resistive-switching behavior in Ti/Si3N4/Ti memory structures for ReRAM applications

Kim Hee-Dong [1]

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A bipolar resistive switching behavior in Ti/Si3N4/Ti memory cells was clearly observed at a low voltage of about ±2.5 V. This bipolar switching behavior is attributed to the conductivity modulation by electron trapping process through nitride-related traps, which relies on a formation and a rupture of conducting path in the Si3N4 film. We believe that the proposed resistive switching memory cell could be a fully compatible with a standard complementary metal-oxide-semiconductor process.

P-NANO-052 – Schottky Barrier Height reduction using strained silicon-on-insulator and dopant segregation

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This paper investigates the tensile strain effect in SOI substrate coupled to dopant segregation on the barrier height of Schottky contacts. For that sake, a two back-to-back diodes test structure is used to extract PtSi Schottky barrier height from current-voltage-temperature characteristics on strained and unstrained substrates. We demonstrate the compatibility between biaxial tensile strain and dopant segregation producing a cumulative Schottky barrier reduction for both types of carriers.

P-NANO-053 – Schottky-barrier modulation of silicon nanowire field-effect transistors prepared by metal-assisted chemical etching

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We fabricate silicon nanowire (NW) field-effect transistors (FETs), where the NWs are prepared by metal-assisted chemical etching. This low cost, wet-etching technique creates densely-packed arrays of high-aspect ratio NWs. The devices form Schottky-barrier (SB) FETs, where modulation of the source SB determines the characteristics. The characteristics are modelled by thermionic emission of carriers across a reverse-biased source SB, where the applied bias controls the SB height and width.

P-NANO-054 – Silicon Nano-Cantilever

Manuel Hofer [1], Konstantin Gorovoy [1], Ivo W. Rangelow [2]

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Micro- and nano mechanical cantilevers are widely used as fast operating sensors and as nano-balances to detect small quantities of adsorbed molecules through shifts in oscillation frequency. To achieve high oscillations we fabricated nano machined cantilever which promise resonance frequencies in MHz range. Here we demonstrate SOI-based nano mechanical resonators which can be used as fast scanning cantilever with molecular mass resolution and fast scanning properties.

P-NANO-055 – Single Crystal Silicon Nanowires for Femtonewton Detection

Manuel Hofer [1], Ivo W. Rangelow [2], Babak Sanii [1], Paul D. Ashby [3]

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We introduce a noninterferometric optical approach to determine the position of nanowires (NW) with high sensitivity and bandwidth. Measurements in water with force sensitivity of 6±3fN/√Hz have been successfully demonstrated. To achieve higher force sensitivity we shrunk the physical dimensions of Si NW below 50 nm in lateral width and 30 nm in thickness. Due to the high stiffness of the Si we are able to fabricate NW with total length in the range of up to 100 µm free standing in air.

P-NANO-056 – TCAD Simulation of SOI TFETs and Calibration of Non-local Band-to-Band Tunneling Model

Arnab Biswas [1], Cyrille Le Royer [2], Surya Shankar Dan [1], Wladyslaw Grabinski [1], Adrian Ionescu [1]

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This paper reports a numerical 2D simulation based study of FDSOI Tunnel Field Effect Transistor using a commercially available TCAD device simulator. The nonlocal Band-to-Band(B2B) tunneling model implemented in Synopsys TCAD has been analyzed, demonstrating the importance of model parameters. Reference single gate TFET devices based on 20nm SOI technology fabricated by CEA-LETI were measured and simulated to extract non local B2B model parameters.

P-NANO-057 – The Effect of Floating Gate Microstructure on the Electrical and Reliability Characteristics in NAND Flash Memory

Young-suk Kim [1], Eun-Suk Cho [1], Seong-soon Cho [1], Jai-hyuk Song Jai-hyuk Song [1], Hae-bum Lee [1], Jeong-hyuk Choi Jeong-hyuk Choi [1], Yong-han Roh [1]

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NAND flash memory has doubled its capacity every year, and as the device size shrinks each individual electron has a greater impact on the Vth variation of the cell transistor and can cause a larger degradation in the reliability. In this paper, we report on experiments to improve the slow bit cells (with local increase of tunnel oxide thickness) by adding carbon during poly-growth in order to minimize grain size and grain boundary effects which induce abnormal growth of tunnel oxide.

2.4 Carbon Materials & Devices

P-NANO-058 – All-solution-processed assembly of organic field-effect transistor arrays

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We have developed an all-solution fabrication process for plastic electronic devices, in which all components of devices spontaneously assemble with the desired geometry. By forming surface molecular templates having different wettabilities, complete active matrix arrays of organic field-effect transistors have been patterned from solution with excellent operational characteristics and uniformity on a plastic substrate.

P-NANO-059 – An Improved Precise Positioning Method for Self-Assembly of Lateral-Gate Carbon Nanotube Field-Effect-Transistors

Ji Cao [1], Adrian M. Ionescu [1]

[1] EPFL, Lausanne/Switzerland

An improved precise positioning method for fabricating suspended/non-suspended body CNT field-effect-transistors (FETs) based on our previous work is presented and studied in detail. Self-aligned lateral-gate suspended-body CNTFETs with 90 nm air gap has been demonstrated, exhibiting superior I-V characteristics. The proposed precise positioning method provides a more accurate way to assemble CNTs, allowing for batch fabrication of CNT based CMOS circuits and NEMS devices.

P-NANO-060 – CVD Carbon nanotubes without catalyst and their Young's Modulus measurements

Ali Khiat [1]

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Mechanical, electrical and thermal characteristics of Carbon nanotubes (CNTs) are very interesting and promising for many applications in nanotechnology. Nano-interconnects, nano-switches, nano-resonators, nano-composites and AFM tips are some applications which use CNTs. The objective of this study is to determine the Young modulus of a specific CNT generated with Chemical Vapor Deposition (CVD), without catalyst. Electrostatic pull-in method was developed and will be presented

P-NANO-061 – Effect of Surface Treatment to Carbon Nanotubes for Bioassay

Takuya Yabe [1]

[1] Tokyo Metropolitan University, Hino-shi, Tokyo/Japan

We evaluate the influence of surface characteristics of CNTs on bioassay by fluorescence analysis. The result showed that original CNTs had lowest intensity of fluorescence, because original CNTs had difficulty with liquid penetration by hydrophobic property. On contrary, CNTs treated hydrophilic came to have high intensity of fluorescence. In addition, it is confirmed that intensity of fluorescence increased more by introducing defects on the CNT after transforming wettability.

P-NANO-062 – Effects of ultra-violet laser irradiation on graphene

Fujio Wakaya [1], Tsuyoshi Teraoka [1], Toshiya Kisa [1], Tomoya Manabe [1], Satoshi Abo [1], Mikio Takai [1]

[1] Osaka Univ., Toyonaka, Osaka/Japan

Graphene can be applied for transparent electrodes instead of ITO. For patterning of ITO, the maskless laser process was reported as a simple and fast process. Raman spectra and electrical resistances of graphene were measured after UV laser irradiation to investigate the possibility of maskless laser process. The Raman spectrum was affected by laser irradiation (> 3 MW/cm2), indicating defects generation. The resistance was more sensitive to laser irradiation than the Raman spectrum.

P-NANO-063 – Electron Beam Assisted Patterning Of Organic Semiconductors

Andre Joppich [1], Markus Kaiser [1], Fabian Ventsch [1], Klaus Meerholz [1]

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Organic light emitting diodes are a promising technology for a large variety of applications. For cost-effective production of these devices, solution processing of the organic components via spin coating and subsequent crosslinking is beneficial. Usually, this process is initiated by UV-light. In this work, crosslinking of relevant materials by high-energy electrons is shown. The electrical properties are mostly preserved and maskless patterning of micron sized devices should be achievable.

P-NANO-064 – Fabrication of carbon nanotube integrated charge sensor based on transferred carbon nanotube arrays

Xin Zhou [1], Koji Ishibashi [1]

[1] RIKEN, Hirosawa, Wako/Japan

A charge sensor device, has been fabricated based on the well aligned single-wall carbon nanotubes (SWCNTs) by transfer-printed technique. The measurement results showed the source-drain current in one SET is influenced due to the charge number changed by one electron in CNT-dot the other CNT-SET, which indicates success of the charge sensor function of the device. In addition, Coulomb oscillation peaks in one CNT-SET is shifted by the single electron event has also been observed.

P-NANO-065 – Fabrication of SiC nanorods by electrochemical carbon deposition on Si in ethanol

Andrius Stogrin [1], **Ingrida Bruzaite** [2], Valentinas Snitka [1]

[1] Kaunas University of Technology, Kaunas/Lithuania, [2] Vilnius Gediminas Technical University, Vilnius/Lithuania

In this work a „green" electrochemical deposition technique has been employed to produce SiC nanostructures from organic solvent at room temperature. Silicon was employed as counter electrode and shungite plate, the only natural material that contains fullerenes was used as a working and catalytic electrode in 96 vol% ethanol as an electrolyte. We have synthesized nanostrip type SiC on Si(100) wafers in ethanol and performed XRD, AFM, EDX and Raman characterization of the deposited structures.

P-NANO-066 – Focused Ion Beam Lithography and Deposition of Tungsten Contacts on Exfoliated Graphene for Electronic Device Applications

Marek E. Schmidt [1], Harold Chong [2], Zaharah Johari [3]

[1] University of Southampton, Southampton/United Kingdom, [2] Nano Research Group, Southampton/United Kingdom, [3] Universiti Teknologi Malaysia, Johor/Malaysia

We report a rapid prototyping method using focused ion beam (FIB) technique for accurate contacting of graphene layers and realization of a graphene devices using this method. The fabrication method and the requirement for alignment markers is explained. Fabrication results (SEM, Raman, AFM) and electrical characterization of fabricated devices are presented.

P-NANO-067 – Horizontally and on-site grown carbon nanotube membrane for sensitive and selective gas sensing

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We report the fabrication of sensitive, selective gas sensors using CNT membranes as transducers. A TiN/Al2O3/TiN stack is used as a support for the CNT growth catalyst, evaporated at 45° on the vertical wall. This layout allows to grow, selectively and on-site, arrays of aligned and horizontal CNTs. This allows better gas limit detection with working conditions at room temperature and atmospheric pressure. The sensor FET structure allows multiple readouts to achieve a better gas selectivity.

P-NANO-068 – Low temperature growth of carbon nanotubes by PECVD and CVD

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Carbon nanotubes (CNTs) are ideal candidates as electrode materials for neuronal stimulation and monitoring devices. In order to position CNTs at desired locations, chemical vapor deposition (CVD) growth from patterned catalysts is a promising route.However, these processes typically require temperatures above 700°C, which is unacceptable for many flexible substrate materials like polyimide. Therefore growth processes at temperatures below 400°C are desirable.

3. Nanophotonics / Optics

3.1 Nano-Optics

P-PHOT-001 – Scattering Image Analysis for Detection of Patterned Defects Using a FDTD Method

Moonkyung Kim [1]

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In this paper, we analyze a scattering image of patterned lines and discuss how to improve the signal to noise ratio in the detection of defects. we first acquire scattering images using a defect simulator. The simulator uses FDTD method to calculate the near-field pattern, and uses Fourier optics to calculate the image formation. We investigate the scattering image and the far field pattern to detect the defect by changing the wavelength and the polarization of the incident light.

P-PHOT-002 – Creating Metamaterials with a Double Patterning Process

Dennis Lehr [1], Kay Dietrich [1], Ernst-Bernhard Kley [1], Andreas Tünnermann [2]

[1] Friedrich-Schiller-Universität Jena, Jena/Germany, [2] Fraunhofer Institute IOF, Jena/Germany

We present a novel approach to fabricate nanostructures on large surfaces based on a double patterning process and electron beam lithography. The process allows the production of a variety of geometries and can easily be used to generate two- and three-dimensional metamaterials. We demonstrate the process by creating an array of nanorings and present a comparison of the measured optical properties with FDTD simulations.

P-PHOT-003 – Current status of the zone plate development at the Helmholtz-Zentrum Berlin

Stephan Werner [1]

[1] Helmholtz-Zentrum Berlin, Berlin/Germany

We report on two different approaches to improve the spatial resolution for zone plate based X-ray imaging towards 10 nm. Traditionally the resolution is enhanced by decreasing the outermost zone width. The second approach overcomes the problem to manufacture increasingly smaller zone widths by applying high diffraction orders for imaging. This requires advanced nanotechnology processes to increase high order efficiency. We present the status and results for both nano-structuring approaches.

P-PHOT-004 – Novel Concepts for Reflective Optical Components based on Resonant Waveguide Gratings

Stefanie Kroker [1], Thomas Käsebbier [1], Ernst-Bernhard Kley [2], Andreas Tünnermann [3]

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We discuss a novel approach to combine the concept of resonant waveguide gratings (RWG) with reflective diffractive beam splitters. In order to realize low transmittivities stacks of two and three reflectors are investigated. By means of a periodic depth or width modulation of the RWGs a diffracting function is induced to the subwavelength devices. The presented grating designs can contribute to a reduction of coating thermal noise in optical components for high-precision metrology.

P-PHOT-005 – Why is Black silicon black?

Emil Højlund-Nielsen [1]

[1] DTU Nanotech, Kongens Lyngby/Denmark

We present calculations on surface structures in the context of the mean-field approximation. The calculation model is used to explain general reflectivity trends for silicon materials and is compared to the experimental results in and measurements on fabricated Black silicon structures. The low specular reflectivity of Black silicon including angular dependence is seen to originate from a continuous effective refractive index that reduces the Fresnel reflection.

3.2 Photonic Structures & Devices

P-PHOT-006 – All-optical fabrication of 3D photonic crystals in photopolymers

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A new approach for the generation of light-induced three-dimensional photonic crystals is presented. Using newly developed holographic volume recording techniques up to six collimated laser beams generate three-dimensional interference patterns. These are transferred into large-area periodic 3D structures in thick organic photopolymer layers. The structures act as diffractive optical elements or templates for photonic bandgap structures.

P-PHOT-007 – Core-shaped Microstructuring of Sapphire Using UV Imprinting and ICP Etching for Photonic Application

Cho Wei Chang [1]

[1] National Chiao Tung University, Hsinchu/Taiwan

Recently, sapphire is used for optoelectronic devices, as a substrate for light emitting diodes (LED) and lasers, and in high temperature structural components. The aim of this study is to fabricate the core-shaped microstructures of sapphire surface substrate by using the UV imprinting and ICP etching for photonic applications.

P-PHOT-008 – Diffraction Feature of Microlens Array Fabricated by Femtosecond Laser Modification and Assisted Etching Process

Tien-Li Chang [1], Shao-Wei Luo [1]

[1] National Taiwan Normal University, Taipei/Taiwan

With the rapid development of fabrication technology, the advanced femtosecond-pulsed laser (FS-laser) has opened new paths for modifying bonds in transparent materials by multi-photon absorption and optical breakdown processes. In this study, a FS-laser with the central wavelength of 517±2.5 nm is employed to fabricate the embedded gratings inside glass substrate. Based on this process, it will be an easy and rapid process that can demonstrate to fabricate the microlens array of glass.

P-PHOT-009 – Direct wafer bonding of fused silca optical gratings

Gerhard Kalkowski [1], Carolin Rothhardt [2], Uwe Zeitner [1], Tino Benkenstein [1], Jörg Fuchs [1], Ramona Eberhardt [1]

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We report on direct bonding of surface structured glass wafers (fused silica UV grade) of 150 mm diameter and 1.5 mm height to similar unstructured wafers for diffractive optical applications in the visible and near infra-red spectral range. Several high quality binary grating structures with periods ranging from 500 nm to 2000 nm were generated by standard lithography techniques and encapsulated. Bonding strengths and transmission efficiencies were evaulated.

P-PHOT-010 – E-beam fabrication on silicon nitride of Fabry-Perot optical sensors

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New sensing and recognition technologies based on the integration of dye thin films with photonic structures are being investigated. The dye molecules react to changes in the concentration of gases by a change of their fluorescence properties. By the use of photonic resonant structures an enhancement of the dye response is obtained. A photonic resonant structure based on Fabry-Perot cavities operating at visible is introduced and its fabrication process based on e-beam lithography is described.

P-PHOT-011 – Electroplated Ni mask for plasma etching of submicron-sized features in LiNbO3

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The etching of deep structures at the submicron scale is a critical technological step in the realization of a number of devices, particularly in the field of nanophotonics. The use of LiNbO3 in such applications requires the development of specific etching processes. Plasma etching is the most appropriate technique in terms of etch rate, selectivity and resolution. We here report on the fabrication of electroplated Ni masks for etching of sub-micron patterns in LiNbO3 using SF6.

P-PHOT-012 – Embedding and combining of plasmonic elements and photonic crystal structures

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The materials we use for production are SiN or GaP. The refractive index of both materials is sufficiently hig and both have a high transparency in the visible light spectrum. This insures large photonic band gaps and high q-factors. The electron beam-lithography and the reactive ion etching used in the production process allow structure sizes under 80 nm. So we are able to produce photonic crystals with a lattice constant in the dimension of the half wavelength of the visible light spectrum.

P-PHOT-013 – Enhanced electro-optic Bragg modulator based on plasma dispersion effect in Silicon

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we present a new approach for an electro-optical modulator on a silicon chip based upon the plasma dispersion effect in silicon. The idea is to use periodically patterned electrodes on a Si waveguide. According to the plasma dispersion effect, by applying a proper voltage over the periodically electrodes we are able to generate axially periodic distribution of free electrons and thus also a periodic variation of the refraction index

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P-PHOT-014 – Fabrication of Bragg Gratings on LiNbO3 optical waveguides

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We report on three approaches to achieve Bragg Gratings structures (BGs) on X-cut lithium niobate substrates. The first method relies on Reactive Ionic Etching with fluorine gases. The second process is based on Focused Ion Beam milling (FIB) to etch BGs in classical optical waveguides and the last one combines the use of lateral FIB etching and deep-etched ridge optical waveguides defined by “optical grade dicing”. Optical characterizations will be performed on each structure.

P-PHOT-015 – Form birefringent quarter wave plate for polarization conversion

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A spatially varying form birefringent quarter wave plate for the conversion of circularly polarized light to radially polarized light is presented. The plate is based on silicon nitride sub-wavelength gratings and designed for a wavelength of 633nm.

P-PHOT-016 – Formation of porous structure in HF/ethanol solution by potential-assisted electrochemical etching and effect of light illumination

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In this paper, PS structures have been prepared under UV light (12W) and incandescent white light (36 W) at various anodization times. Two morphological structures of pores that are formed under those illuminations are obtained. The evolution of pore structures as a function of anodization time under UV light illumination has been described by three consecutive phases where the lateral etching enhances in <001> and <010> directions.

P-PHOT-017 – Grating couplers for solar harvesting in window panes

Thomas Buß [1], Cameron Smith [2], Mads Brøkner Christiansen [3], Rodolphe Marie [4], Anders Kristensen [2]

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We demonstrate the use of sub-wavelength grating couplers in window panes for solar light harvesting. The grating coupler is used to convert incoming light into guided modes for redirection of the light to solar cells at the side of the window. Optical measurements are performed on devices fabricated by NIL and compared to a simple model based on diffraction and ray-optics. Due to the sub-wavelength dimensions of the gratings, there is no significant reduction in vision quality.

P-PHOT-018 – Inhomogeneous ZnO nanorods as an anti-reflection layer by hydrothermal growth for light harvesting in solar cell application

Tao Wang [1], xinping qu [1], Yifang Chen [1], Jiahong Wu [1]

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Light harvesting is one of the key technologies to achieve high efficiency of solar energy conversion in soar cell applications. ZnO nanorods have good transparency, appropriate refractive index, and hierarchical structure which is suitable to form an inhomogeneous layer to reduce the reflection of lights in wide spectra. We investigate the layer structure control of the ZnO nanorods on Silicon by growth condition (solution concentration, growth time),trying to achieve lowest reflection.

P-PHOT-019 – Large area structural color decorations

Jeppe Clausen [1], **Alexander Bruun Christiansen** [2]

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We present a method for fabrication of cheap, large area, and patterned structural color filters in polymer by replication of black silicon surface structures using a PDMS mold and UV-NIL. In transmission of directional white light different color effects are obtained depending on the type of the imprinted structures, thus facilitating novel applications for black silicon replications in polymer.

P-PHOT-020 – Optical fiber based nanorods for generating radially polarized field

David Elbaz [1], **Asaf Shahmoon** [1], Sophia Buhbut [1], Benjamin Zeev Kupfer [1], Arie Zaban [1], Zeev Zalevsky [1]

[1] Bar Ilan University, Ramat-Gan/Israel

The aim of this study is to propose a one-piece tool that consists of a special type of optical fiber that will be able to convert non-polarized light emitted by a laser to a radially polarized beam and later on to use it in various photonics related applications. The device is composed of a tapered fiber having a classical core while on top of its external surface, radially oriented nanorods are disposed. Those nanorods act as a nanometric radiating antennas which generate a surface plasmons.

P-PHOT-021 – PFPE-based materials for micro and nanofabrication of optical components

Manuel Gomez [1]

[1] Santiago de Compostela University, Santiago de Compostela/Spain

A perfluoropolyether (PFPE)-based elastomer has been synthesized by photopolymerization of perfluoropolyether tetra-urethanemethacrylate prepolymer prepared by reaction of a tetrafunctional PFPE with isocyanate-ethylmethacrylate. This polymer is transparent and has the capability of generating high resolution replica molding, allowing fabrication of micro and nano-optical components (microlens arrays, free form phase plates, diffraction gratings, photonic crystals, waveguides and microfluidics).

P-PHOT-022 – Tunable Fano resonance in large scale polymer-dielectric slab photonic crystals

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[1] University of Tehran, tehran/Islamic Republic of Iran, [2] University of Shahid Beheshti, Tehran/Islamic Republic of Iran

Using interference lithography and deposition technique we have fabricated large scale quasi one dimensional polymer-dielectric photonic crystal that is providing sharp Fano resonance with suitable dip in transmission. The obtained Fano resonance can be used as thermo-optical tunable filter or switch.

P-PHOT-023 – 2D plasmonic crystals from thermal imprinting of ITO-based films

Laura Brigo [1], Giovanni Mattei [2], Nicola Del Debbio [1], Giovanna Brusatin [3]

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2D plasmonic crystals are typically fabricated through double exposure interference lithography or soft nanoimprint lithography on commercial polymeric resists. We have developed an organic/inorganic hybrid material based on Indium Tin Oxide nanoparticles, embedded in a titania/oligomer network, as high refractive index and patternable coating for the realization of 2D plasmonic crystals. 2D hexagonal lattice photonic crystals on ITO-based films have been made by nanoimprint lithography.

P-PHOT-024 – Design of a plasmonic structure integrated on a GaAs HEMT photodetector for biosensing applications

Gianluca Bovo [1], **Davide Sammito** [2], Davide De Salvador [1], Giorgio Biasiol [2], Michele Gaio [1], Valentina Giorgis [2], Pierfrancesco Zilio [3], Tommaso Ongarello [3], Filippo Romanato [4]

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This work deals with the design of an innovative photodetection scheme combining plasmonic resonances and high electron mobility devices. A plasmonic crystal is realized depositing of a thin gold film on an grating of V-grooves patterned on the GaAs cap layer of an AlGaAs/GaAs HEMT. Both electro-optical simulations and measurements have been performed to optimize the grating and the device layout in order to maximize the sensitivity to functionalization of the Au surface with bio-analytes.

P-PHOT-025 – Estimation of Electric Fields at Bow-tie Antenna Gaps

Wen-Yu Chen [1], Chun-Hung Lin [1]

[1] National Cheng Kung University, Tainan/Taiwan

The fundamental surface plasmon mode of bow-tie antenna was solved by using the electrostatic approximation. We derived the excitation amplitude from energy conservation theory. The estimation has greater precision than the prediction of former method derived by Mayergoyz et al. The near fields of RCWA simulation show standing-wave resonance between antenna tips. The resonance enhances the electric field in gap, which responses for the error of our prediction.

P-PHOT-026 – Fabrication of Plasmonic Bow-Tie Structures with Trapped CdSe Nanorods as a Biosensor

Anisha Gopalakrishnan [1], Manohar Chirumamilla [1], Romain Lavieville [1], Andrea Toma [1], Roman Krahne [1], Enzo Di Fabrizio [1], Gobind Das [1]

[1] Italian Institute of Technology, Genova/Italy

The main intention of the present work is to trap the nanoparticles in between the arrow shaped electrodes and then confining this system to maximize electric field enhancement. Raman measurements show a clear presence of CdSe nanorods in the centre of bowtie structures due to strong enhancement in electric field. These results assert the utility of these structures in applications such as bio-chemical sensing, opto-electronics and nano-photonics.

P-PHOT-027 – FIB Lithography of Nanoporous Gold slits for Extraordinary Transmission

Gianluca Ruffato [1], Denis Garoli [2], Sandro Cattarin [3], Simona Barison [3], Filippo Romanato [4]

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In last decades Nanoporous Gold(NPG) has known an increasing interest in Plasmonics thanks to the concomitance of a greater surface-to-volume ratio and of the plasmonic behaviour in a range that can be tuned by acting on fabrication conditions. In this work NPG membranes are designed, fabricated and characterized to exploit the phenomenon of extraordinary transmission in the nearIR range. NPG surfaces are patterned with FIB lithography in order to create plasmonic supports for sensing purposes.

P-PHOT-028 – Focused Ion Beam Patterned Nanorod Plasmonic Waveguides

Josh Einsle [1]

[1] Centre for Nanostructured Media, Belfast/United Kingdom

This works expands on earlier bottom up approach for fabrication of nanorod waveguide devices. By patterning the Au under layer before creation of the AAO template, a high degree of control over the geometry and scale of the waveguide can be achieved.

P-PHOT-029 – Large-scale plasmonic crystal structures for surface plasmon resonance sensor applications

Dong-Jin Lee [1], Min-Woo Lee [1], Bo-Soon Kim [2], Hae-Dong Yim [1], Seung-Gol Lee [3], Se-Geun Park [3], El-Hang Lee [3], Beom-Hoan Oo [3]

[1] Inha University, Incheon/Republic of Korea, [2] INHA University, Incheon/Republic of Korea, [3] Inha university, Incheon/Republic of Korea

Large-scale plasmonic crystal structures based on periodic arrays of gold nanowells are fabricated on glass substrates, and studied the refractive index sensitive transmission and reflection by measurements and by Finite Difference Time Domain (FDTD) simulations. To generate plasmonic crystals, we utilized the near-field holography (NFH) system by using a double exposure in which the substrate was rotated 90°.

P-PHOT-030 – Microfabricated polymer-substrates for SERS

Uwe Huebner [1], Karina Weber [2], Dana Cialla [2], Robert Haehle [3], Henrik Schneidewind [1], Matthias Zeisberger [1], Hans-Georg Meyer [3], Juergen Popp [2]

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We introduce a method using microfabricated polymer masks as highly sensitive substrates for surface enhanced Raman spectroscopy (SERS). Pure polymers surfaces are Raman-active and not directly suitable for SERS applications. Plastic substrates might be a strategy for the employment of the SERS technique for (bio)analytical applications. Our approach combines e-beam lithography, atomic layer deposition of Al2O3 as protection layer for the PMMA mask and Ag evaporation for the SERS-active film.

P-PHOT-031 – Mid Infrared Nanoantenna Arrays for sensing applications

Luca Businaro [1], Michele Ortolani [2], Annamaria Gerardino [3], Odeta Limaj [4], Stefano Lupi [4]

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We report the fabrication and systematic characterization of mid-Infrared nanoantennas arrays with several different geometry, to characterize their performance and investigate their sensitivity to protein monolayers. We realized six different patterns with five different lattice constants each. The fabrication is based on an electron beam lithography process followed by a Au evaporation and liftoff. The transmittance and reflectance spectra were measured by means of an Infrared interferometer.

P-PHOT-032 – Noble Metal Nanostructure for Near Infrared Localized Plasmon Sensing

Takao Fukuoka [1], **Yuichi Utsumi** [1]

[1] University of Hyogo, Hyogo/Japan

We developed the new nanovalley microstructure where the surface enhanced Raman scattering (SERS) active anisotropic assembles were built on a polymer substrate. The self-assembling of gold nanoparticles were used to generate SERS in near infrared region.SERS appeared within 5 s after the immersion and the SERS intensity almost maintained constant value for 20 h. The unique nanovalley microstructure with the anisotropic gold nanoparticles assembles results in high throughput SERS measurements.

P-PHOT-033 – Optimization and Characterization of Au Cuboid Nanostructures as a SERS Device for Biosensing Applications

Manohar Chirumamilla [1], Andrea Toma [1], Anisha Gopalakrishnan [1], Remo Proietti [1], Carlo Liberale [1], Francesco Deangelis [1], Enzo Difabrizio [1], Gobind Das [1]

[1] Italian Institute of Technology, genoa/Italy

The main purpose of the present work is to determine quantitatively the effect of cuboid size on SERS intensity for molecules adsorbed onto the surface,there by confining the optimal size of cuboid structure to maximize electric field enhancement.Gold cuboid nanostructures with size in the range from 40 nm to 100 nm are fabricated by top-down lithographic technique, electron beam lithography(EBL). A monolayer of Rhodamine-6G used as a Raman probe and SERS enhancement factor is found to be 10^5.

P-PHOT-034 – Realization of long range surface plasmon interference lithography

Xiaowei Guo [1]

[1] University of Electronic Science and Technology, Chengdu/China

In this paper, we experimentally report long range surface plasmon interference lithography. Using an cidence wavelength of 441nm, we obtain about /X4 resolution. The Fresnel quation is used to design the incidence angle and optimize the structure.

P-PHOT-035 – Surface Chemical Imaging at the Nanoscale

Francesco de Angelis [1]

[1] Istituto Italiano di Tecnologia, Genova/Italy

The fields of plasmonics, Raman spectroscopy, and AFM experienced a huge but independent development in the last decades. Here we demonstrate that their convegence can open access to topographic, chemical and structural information on a spatial scale of few nm. We report on the design, fabrication and measurements of a plasmonic device that is fully compatible with atomic force microscopy and Raman spectroscopy, enabling surface chemical imaging and topography at the nanoscale.

P-PHOT-036 – The optical responses of gold pillar arrays fabricated by direct nanoimprinting of gold nanoparticles

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The gold pillar arrays were fabricated by direct nanoimprinting of gold nanoparticles (AuNPs). This approach combines the patterning and lift-off processes into a simple one-step process without the need for expensive patterning lithographies and the stringent requirement of the lift-off process for nanostructures. Various annealing parameters were used for fabricating the gold pillar arrays and the optical responses of these gold pillar arrays were investigated.

P-PHOT-037 – Amorphous Silicon Thin Film Solar Cells with Nano-sized Pattern Layer

Kang-Soo Han [1], Ji-Hoon Jang [2], Ju-Hyeon Shin [1], Yang-Doo Kim [1], Jeong-Chul Lee [2], Heon Lee [1]

[1] Korea University, Seoul/Republic of Korea, [2] Korea Institute of Energy Research, Daejeon/Republic of Korea

Thin film solar cells require a transparent substrate. The surface treatment of glass substrate to enhance the conversion efficiency of solar cell has been studied recently.In this study, we made randomly distributed nano and micro sized, hexagonal pyramid structures on the bulk glass surface. Therefore, the light diffuse through the glass more widely and thus conversion efficiency of solar cell can be increased.

P-PHOT-038 – The Electro Static Spray Method for Organic Solar Cell Fabrication

Jung Su Kim [1], Min Cheol Lee [2], Dong Soo Kim [1]

[1] Korea Institute of Machinery and Materials, Deajeon/Republic of Korea, [2] Pusan National University, Busan/Republic of Korea

It is experimented by forming the thin films of PEDOT:PSS layer and active layer which consist of the P3HT:PCBM. The organic solar cell based on a P3HT/PCBM active layer and a PEDOT:PSS electron blocking layer prepared from ESD method shows solar-to-electrical conversion efficiency of 1.42% at AM 1.5G 1sun light illumination, while 1.86% efficiency is observed when the ESD deposition of P3HT/PCBM is performed on a spin-coated PEDOT:PSS layer.

P-PHOT-039 – Using self-assembly technology to fabricate silver particle array for organic photovoltaic devices

Yidong Hou [1]

[1] Sichuan University, Chengdu/China

to make a proper enhancement for organic solar cells, we designed a high-efficiency organic solar cells structure based on LSP technology, which is composed of ITO/ P3HT:PCBM3/ Ag particles/Ag film/glass substrate. We optimize the size, thickness and period of the nano-triangle array. Simulations show that a optimized nano-triangle array can enhance the light absorption till to 21.5 times. we fabricated a silver nano-triangle array using a close-pack PS array as a mas.

4. Micro- and Nanoengineering

4.1 Metrology and Modelling

P-MEMS-001 – A FIB/SEM based study of a fuel cell catalyst layer

Hossein Ostadi [1]

[1] University of Birmingham, Birmingham/United Kingdom

In the research presented here, a thorough cross section of a fuel cell nanoporous catalyst layer is provided by FIB milling for an SEM study, while the cross section image is coupled with finite element (FE) analysis to reveal the effective diffusivity through the layer.

P-MEMS-002 – Coherent Fourier scatterometry: a tool to achieve high accuracy in lithography inspection

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[1] Delft University of Technology, Delft/Netherlands, [2] ASML, Veldhoven/Netherlands

A first prototype of a Coherent Fourier Scatterometer, for wafers inspection, is presented. Laser light is used as source. This leads to improvements of the technique performances in terms of accuracy and robustness. Additionally, the far field pattern, composed of intensity maps, can be enriched by the phase profile as well, by using approaches currently known under the name of phase retrieval methods

P-MEMS-003 – Cu thin film characterization by scanning electron microscopy

Satoshi Takada [1]

[1] Hitachi High-technologies, Delmar, NY/United States

A novel characterization method of Cu thin film by Scanning Electron Microscopy (SEM) was considered. In order to optimizing the SEM imaging condition, a Monte Carlo code for SEM imaging is developed to implement a capability of the crystallographic contrast simulation. In the experiment, a case study of SEM imaging was performed. Cu interconnects were fabricated and annealed in three different conditions. Comparison with SEM imaging, EBSD analysis and Monte Carlo simulation were made.

P-MEMS-004 – Eigenmode characterization of SPM cantilevers: Modelling, simulation & measurement of fundamental & higher modes

Wolfgang Engl [1], Christoph Richter [1], Oliver Krause [1], Louise Decoin [1], Thomas Sulzbach [1]

[1] NanoWorld Services GmbH, Erlangen/Germany

The oscillation of commercially available SPM cantilevers in different eigenmodes has been analyzed in detail by means of a scanning laser vibrometer setup. Analytic calculations and FEM simulations of the eigenmodes were compared with the vibrometer measurements. Silicon cantilevers with a trapezoidal cross-section as well as silicon nitride cantilevers with rectangle cross section and diving board or triangular shape were investigated.

P-MEMS-005 – Electron-beam diagnostics microtomography and spectroscopy of microelectronics device structures

Nikolay Aleksandrovich Orlikovsky [1], Eduard Ivanovich Rau [1], Andrey Andreevich Tatarintsev [1]

[1] FTIAN, Moscow/Russian Federation

Some possibilities of subsurface diagnostic of microelectronic devices structures based on a scanning electron microscopy, BSE-microtomography and spectroscopy is described. The electron-beam diagnostic methods allows the nondestructive contactless examination of multilayered micro- and nanostructures.

P-MEMS-006 – In situ Formation of nano hydroxyapatite whisker reinfoced porous βTCP scaffolds

Hu Hongtao [1]

[1] Shanghai changzheng hospital, Shanghai/China

Adding nano hydroxyapatite whisker to ceramic was a way that has been to strengthen the ATCP scaffold. In this work, we use a method of adding kalium ion and reducing stintering temperature by the bioglass, to maintain the appearance of nHA whiskers. And have successfully prepared porous nHAW/ATCP scaffold in situ Formation of nano hydroxyapatite whisker. The nHA whisker and the suuface of scaffold were observed by SEM and TEM, and the phase content was determined by XRD.

P-MEMS-007 – Modelling of the response time of thermal flow sensors

Safir Issa [1], Hannes Sturm [1], Walter Lang [1]

[1] University of Bremen, Bremen/Germany

This paper introduces a modelling program for the response time of thermal flow sensors. This model uses the finite-difference method to solve the heat transfer equations (transient conduction and convection) within the sensor membrane and the surrounding fluid. Program results agree with experimental measurements and explain its dependence on the velocity and the sensor geometry. Values of the response time vary from about 5 ms in the stagnant flow case to 1.5 ms for flow velocity of 44 m/s.

P-MEMS-008 – Morphology Control of Nickel Oxide Nanowires

Kaname Sekiya [1]

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Nickel oxide nanowires are considered to be hopeful materials. In this study, we investigate how structure of NiO nanowires changes as a function of annealing temperature. NiO nanowires are fabricated by a simple and short-term calcining process. It was confirmed that nanowires grew densely when annealed at 600°C in our process. We will research how structure of NiO nanowires change when other parameters are controlled such as calcining time, gas, and pressure during calcining process.

P-MEMS-009 – Nanoprober based EBIC measurements for nanowire transistor structures

Kai Arstila [1], Thomas Hantschel [1], Andreas Schulze [1], Anne Vandooren [1], Anne Verhulst [1], Pierre Eyben [1], Wilfried Vandervorst [1]

[1] imec, Leuven/Belgium

A nanoprober based technique has been developed for creating direct electrical contacts to nanostructures for EBIC measurements. The nanoprober setup consists of four nanomanipulators and a linear sample stage placed in a SEM chamber and connected to a parameter analyzer and an EBIC amplifier. Each nanomanipulator can independently position a tip in centimetre range with nanometre precision. This allows for contacting one or several tips simultaneously on the same nanostructure.

P-MEMS-010 – Novel Focus Monitoring Using Diffraction Image of Forbidden Pitch Patterns

Jinseok Heo [1], Jeongho Yeo [1]

[1] Samsung Electronics, Hwasung-City/Republic of Korea

In this paper, we introduce the modified focus monitoring method using forbidden pitch patterns. The modified method uses the wafer on which the forbidden pitch patterns are exposed, and just performed PEB (post exposure bake) process without development process. The detailed performance of this modified focus monitoring method and its experimental verification results will be discussed in this paper.

P-MEMS-011 – Prediction of etch bias for polysilicon etching based on coupled equipment- and feature-scale modeling

Eberhard Baer [1], Uwe Paschen [2], Juergen Lorenz [1]

[1] Fraunhofer IISB, Erlangen/Germany, [2] Fraunhofer IMS, Duisburg/Germany

The purpose of this work is to demonstrate the prediction of polysilicon profiles resulting from a dry etching process of a masked polysilicon layer. To this end, coupling of equipment- and feature-scale simulation has been carried out. As an example for evaluating the simulation results, the so-called iso/dense bias, i. e. the variation of etch bias between isolated and dense lines, is considered. The simulated iso/dense bias is compared to values obtained experimentally.

P-MEMS-012 – Three-dimensional Simulation System for Ultraviolet Lithography of Thick SU-8 with Experimental Verification

Zai-Fa Zhou [1], Li-Li Shi [1], Qing-an Huang [1]

[1] Key Laboratory of MEMS of the Ministry of Education, Nanjing/China

An efficient and accurate three-dimensional simulation system for the lithography process of thick SU-8 has been implemented based on a modified fast marching method. Various simulations have been conducted by the simulation system, and the corresponding experiments have been implemented. The simulated development profiles demonstrate to be in agreement with the experimental results, with the maximum error less than 9.5% during this study.

P-MEMS-013 – Titanium/polyimide and SiO2/Si nanotowers fracture on the Scanning Force Microscope

Dariusz Jarzabek [1], Thomas Jung [1]

[1] Paul Scherrer Institut, Villigen PSI/Switzerland

Micro-structured nanotowers are mapped and modified with an Atomic Force Microscope (AFM). By using increased forces acting between the cantilever-tip and the substrate in suitable experimental procedures, nanotowers can be broken selectively, which makes it possible to write patterns. The fracture forces FN and FL give an indication for the nature of the interface and permit the study to the tribology on the nanometre scale.

P-MEMS-014 – Towards a deeper understanding of the dynamic properties of cantilever probes

Christiane Weimann [1], Maria-Astrid Schröter [1], Matthias Holschneider [2], **Heinz Sturm** [1]

[1] Federal Institute for Materials Research and Testing, Berlin/Germany, [2] University of Potsdam, Institute for Mathematics, Potsdam/Germany

In this poster a first step to measure and understand the dynamics of small and weak mechanical structures with ultra-high precision and sensitivity is presented. For this reason we analyze different types of silicon cantilevers as a simplified mechanical model with a special focus on T-shaped cantilevers. For dynamic measurements of small vibrating structures a hybrid of a Scanning Electron Microscope (SEM) and a Scanning Force Microscope (SFM) is used.

P-MEMS-015 – Wafer level measurements of mechanical parameters of microsensors structures

Pawel Janus [1], Magdalena Ekwińska [1], Krzysztof Domański [1], Piotr Grabiec [1], Teodor Gotszalk [1], Konrad Nieradka [1]

[1] Institute of Electron Technology, Warszawa/Poland

In this paper, authors present technique utilizing combined nanoindentation and interferometric approach allowing for precise and quick characterization of various types of silicon microcantilevers and micromechanical structures. The results of wafer level static (stiffness) and dynamic (resonance) characterisation of various microsensors will be reported and discussed. Mentioned above results will be compared with parameters obtained from tests performed on final application of sensors.

P-MEMS-016 – A self-aligning shadow mask technique for micropatterning on wafer scale

Marco Becker [1]

[1] NanoWorld Services GmbH, Erlangen/Germany

A self-aligning shadow mask technique for micropatterning on wafer scale is presented in this work. The main idea is to use ridges on the bottom of a shadow mask which snap into grooves on the target wafer. With this technique, an easy and fast alignment in all three dimensions is possible. The alignment accuracy of this shadow mask technique for two consecutive coating runs using the same shadow mask was also analyzed.

P-MEMS-017 – Black silicon maskless templates for carbon nanotube forests

Rafal Wierzbicki [1]

[1] DTU Nanotech, Kgs. Lyngby/Denmark

We present a novel cost-effective maskless fabrication method of vertically aligned carbon nanotube (CNT) forests. It relies on use of a planar diffusion barrier for the catalyst. The barrier is created from a silicon nanograss conformally coated with titanium tungsten. Density and vertical size of the nanograss is well controlled during dry reactive ion etching of a silicon wafer. This paper presents a proof of concept for that technology, with fabrication details and CNT uniformity analysis.

P-MEMS-018 – Copper metal stamp coated with gold nanolayer for rapid fabrication of microstructures

Petr Cervenka [1]

[1] Institute of Chemical Technology, Prague/Czech Republic

Fabrication of microstructures in hard polymer materials require a template as a tool to transfer patterns into polymer surface. We have developed a novel fabrication technique for production of hybrid gold/copper stamps. This procedure relies on the PDMS casting process, transferring of microstructures into UV curable resin and galvanic deposition of copper. The durability of these stamps pretends them to be a cheap and achievable alternative to metal stamps fabricated by the common techniques.

P-MEMS-019 – Depth modulated binary structures produced by using double exposure electron beam lithography

Petri Stenberg [1], Markku Kuittinen [1]

[1] University of Eastern Finland, Joensuu/Finland

Depth modulated binary structures are desired in many optical applications. On the other hand surface modulated structures can thought to be used for texturing different materials through standard mass production methods i. e. nano imprinting, hot embossing and roll to roll. In our presentation, we describe a method to fabricate depth modulated sub-micron binary structures. In fabrication, we have used electron beam lithography, double exposure and plasma etching.

P-MEMS-020 – Effects of ink cohesion and adhesion during gravure offset printing

Inyoung Kim [1], Sun-Woo Kwak [2], Jae-Ho Noh [1], Bongmin Kim [1], Taik-Min Lee [3]

[1] Korea Institute of Machinery and Materials (KIMM), Daejeon/Republic of Korea, [2] KIMM, Daejeon/Republic of Korea, [3] Korea Institute of Machinery and Material, Daejeon/Republic of Korea

This study was aimed at investigating the ink transfer mechanism of the gravure offset printing from a quantitative perspective. The measurement concepts of the ink cohesion were also defined and realized by modifying a tribometer. The ink cohesion increased during the printing process because of the solvent absorption into the PDMS, which played a crucial role on the ink transfer during the printing. The effect of the various printing conditions on the printing quality was also investigated.

P-MEMS-021 – Electroplated nano sieves for microfiltration based on electron beam lithography

Axel Rudzinski [1], Michael Kahl [1], Markus Fleger [2], Oliver Humbach [2]

[1] Raith GmbH, Dortmund/Germany, [2] temicon GmbH, Dortmund/Germany

This work demonstrates the first ideal metal membrane with sharp pore size distribution and cylindrical pore shape. It consists of a thin effective membrane layer respectively to pore size. Major material advantages can be seen as the high flexibility and good mechanical, chemical and thermal stability. Additionally metal has positive vibration behavior when being cleaned and enables optical inspection (good reflectivity). The production process enables a monolithic supporting structure.

P-MEMS-022 – Fabrication and investigation of regular arrays of magnetic nanowires using a template synthesizing technique

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Porous Alumina Membranes (PAMs) are used as a template. They are composed of hexagonal arranged cylindrical pores which stand perpendicular on a substrate. The substrate and the pores are divided by an insulating alumina barrier layer which is removed by two etching methods . The pores are filled by electrodeposition. The PAM can be dissolved to obtain freestanding nanowire arrays on a large scale. Their structural and magnetic properties are investigated by SEM, TEM, VSM, FMR and MFM.

P-MEMS-023 – Fullerene based Spin on Carbon Hardmask

Jedsada Manyam [1], Andreas Frommhold [1], Richard Palmer [1], **Alex Robinson** [1]

[1] University of Birmingham, Birmingham/United Kingdom

As device feature sizes have shrunk ultrathin resist films have become necessary to mitigate mechanical failure. We have previously demonstrated high durability resists capable of aspect ratios >5:1 for 25 nm halfpitch. However, even with such a resist overall etch depth is limited by film thickness. The use of multilayer hardmasks allows further increase of aspect ratio. Here we introduce a fullerene based ‘spin on carbon‘ with high etch durability.

P-MEMS-024 – Injection Molding of High Aspect Ratio Nanostructures

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We present a process for injection molding of 40 nm wide and >100 nm high pillars (pitch: 200 nm). We explored the effects of mold coatings and injection molding conditions on the replication quality of nanostructures in cyclic olefin copolymer. We found that optimization of molding parameters using native nickel molds only lead to slight improvements in replication quality. In contrast, a fluorocarbon based antistiction coating (FDTS) was found to improve the replication quality significantly.

P-MEMS-025 – Irregular film thickness distribution in C4F8 inductively coupled plasma polymer deposition

Burkhard Volland [1], Maik Hauguth [1], Valentyn Ishchuk [1], Ivo W. Rangelow [2]

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Under certain process conditions, plasma polymerization of fluoro-carbons on structured silicon samples shows two distinctive effects: First, the growth rate at a certain depth inside the trenches is considerably larger than at the shoulders, the trench bottom or other areas of the sidewall. Second, an initial sidewall texture is enlarged in the shape of the deposited polymer film

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P-MEMS-026 – Laser-Scanning Imprinting for Large-Area Nanostructures

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Laser-assisted imprinting, a high-throughput method of imprinting, was demonstrated; however, scanning a laser is needed to imprint a large area because the power of the laser has a limitation. In this study, we demonstrate a laser-scanning imprinting for a large-area nanostructured film. We successfully imprinted 500-nm-pitch pattern on a spot area, a line area with a speed of 10 mm/s, and an area with a size of 10×10 mm2 in 12 s.

P-MEMS-027 – Nano and microstructuring of industrial-scale surfaces using colloidal lithography

Anne Gry Hemmersam [1], Jacob Ask Hansen [2], Troels Bach Nielsen [1], Inge Hald Andersen [1]

[1] Danish Technological Institute, Aarhus C/Denmark, [2] The Danish Technological Institute, Aarhus C/Denmark

Through the last decades, nano and microstructuring of surfaces has been an active research area resulting in the fabrication of increasingly complex surface structures with novel properties. Here we pressent two methodes for nano and micro structuring 3D industrial surface based on colloidal lithography. Surface coverage of the microstructure can be varried between 1-55%. The surfaces are tested for improved heat transfer using water as a colling liquid.

P-MEMS-028 – Plasma Induced Self-Aligned Double Patterning

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In this paper, a simple self-aligned double patterning process (SADP) based on plasma deposition and etching is introduced. Plasma induced sidewall re-deposition was carried out in etching chamber on patterned resist. The deposited sidewall is resistant to O2 plasma, therefore initial resist can be removed to retain the sidewall structures. Both doubled frequency gratings and nano-rings have been successfully demonstrated.

P-MEMS-029 – Precise fabrication of copper micro-coils using dissociation etching

Toshiyuki Horiuchi [1], Hidetoshi Ishii [1]

[1] Tokyo Denki University, Tokyo/Japan

Copper micro-coils with a diameter of 100 μm, homogeneous coil widths of 55±2.1 μm were constantly fabricated using dissociation etching in aqueous solution of sodium chloride and ammonium chloride. In conventional chemical etching, coil widths often fluctuated terribly, and had to be controlled by observing the coils on the way of etching. Applying the new etching, coil widths became homogeneous without the halfway observation. In addition, etching time was shortened to about 1/4.

P-MEMS-030 – Process Optimization and Simplification of Self-aligned Triple Patterning

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Self-aligned triple patterning (SATP) offers both improved resolution and design flexibility for scaling IC down to sub-15nm half pitch. SATP technology is a prospective trend that not only increase the feature density, but also relaxes the overlay requirement and allows 2D layout. Further optimization and simplification of SATP process is needed to compete with SAQP (4x) and EUV+SADP schemes. We shall discuss several key issues in SATP process optimization & simplification and mandrel etching.

P-MEMS-031 – Relatively large polyimide microstructures fabricated using hot embossing

Ryuta Ikoma [1], Hiroki Komatsuzaki [1], Kenta Suzuki [1], Takayuki Komori [1], Keigo Kuroda [1], Hirohumi Saitou [1], Sung-won Youn [1], Masaharu Takahashi [1], Ryutaro Maeda [1], Yasushiro Nishioka [1]

[1] Nihon University, Chiba/Japan

Polyimide has many advantages for MEMS applications. However, it has been difficult to define relatively large micro-patterns on polimide surfaces. This paper presents optimized hot embossing processes to fabricate a micropump patterns with the dimensions larger than 100 μm and the depth of 200 μm on a 300 μm-thick PI film. Good shapes of the micropump structures were projected to the PI substrate using anti-adhesion coating on the mold at 350during hot embossing.

P-MEMS-032 – Self-assembly, Plasma Directed Assembly and Plasma Etching for vertical Silicon Nanowire Formation

Athanasios Smyrnakis [1], Angeliki Tserepi [1], **Evangelos Gogolides** [1]

[1] Institute of Microelectronics, NCSR Demokritos, Aghia Paraskevi/Greece

In this paper, we explore the vertical Si nanowire formation using as a template two self-assembly methods: colloidal lithography and plasma directed assembly. For the pattern transfer to a Si substrate, we optimized a cryogenic Si etching process. Si nanowires with diameters in the range of 40-500 nm and high aspect ratio (up to 20:1) can be fabricated. The optical properties of the nanostructured surfaces are studied by measuring their reflectivities. Potential applications will be discussed.

P-MEMS-033 – Shape and Size Control of Gold-Nanoparticles through Variations in Electrodeposition Parameters

Maximilian Amberger [1], Klaus Bade [1]

[1] Karlsruhe Institute of Technology (KIT), IMT, Eggenstein-Leopoldshafen/Germany

The fabrication of nanocrystalline gold structures by means of pulsed- and direct current electrodeposition was investigated. By using different plating parameters such as current density and pulse plating, we were able to create a variety of shapes and sizes whilst maintaining a constant charge density. Current density proofed to have the biggest impact on particle size and distribution. Especially at high current densities, particle size decreased but nucleation density was becoming larger.

P-MEMS-034 – Silver lines Transferring Printing for Solar Cell Electrode

Liangjin Ge [1]

[1] University of Science and Technology of China, Hefei/China

We developed a transfer printing process to fabricate micro silver fingers on the poly-silicon using a silicone rubber as the transfer layer. In the study, we prepare the mixture binder for silver paste to improve the property of transferring. To avoid widen problem, UV surfactant aided transferring printing is also developed. The parameters of the transfer process, including paste properties, pressure, surface energy, are studied in this paper.

P-MEMS-035 – Sol-gel based magnetic inkjet ink in combination with solvent assisted micro molding

Barbara Unterauer [1]

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Sol-gel based inks lead to a dense structure when treated with apt temperature after the printing process. An additional structure and better solvent evaporation can be achieved, when utilizing a micro molding process to the surface. This combination of technologies can also be interesting when aiming at a micro- and nanopatterning process using solvent-assisted micromolding and specialized inks that cannot or should not be spin-coated. Furthermore magnetic particles are suspended in the ink.

P-MEMS-036 – Strain microgauge implementation on cylindrical metal substrates

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[1] TIMA Laboratory, Grenoble/France, [2] CEA-INAC, Grenoble/France

We describe the design and fabrication process of germanium piezoresistive strain microgauges implemented on stainless steel and Ti/Ni thin cylinders. These microsensors enable the real-time measurement of the cylinder's strain distribution and deflection status. Several adjustments have been made to adapt the cylindrical substrate to typical micromachining equipment. The microfabrication process is defined with respect to substrate particularities.

P-MEMS-037 – Superior Cu Trench Etching Technique without Multi Layer Mask based on ArF PR Mask beyond 45nm-Node

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In backend process with Cu, multi layer mask is usually used in ArF lithographic. it has remarkably two demerits. one is complicated photo and etch processes The other is difficulty to define some defects. For this reasons single PR process could be adopted if the etch process would be stable. This paper presents the unique technique of the Cu trench etch process based on single PR mask. Novel technique by controlling various gas and RF power, process pressure from etch process will be proposed.

P-MEMS-038 – Ta/TiN midgap full-metal single gate fabrication using combined chlorine-based plasma and highly selective chemical metal etching for decananometer CMOS technology

Zhenkun Chen [1], Emmanuel Dubois [2], Florent Ravaux [3], François Danneville [3]

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The full metal gate integration in CMOS technology emerges as the ideal option not only to solve polysilicon gate depletion but also to drastically reduce the gate resistance that hampers high frequency operation. However, metal gate etching remains a challenge in terms of selectivity, roughening and non-volatile residues. This paper demonstrates a two-step dry and wet etching strategy that produces vertical roughness-free sidewalls and features an ultra high metal/oxide etch selectivity (>500).

P-MEMS-039 – Template-assisted electrostatic spray deposition as a new way to micropattern hydroxyapatite/silk fibroin composite nanocrystals onto surfaces

Yunrong Zhu [1], Guohua Xu [1], Xiaojian Ye [1], **Yuyun Chen** [1], Dannong He [1], Jian Zhong [1]

[1] National Engineering Research Center for Nanotechnology, Shanghai/China

In this work, we constructed an electrostatic spray deposition (ESD) apparatus and then micropatterned hydroxyapatite (HA) / silk fibroin (SF) composite nanocrystals onto template-covered Ti alloy substrates. Three types of micropatterns (ring, stripe, and square arrays) of the composite nanocrystals onto Ti alloy substrates were obtained. The results demonstrate that the precise micropatterns onto the substrates can be easily achieved by the template-assisted ESD.

P-MEMS-040 – Ultra fast Capillary assembly for surface patterning of colloids and living objects

François-Damien Delapierre [1]

[1] Institut Curie, Paris/France

Capillary assembly is a technique to pattern structured surfaces using nanoparticles suspended in a liquid. A drop of suspension is dragged along the surface at micrometric speed: On the flat areas, particles are carried away by the meniscus. However, where the surface is patterned, particles are trapped in the structures. We have increased the process speed, up to 1mm/s and demonstrated that it can be used with suspended cells

4.3 MEMS/NEMS, MOEMS/NOEMS

P-MEMS-041 – All-inkjet-printed electric components and circuits on a flexible substrate

Byung Ju Kang [1], Je Hoon Oh [1]

[1] Hanyang University, Ansan, Gyeonggi-do/Republic of Korea

Inkjet printing is considered a promising technique which enables the flexible electronics to be realized in many applications. In this work, all passive components including a resistor, capacitor and inductor were inkjet-printed on a polyimide substrate. Electric circuits were also fabricated based on the results of the printed passive components. In addition, We evaluated and discussed electrical characteristics of the inkjet-printed components and circuits.

P-MEMS-042 – ARCH-Type Microcantilever FPA for uncooled IR Detection

Marek Steffanson [1]

[1] TU Ilmenau, Ilmenau/Germany

A novel ARCH-Type microcantilever focal plane array (FPA) has been developed for uncooled IR (7-14um) detection. This type of sensor has several advantages in contrast to current uncooled IR sensors. We will be presenting first experimantal results of IR detection and a technology proccess flow for 640x480 FPA fabrication with standard MEMS technology. Current development work includes system integration, real-time large scale thermographic imaging and scaling down pixel size to sub-50um.

P-MEMS-043 – Cancellation of the Parasitic Current in an integrated CMOS-MEMS Clamped- Clamped Beam Resonator

Joan Giner [1], Arantxa Uranga [1], Eloi Marigo [1], Jose Luis Muñoz-Gamarra [1], Julien Arcamone [1], Nuria Barniol [1]

[1] CEA-Leti/Minatec, Grenoble/France

This work proposes and efficient transduction to cancel the parasitic current effect in a 22um x 500nm CMOS-MEMS Clamped-Clamped Beam resonator. Four electrodes with a 100nm gap are used in one hand, to drive the electrostatic force and on the other hand to modify the gap between the electrode and the resonator. Using a efficient polarization it is posible to cancel all the parasitic contributions and obtain only the resoant peak at the output.

P-MEMS-044 – CMOS-MEMS Dogbone resonator with capacitive and piezoresistive sensing capabilities

Eloi Marigó [1], Jose Luis Muñoz [1], Joan Giner [1], Arantxa Uranga [1], Núria Barniol [1]

[1] Universitat Autònoma de Barcelona, Bellaterra/Spain

This contribution reports the design, fabrication and characterization of a bulk acoustic mode resonator at VHF band using the polysilicon layer of a standard CMOS technology (AMS 0.35 um) with capabilities for piezoresistive sensing.

P-MEMS-045 – Controlled microbubble generation by a microprobe electroanalysis

jun zou [1], Jilin Liu [1], **Xin Fu** [1]

[1] Zhejiang University, Hangzhou/China

In the paper, we develop a microprobe electroanalysis device for controlled generation of microbubbles. It is a simplistic and economized method for microbubble generation and control instead of the employment of fluidic structures realized by complex and expensive fabrication techniques. The size of the generated bubbles can be controlled by simply altering the electrolytic voltage, corresponding to given microprobe dimensions.

P-MEMS-046 – Design and fabrication of a novel flowmeter with corrugated structure

Sang Hoon Lee [1], Dae Keun Choi [1]

[1] Seoul National University of Science and Technology, Seoul/Republic of Korea

We designed and fabricated a novel air flowmeter for the detection of small air flow velocity. The device is located perpendicular to the air flow, and the corrugated structure is applied to improve the flow sensitivity. The various experiments are performed in the wind tunnel, and the results show the fabricated device has the better sensitivity compared with flat one, and measures the small air flow velocity less than 1m/s.

P-MEMS-047 – Effect of Annealing on Ultra-thin Silicon Nanomechanical Resonators Fabricated by Focused-Ion-Beam Implantation

Hui Liu [1], Reo Kometani [1], Shin'ichi Warisawa [1], Sunao Ishihara [1]

[1] The University of Tokyo, Tokyo/Japan

Effects of thermal annealing on vibration characteristics of the ultra-thin Si resonators fabricated by the local Ga+ implantation technique using focused-ion-beam (FIB) had been evaluated in this study to achieve the silicon resonators having the high frequency and high quality factor. We found that the tensile stress, applied by the annealing treatment at 600 °C ~ 700 °C, was effective to improve the resonant properties of ultra-thin Si resonators fabricated by Ga+ FIB implantation technique.

P-MEMS-048 – Effects of Bottom Electrode on Feed-Through Capacitance and Electrical Transmission of MEMS Resonator

Jung-Mu Kim [1]

[1] Chonbuk National University, Jeonju/Republic of Korea

In this work, the effects of the bottom electrode on the feed-through capacitance and the resonance peak height of MEMS resonator with the push-pull configuration were presented by measuring the feed-through capacitance and the electrical transmission. The results of this paper showed that the reduction of the feed-through capacitance of MEMS resonator is not always proportional to the performance of the MEMS resonator.

P-MEMS-049 – Electroless Deposition of Silver Thin Films on Gold Nanoparticles for Micro and Nanoelectronics Applications

Alexandra Inberg [1], **Pavel Livshits** [1], Zeev Zalevsky [1]

[1] Bar-Ilan University, Tel Aviv/Israel

In this work new electroless deposition (ELD) process of silver (Ag) ultra-thin films on insulated substrates activated by gold nanoparticels (AuNPs) is presented. Three characteristic Ag films growth stages were observed. The electrical and optical properties of the films are in agreement with the theory. The work also presents rather interesting and not-discussed before phenomenon of precipitation mechanisms of AuNPs on SiO2/Si surfaces.

P-MEMS-050 – Evaluation of anisotropic structure in electrodeposited Ni film using micro-sized cantilever

Hirohito Imamura [1], Masato Sone [1]

[1] Tokyo Institute of Technology, Yokohama/Japan

Electroplating is a key technology for fabricating micro components used in MEMS. Tensile test is usually used to examine strength of micro component fabricated from electrodeposited film. However it is difficult to examine effects of grain growth direction in tensile test, because of the difficulty to prepare the micro-sized tensile test specimen. In this study, a novel mechanical bending test method using micro sized cantilever fabricated by focused ion beam is proposed.

P-MEMS-051 – Fabrication and strength analysis of humanoid focusing mechanism

Yao-Chuan Tsai [1], Po-Keng Chung [1], Wen-Pin Shih [1], **Pei-Chen Su** [2]

[1] National Taiwan University, Taipei/Taiwan, [2] Nanyang Technological University, Singapore/Singapore

A humanoid focusing mechanism which consists of parylene nanofibers and soft polymer lens was demonstrated. The soft polymer lens consists of a PDMS envelope and a silicone core. The parylene nanofrillar film was used to adhere to the lens and to transfer the accommodation force. The testing of the mechanism implicitly explains the adoption of fibrillar structure which connects the lens to the ciliary muscle in human eyes. The focus increases when a pulling force is applied.

P-MEMS-052 – Fabrication method for single crystal Ni micro component by electrodeposition in additive free Watt's bath

Taiki Uemura [1], Masato Sone [1]

[1] Tokyo Institute of Technology, Yokohama/Japan

In this study, we propose a novel method to fabricate single crystal metallic micro components using electrodeposition by controlling the composition of the electrolyte and both flatness and crystal orientation of the substrate surface. With this method, we obtained the large grain fabricated by electrodeposition for the single crystal micro component. The size of large grains was about 1mm in diameter. This fabrication method can be an important candidate for the application of MEMS devices.

P-MEMS-053 – Fabrication of electrohydrodynamic printing module and its printing capability

Kyoung Il Lee [1], Byung Jik Lim [1], Hyun Joo Lee [1], Seong Hyun Kim [1], Chul Seung Lee [1], Jin Woo Cho [1], Seungjun Chung [1], Yongtaek Hong [1]

[1] Korea Electronics Technology Institute, Seongnam/Republic of Korea

A ceramic nozzle electrohydrodynamic printing module has been fabricated with a micromachining technology and stable continuous or drop on demand printing have been realized. Our approach is to combine a traditional high precision machining technology and photolithography to make a high aspect ratio nozzle shape. We could achieve a continuous line patterns with a width of 20 microns without any special surface treatment and dot array patterns with a diameter of 28 microns at 2 kHz

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P-MEMS-054 – Fabrication of MEMS Actuators from the BEOL Module of a 0.25µm BiCMOS Technology Platform

Philipp Kulse [1]

[1] IHP, Frankfurt (Oder)/Germany

To meet the increasing demand for monolithically embedded MEMS devices, new manufacturing techniques are requested. A new technological fabrication method has been developed, which offers thin TiN MEMS actuators from the BEOL module of a 0.25µm CMOS/BiCMOS technology platform.

P-MEMS-055 – FEM-based design and fabrication of Aluminum Nitride–based PMAT Hydrophones for oceanographic applications

Francesco Guido [1], Antonio Qualtieri [2], Francesco Rizzi [1], Massimo De Vittorio [1]

[1] Università del Salento, lecce/Italy, [2] Instituto Italiano di Tecnologia, Arnesano/Italy

In this paper a FEM based algorithm has been used to design a Piezoelectric Micro Acoustic Trasducer sensitive in the 100Hz–10kHz range in water environment for biomarine researches. A 350µm squared AlN-based piezoelectric membrane on a 1.5µm thick SiN structural layer by conventional micromachining techniques has been fabricated. The preliminary results obtained, can be used to form a set of designing guidelines for the performance optimization of micromachined piezoelectric membrane.

P-MEMS-056 – Flexible piezoelectric cantilevers of AlN fabricated on polyimide substrate

Simona Petroni [1], Enrica Montinaro [1], Francesco Guido [2], Adriana Campa [1], Adriana Passaseo [1], Maria Teresa Todaro [1], Massimo De Vittorio [1]

[1] IIT-Italian Institute of Technology, Arnesano (LE)/Italy, [2] Università del Salento, lecce/Italy

In this work we present for the first time the fabrication and the RF characterization of flexible piezoelectric micro cantilevers based on Aluminum Nitride as piezoelectric active layer and polyimide as elastic layer. The cantilever structure is defined in two masks: the first mask defines the top electrode and the piezoelectric layer, the second defines the trench into the Molybdenum bottom layer and the Kapton to release the beam. The one-port S11 scattering parameters have been measured.

P-MEMS-057 – Freely Movable Ferromagnetic Shape Memory Nanostructures for Actuation

Mario Schmitt [1], Anja Backen [2], Sebstian Fähler [2], Manfred Kohl [1]

[1] Karlsruhe Institute of Technology, Karlsruhe/Germany, [2] IFW Dresden, Dresden/Germany

In this paper, we present the design and fabrication of freely movable ferromagnetic shape memory nanostructures for actuation in nanometer dimensions made of Ni-Mn-Ga. Ni-Mn-Ga has superior material properties for nanoactuation, for example high magneto strain and good scaling behavior. Key elements of the fabrication process are the epitaxial growth of the metal buffer and Ni-Mn-Ga layers and the subsequent electron beam lithography and dry etching steps.

P-MEMS-058 – High frequency piezoresistive 3C-SiC Atomic Force Microscopy cantilevers using electrothermal actuation

Rachida Boubekri [1]

[1] CNRS, France, Marcoussis/France

we realized nanofabrication of high frequency cantilever for Atomic Force Microscopy (AFM) using 3C-SiC/Si epilayers. The cantilevers are electrothermally actuated, the detection is based on piezoresistive mode. The nanofarication use differents steps of e- beam lithography and different photoresist.Controlled TMAH etching of Si is used to release the cantilevers.

P-MEMS-059 – Highly uniform and conformal thin film metallization with thermal and plasma-enhanced atomic layer deposition

Minna Toivola [1], **Juhana Kostamo** [1], Timo Malinen [1], Tero Pilvi [1], Tero Lehto [1]

[1] Picosun Oy, Espoo/Finland

Industrially upscalable ALD processes were developed for several metals and metallic compounds, i. e. Pt, Ir, Ru, Cu, Ag, Au, TiN and TiAlCN. Deposition of metals can be done with ALD and plasma-enhanced (PEALD). The main benefits of the PEALD technique are the possibility to use reductive processes instead of oxygen, lower deposition temperatures which decreases the thermal stress on the substrates, and a wider variety of precursor chemicals.

P-MEMS-060 – Low temperature PECVD-SiO2 on germanium

Stephan Brabender [1], Klaus Kallis [1], Christopher Kontis [1], Horst Fiedler [1]

[1] TU Dortmund, Dortmund/Germany

Outperforming the limits of silicon substrates by the usage of germanium leads to the need for new manufacturing processes. The fabrication of new sensor technologies on germanium substrate for example has demands for qualified deposition processes. Particularly problematic is the lack of an easy to create species-specific germanium oxide as an isolator. This work discusses the potential of an advanced plasma enhanced chemical vapour deposited (PECVD)-silicon dioxide as alternative isolator.

P-MEMS-061 – MEMS thermal flow sensor for fuel cell system

Tak Gen Kim [1], Dongho Kim [1], Si-Hyung Lim [1]

[1] Kookmin University, Sungbookku, SEOUL/Republic of Korea

In this study, MEMS thermal flow sensor has been developed for fuel cell system. The operating characteristics of the developed MEMS thermal flow sensor have been measured in the range of 0 ~ 5000 sccm air flow rate.

P-MEMS-062 – Microfabricated 3D micro- and nanoelectrodes for neuron studies

Patricia Vazquez [1], Maria Dimaki [1]

[1] Technical University of Denmark, Kgs. Lyngby/Denmark

The purpose of this work is to develop novel 3D micro- and nanoelectrodes for neurological applicaitons by use of carefully optimized standard microfabrication techniques. Two types of electrodes have been developed: 1) small electrodes with nanosized tips and heights in the 3-5 µm range for electrophysiological and electrochemical measurements in cell cultures and 2) high aspect ratio electrodes with a pronounced scalloped profile for electrical recordings of brain tissue in vitro.

P-MEMS-063 – Micromachined pressure sensors based on AlGaN/GaN circular HEMT sensing devices

Tibor Lalinsky [1], Peter Hudek [2], Gabriel Vanko [1], Pavlina Choleva [3], Martin Vallo [1], Ladislav Matay [4], Ivan KostiΛ[4], Milan Držík [5]

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In this work we present – for the first time – a new design concept of a C-HEMT based micromachined pressure sensor. The design consists of C-HEMT devices integrated on a 2 um thick circular AlGaN/GaN membrane. So, the circular symmetry of the 2DEG channel of the C-HEMT is fully compatible with the circular AlGaN/GaN membrane structure preferentially used for MEMS pressure sensors design. The front-side processing of our C-HEMT device is combined with a bulk Silicon micromachining.

P-MEMS-064 – Parylene-coated bioinspired artificial hair cell for liquid flow sensing

Antonio Qualtieri [1], Francesco Rizzi [1], Gianmichele Epifani [2], Massimo De Vittorio [1]

[1] Instituto Italiano di Tecnologia, Arnesano/Italy, [2] Istituto Italiano di Tecnologia, lecce/Italy

In this work we outline the design and the development of a waterproof Si/SiN multilayered cantilever based on a stress driven geometry for flow sensing. As this sensor has to be implemented on a robofish a water resistant parylene conformal coating has been deposited on the artificial hair cell. A set-up for applying up to 50 cm/sec water flow velocity demonstrated initial sensing capabilities and the mechanical resistance of the flow sensors in this velocity range

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P-MEMS-065 – Performance evaluation of carbon nanomachines under electron irradiation: Molecular dynamics study

Masaaki Yasuda [1], Yoshinori Chihara [1], Hiroaki Kawata [1], Yoshihiko Hirai [2]

[1] Osaka Prefecture University, Sakai/Japan, [2] Osaka Prefecter University, Sakai/Japan

The electron irradiation effects on the performances of carbon nanomachines are evaluated with the molecular dynamics simulation. The rotation of the carbon nanobearing deaccelerated earlier under electron irradiation. The period of the C60 oscillator became longer and the oscillation decayed earlier under electron irradiation. The electron irradiation largely affects the performances of carbon nanomachines.

P-MEMS-066 – Reactive Ion Etching of Polymer Materials for Energy Harvesting Devices

Fei Wang [1]

[1] Technical University of Denmark, Kgs. Lyngby/Denmark

In this paper, we demonstrate deep reactive ion etching of polymer materials , which may be useful for electret based energy harvesting devices. The CYTOP is patterned for the electret in the charging while the TOPAS is used as a wafer bonding material. Three mask materials are investigated for the RIE process. The CYTOP polymer is charged after patterning and wafer-level bonding between CYTOP and TOPAS is successively performed using a low temperature thermo-compression bonding technique.

P-MEMS-067 – Relationship between Q factor and the surface condition of the DLC nanoresonator fabricated by focused-ion-beam chemical vapor deposition

Reo Kometani [1], Hiroki Shimizu [1], Shin'ichi Warisawa [1], Sunao Ishihara [1]

[1] The University of Tokyo, Tokyo/Japan

Relationship between Q factor and surface condition of diamond-like carbon (DLC) nanoresonator fabricated by focused-ion-beam chemical vapor deposition and wet-etching process was examined to achieve an extremely sensitive sensing device. Surface condition of DLC was modified by RIE process. As a result, Q factor increased with the decrease in the surface free energy of DLC surface. Surface modification using RIE treatment was a useful technique to improve Q factor of the DLC nanoresonator.

P-MEMS-068 – S-shaped double-spring structures for high stiffness and spring height

Thomas Hantschel [1], Eugene Chow [2]

[1] imec, Leuven/Belgium, [2] Palo Alto Research Center, Palo Alto/United States

Stress-engineered metal films allow the microfabrication of curved beamd which have been demonstrated for many applications. Although the beam curvature can be adjusted by the stress gradient within a wide range, the shape of the beam is basically limited to circular shapes. Therefore, we have developed a double-spring approach with an S-shape side profile. It allows for extreme spring heights and different shapes. This presentation introduces the double-spring concept and fabrication.

P-MEMS-069 – Screen-printing processing of polymer-based cantilevers with the help of an organic sacrificial layer: application to moisture detection

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In this work, screen-printing technology associated to a sacrificial layer is proposed for the fabrication of epoxy-based cantilevers. Polyester material is used as a sacrificial layer which is dissolved in acetone after the curing cycle. The fabrication steps of the screen-printed epoxy-based cantilevers are described. The cantilevers are then functionalized with agarose hydrogel for the detection of humidity, using the static deflection of this cantilever giving a sensitivity of 4.6µm/%RH.

P-MEMS-070 – Self-sustained oscillation of a piezoelectric micromechanical resonator

Ronald van Leeuwen [1], Devrez Karabacak [2], Sywert Brongersma [2], Mercedes Crego-Calama [2], Herre van der Zant [1], Warner Venstra [3]

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The fluidic energy losses have significantly hindered the wide spread adoption of M/NEMS resonators especially in sensing applications. In an effort to overcome some of these limitations, we explore the potential of Q-enhancement by operation of a microbridge resonator in a feedback loop. Here, we show that by adjusting the phase lag and the loop gain, we can bring the resonator into self-sustained oscillation, which results in an improvement of the Q-factor by one or two orders of magnitude.

P-MEMS-071 – Soft molding technique for fabrication of a ceramic micro-combustor

jitkai chin [1], Kean-how Cheah [1]

[1] University of Nottingham Malaysia Campus, Semenyih/Malaysia

A micro-combustor was fabricated with well-dispersed suspension of Al2O3 powder and PSZ preceramic resin into a lithography-prepared PDMS soft mold and sintered at 1200°C. Shrinkage of about 20% was noticed after sintering. TGA analysis on the fabricated composite reveals its good thermal stability as weight loss at 1000°C is only 1.3wt%. SEM-EDX analysis verifies the formation of Al2O3-SiO2 composite as only elements of Al, O and Si exist with a negligible amount of residual carbon.

P-MEMS-072 – The development of novel multi axis detection gyroscope using surface acoustic wave

Haekwan Oh [1]

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We propose a new multi axis gyroscope based on SAW (Surface Acoustic Wave). It consists of two SAW gyroscopes in which the bottom element is used for y-axis detection and the top element is used for x-axis detection at the same time. The sensitivity and linearity of the SAW gyroscopes with y-axis were measure to be 43.47 Hz deg-1s-1. And the sensitivity and linearity of the SAW gyroscopes and 0.837, respectively. We got meaningful result about multi axis detection using SAW gyroscope.

P-MEMS-073 – The Metallic Diaphragm for Hybrid Sturctured MEMS Pressure Sensor of Metallic Glass and (100)Si

Yasunori Saotome [1], Masashi Kobayashi [2], Akihisa Inoue [3]

[1] Tohoku University, Himeji/Japan, [2] Gunma University, z/Japan, [3] Tohoku university, Sendai/Japan

Glassy alloys are amorphous metallic materials and exhibit high strength, low elastic coefficient, large elastic strain up to 1.9% and superior corrosion resistance. They are favorable materials for thin diaphragm and enable fabrication of highly sensitive and wide ranged pressure sensor. Here glassy alloys were sputtered on Si structures and applied to fabricate a diaphragm structure for pressure sensor and the results demonstrated the advantages of glassy alloys for MEMS materials.

P-MEMS-074 – Thermoelectric micro generators manufactured using CMOS-MEMS technique

Wen-Jung Tsai [1], **Ming-Zhi Yang** [1], Ching-Liang Dai [1]

[1] National Chung Hsing University, Taichung/Taiwan

This paper presents the fabrication and characterization of thermoelectric micro generators using the CMOS (complementary metal oxide semiconductor)-MEMS (microelectromechanical system) technique. The micro generator consists of 33 thermocouples in series. Materials of thermocouples are constructed by p-type and n-type polysilicons. A post-COMS process is used to release the suspended structures of hot part in the thermocouples. Experiments show that the generator has a high output power.

P-MEMS-075 – Trench integrated cavity wafer for low-cost and flexible fabrication of 3D MEMS

Gang Zhao [1]

[1] National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba/Japan

This paper proposed a low-cost and flexible process using trench integrated cavity wafer for 3D MEMS fabrication. This method shows the advantages of less etching time and energy consumption and no specific limits for devices fabrication. Trenches were designed onto the cavity wafer, so as to prevent the device layer broken and increase the success rate of devices fabrication. This paper demonstrated that this method is a good candidate for 3D MEMS devices fabrication.

P-MEMS-076 – U-shape Bimorph Micro-Electromechanical Cantilevers with Combined Thermal/Electrostatic Actuation

Gregory Panaitov [1]

[1] Research Center Jülich, Jülich/Germany

We have developed cantilevers which use the combined thermal/electrostatic actuation and operate at low voltage supply. The new technique for fabrication of U-shape bimetal micro-cantilevers is based on Au/Nb multilayers. The technology utilises low temperature processing, which makes it compatible with the standard integrated circuit technology. In order to demonstrate the application of our devices as microwave switches the MEMS structures have been integrated into the coplanar waveguide.

P-MEMS-077 – µhotplate release and etching characterization in a CMOS compatible environment

Jordi Teva-Meroño [1], Günther Koppitsch [1]

[1] austriamicrosystems AG, Unterpremstaetten/Austria

In this paper, techniques for releasing CMOS compatible fabricated µhotplates together with a non-destructive etch-depth characterization technique are presented. The releasing technique is based on a frontside releasing approach by a combination of anisotropic and isotropic dry etching. The characterization of the etch rate and the final release of the µhotplate is done by an optical technique, which in contrast to other traditional methods is a non-destructive and fast measuring method.

P-MEMS-078 – A High-Sensitivity Accelerometer Fabricated By Producible 0.18µm CMOS MEMS Process

Sheng-Hsiang Tseng [1]

[1] National Applied Research Laboratories, Hsinchu/Taiwan

The resonant frequency of our CMOS MEMS accelerometer is designed as 4.6 kHz and the sensitivity of the capacitance is simulated as 2.2 fF/G by CoventorWare. The total gain of the amplifier is 117 mV/fF and power consumption is about 1 mW. The whole chip size is 1.1 x 0.9 mm2. The accelerometer is measured by a shaker with 100 Hz sinusoidal excitation from 1 G to 8 G. The measured sensitivity is 258 mV/G and the non-linearity of accelerometer is 2.7%. The output noise floor is 2.5 mG/rtHz.

P-MEMS-079 – A TSV Membrane Reinforcement to Improve Mechanical Durability

Günther Koppitsch [1]

[1] austriamicrosystems AG, Unterpremstätten/Austria

Combined CMOS-Sensor applications utilise TSVs to set up electrical connections between back- and frontside of the IC. With this work the IC is approached from the backside by an open TSV. Launched from the back, the deep silicon etch will stop on the IC's stack of layer of dielectrics and metallisations. These layer may pose a delicate membrane. Finite element simulations show, that a reinforcement structure, which is built into the CMOS IC will add mechanical stability.

P-MEMS-080 – An Integrated Resistance Welding and TSV Process for Microsystems Packaging

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This paper proposes a novel wafer level packaging for integrated circuits (IC) and micro-electromechanical system (MEMS) devices. In this method, two wafers were bounded by resistance welding with simultaneously through-silicon-via (TSV) connection and cavity sealing.

P-MEMS-081 – Chemically etched conical microlens for manipulating and isolating biological cells without physical contact

Kozo Taguchi [1]

[1] Ritsumeikan University, Kusatsu/Japan

In this paper a novel tapered single fiber optic tweezers was proposed: this system is simpler and more flexible than conventional optical tweezers. From experimental results, it was found that our proposed method was a promising tool for the isolation of microorganisms which cannot be obtained in pure culture by conventional methods.

P-MEMS-082 – Common-path Fourier domain optical coherence tomography with a conical-tip fiber

Kozo Taguchi [1], **Kozo Taguchi** [1]

[1] Ritsumeikan University, Kusatsu/Japan

In this paper, we propose a high lateral resolution common-path Fourier domain OCT system with the use of a chemically etched single mode fiber in the sample arm of the fiber based OCT setup. This approach permits high lateral resolution without adversely affecting depth of focus. From experimental results, we verified that the apex angle of the chemically etched single mode fiber tip was very important parameter for generating high-resolution OCT images.

P-MEMS-083 – Concept for Performance-Enhancement of Ultra-Precision Dicing for Bulk Hard and Brittle Materials in Micro Applications by Laser Dressing

Manuel Stompe [1], Philipp von Witzendorff [1]

[1] Institute for Micro Production Technology, Garbsen/Germany

Due to their specific chemical and physical properties, advanced ceramics offer new fields of applications. A major challenge for industrial implementation is the machining ability of silicon-carbide. The conventional contact dressing (truing and conditioning) requires time consuming setup times. For enhancing the dicing process of bulk hard and brittle materials, inline laser dressing with picosecond laser pulses was investigated.

P-MEMS-084 – Design and simulation of a dielectric field capacitive transducer

Amir Heidari [1]

[1] Nanyang Technological University, Singapore/Singapore

In this work, a dielectric field capacitive transducer is designed. The Q-factor of the resonator is simulated in CoventorWare. Air damping, anchor loss damping and intrinsic damping of single crystal silicon (thermo-elastic dissipation (TED)) are considered as the main dominant damping mechanisms. The designed resonator shows low motional resistance and high Q-factor which is promising for many wireless and sensing applications.

P-MEMS-085 – Development and characterization of a needle-type microelectrode array for stimulation and recording of neuronal activity

Sebastian Roehler [1], Jochen Held [1], Wilfried Nisch [1], Dieter Kern [2], Claus Burkhardt [1], Alfred Stett [1]

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We developed processes to fabricate arrays with needle-type microelectrodes on any substrate for recording and stimulating nerve cell activity inside of neuronal tissue. The height of a microneedle amounts to 50 µm. A typical value for the base diameter is 20 µm and a few microns for the tip radius. The microneedles are investigated in a combined focused ion beam and scanning electron microscope.

P-MEMS-086 – Development of hybrid LED package system having micro optical pattern based on micro machining technology and Taguchi method

Eun-chae Jeon [1], Jun-Ho Jeon [1], Tae-Jin Je [1], Sunghwan Chang [1], Doo-Sun Choi [1], Sang-Kyu Choi [1]

[1] Korea Institute of Machinery and Materials, Daejeon/Republic of Korea

Hybrid LED package system can increase optical efficiency by its integrated micro optical pattern. The optimization of the shape of the micro pattern was performed using Taguchi method, and a micro stamp was machined for manufacturing the micro pattern in this study. The micro pattern was proved to increase optical efficiency about 30%, and the micro stamp having square pyramidal pattern of 20um height was machined successfully.

P-MEMS-087 – Drug-delivery check-valve built using a novel PDMS ferrogel

Jasmina Casals [1]

[1] Technical University of Catalonia, Terrassa/Spain

A micromachined magnetic PDMS microvalve is built using a magnetic ferrogel. Coupling the elastic properties of PDMS with the magnetic properties of a ferrofluid in a composite material (ferrogel) provides an ideal approach to achieve magnetization and therefore a portable device. Several initial prototypes have been micro-machined using a combination of soft-lithography conventional machining. Prototypes are tested demonstrating the proper functionality as active controller and check valve.

P-MEMS-088 – Fabrication of high aspect ratio SU-8 micropillars arrays

Letizia Amato [1]

[1] Technical University of Denmark, Lyngby/Denmark

The processing optimization of dense arrays (2,5µm pitch) of SU-8 micropillars with nominal height 22µm and nominal Ø 2,5µm (aspect ratio=9) is described. For the pillar fabrication, we compare 2 methods having time and temperatures (T) during the baking steps as variables. We demonstrate that performing the baking steps at low T for long time is essential for the fabrication of high aspect ratio structures with dimensions close to the resolution limit of the UV photolithography.

P-MEMS-089 – Fabrication process development for a high sensitive electrochemical IDA sensor

Stefan Partel [1], Peter Hudek [2], Markus Mayer [1], Can Dincer [1], Jochen Kieninger [1], Kristian Motzek [3], Gerald Urban [1]

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We present recent results of the development and the fabrication process of an electrochemical sensor with high sensitivity. The sensor is based on an enzyme-linked immunosorbent assay. The lithography process steps were optimized by simulation. Photoresist characteristics were determined using a dissolution rate monitor. The final sensor was tested and an amplification factor of more than 10 was measured in a flow cell.

P-MEMS-090 – GHz-blanker for creating sub-picosecond electron beam pulses

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[1] TUDelft, Delft/Netherlands, [2] Delft University of Technology, Delft/Netherlands

In this abstract we describe the design and fabrication of an electron beam blanker to be installed in a standard SEM giving a sub-picosecond pulse time at a frequency of ~ 15 GHz. When synchronized with a pulsed femtosecond laser ultrafast diffraction can be performed. Here atomic spatial resolution (Å) and femtosecond temporal resolution would allow us to study atomic motion in real time.

P-MEMS-091 – High speed quasi-monolithic Silicon/Piezostack SPM scanning stage

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[1] TU Ilmenau, MNES, Ilmenau/Germany, [2] Ilmenau, University of Technology, Ilmenau/Germany

We developed a new scanner design based on compact stack piezos which allows the construction of a scanner with 10 µm scan range at high frequencies(>5kHz). We used high quality linear piezo stacks as actuators which are coupled together to form a 2D scanner by stiff Silicon flexures. The scanner is also equipped with into Silicon-crystal strain gauge sensors. Moreover, the use of piezoresistive cantilever with integrated actuator provides the best solution to realize high speed noncontact-AFM.

P-MEMS-092 – Injection molded polymer chip for electrochemical and electrophysiological recordings from single cells

Simone Tanzi [1], **Simon Tylsgaard Larsen** [2], Rafael Taboryski [3]

[1] Nanotech DTU, Kgs. Lyngby/Denmark, [2] Technical University of Denmark, Kgs. Lyngby/Denmark, [3] Technical University of Denmark, Lyngby/Denmark

We present a novel method to fabricate an all in polymer injection molded chip for electrochemical cell recordings and lateral cell trapping. The complete device is molded in thermoplastic polymer and it results from assembling two halves. We tested spin-coated conductive polymer poly(3,4-ethylenedioxythiopene) and showed that it can be used as an electrode material for detecting neurotransmitters electrochemically in biosensors.

P-MEMS-093 – Investigation on the Leakage Current Analysis Using a Generation Life Time in Heavily doped Gated-Diodes with Sub 3nm EOT

Sanghyeon Jeon [1], Taehong Ha [2], Youngwoo Kim [2], Bocheol Jung [2], Sangyeon Han [2], Taewoo Lee [2], Soocheol Lee [2], Donggun Park [2], Yonghan Roh [3]

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In this paper, we demonstrated that a generation lifetime and surface generation velocity can be utilized to acquire more information of junction leakage current of DRAM peripheral transistors with below 3nm of the equivalent oxide thickness (EOT) and 100nm of channel length. We found that the generation life time method is effective to describe detailed analysis of surface and space-charge region (SCR) under gate only if a depletion width can be calculated precisely.

P-MEMS-094 – Micro Flow Sensor for Detection of Thrombus Formation in Fine Blood Vessels

Eiji Makino [1], Yusuke Sano [1], Kenichi Watanabe [1], Takashi Mineta [2], Takahiro Kawashima [3], Takayuki Shibata [3]

[1] Hirosaki University, Hirosaki/Japan, [2] Yamagata University, Yonezawa/Japan, [3] Toyohashi University of Technology, Toyohashi/Japan

In order to detect formation of thrombus in a fine blood vessel, we developed a thermal type micro flow sensor. It had high detection sensitivity for changes of flow rate at less than 20mm/s, indicating possibilities for detection of thrombus formation. By connecting the sensor with a thread of a surgical needle, the integrated sensor was introduced easily into the fine blood vessel and aligned easily at the center of the vessel.

P-MEMS-095 – Micro-structured Surfaces for Enhanced Heat Transfer

Jacob Ask Hansen [1]

[1] The Danish Technological Institute, Aarhus C/Denmark

Development of surfaces exhibiting very high efficiencies in boiling heat transfer is of ever increasing interest to the heat exchanger industry, as increasing demands for energy efficient heat exchangers are put forth. In this study, we look at both the effects of surface energy and micro/nano structure on the surfaces in order to optimize heat transfer in boiling CO2.

P-MEMS-096 – Microfabrication of magnetically actuated PDMS-Iron composite membranes

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We report on the preparation of nanocomposite membranes of different diameters (from 1 mm up to 10 mm) consisting of 20% carbon coated iron powder uniformly dispersed in a PDMS matrix. We investigate the photolithographic process followed for the release of the free-standing nanocomposite membrane. Preliminary results show that a deflection of 120 µm induced by a 500 mT external magnetic field is obtained on a membrane with a diameter of 10 mm.

P-MEMS-097 – Nano photoelectron ioniser chip using LaB6 for ambient pressure trace gas detection

Cordula Zimmer [1], Michael Kieschniek [1], Klaus Kallis [2], Jürgen Schubert [3], Ulrich Kunze [1], Theodor Doll [1]

[1] Ruhr-Universität Bochum, Dortmund/Germany, [2] TU Dortmund, Dortmund/Germany, [3] Forschungszentrum Jülich, Jülich/Germany

In this work an alternative detector to the commercial available photo ionisation detector (PID) is presented reducing the main disadvantage of a PID – the UV source aging by radiation damage. The alternative is working with a low-energy UV LED, which generates photoelectrons performing the ionisation of gaseous substances instead of photons. This is realised by a photoelectron ioniser chip, whose manufacture, emission and ionisation behaviour is explained here in detail.

P-MEMS-098 – Organic Half-Wave Rectifier Fabricated by Stencil Lithography on Flexible Substrate

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[1] Ecole Polytechnique Federale de Lausanne, Lausanne/Switzerland, [2] EPFL, Lausanne/Switzerland, [3] EPFL/Nanolab, Lausanne/Switzerland

The motivation behind this work is to demonstrate the feasibility of fabrication method combining classic and stencil lithography for producing simple organic rectifying circuits for use in radio frequency range. This rectifier is made of one organic Schottky diode, followed by a MIM (Metal-Insulator-Metal) capacitor, integrated on the same flexible substrate. The devices are fabricated on a flexible polyimide foil by two aligned levels of stencil lithography using ALD deposited high-k HfO2.

P-MEMS-099 – Process development for high precision metal patterning on low Tg polymer substrates

Zhaohong Huang [1]

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A novel photolithography process with infrared (IR) radiation pre-baking for high precision metal patterning on low Tg polymer substrates was developed. In this process, the conventional pre-baking methods through contact (e.g., hot plate) and/or convection (e.g., oven) are replaced by IR radiation. After process optimization, critical metal features smaller than 10 µm were successfully achieved on PC and PMMA substrates.

P-MEMS-100 – Properties of an electro-sprayed transparent electrode with a meshed silver pattern

Taik-Min Lee [1], Jae-Ho Noh [1], Sun-Woo Kwak [1], Bongmin Kim [1], Jeongdai Jo [1], Inyoung Kim [2]

[1] Korea Institute of Machinery and Material, Daejeon/Republic of Korea, [2] Korea Institute of Machinery and Materials (KIMM), Daejeon/Republic of Korea

The transparent electrode with the transparency of 82.2 % and sheet resistance of less than 10 ohm/square was obtained. The electro-spray coating method was utilized to coat PEDOT:PSS onto a hydrophobic substrate. As the printing method, gravure offset printing was examined for printing the silver meshes. We expect that the quality of the transparent electrode will be maximized by finding the more optimized electro-spray coating and printing meshes with the finer line-width

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P-MEMS-101 – Reflected Surface Acoustic Wave Actuator Using Micro Groove

Tsunemasa Saiki [1]

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Surface acoustic wave (SAW) devices with very simple structures have attracted attention in a lab-on-a-chip. If not only liquid but also powder can be transported by the SAW actuators, it is expected to expand in application. We thus proposed and fabricated a novel SAW actuator using a reflection wave from a micro groove, and evaluated its ability to move powder. The powder movement using the reflected SAWs can be controlled by adjusting the inclination angle and depth of the micro groove.

P-MEMS-102 – Resistive humidity microsensor with circuit manufactured by the CMOS process

Ming-Zhi Yang [1], Ching-Liang Dai [1], Wei-Yi Lin [1]

[1] National Chung Hsing University, Taichung/Taiwan

The fabrication of a resistive humidity microsensor integrated with sensing circuit on-a-chip using the complimentary-metal-oxide-semiconductor process was investigated. The sensor chip area is about 2 mm2. The sensing film is polyaniline/polyvinyl alcohol synthesized by the sol-gel method. The sensing circuit is used to convert the resistance variation of the sensor into the voltage output. Experiments showed that sensitivity of the sensor was about 10 mV/% RH at 25 C.

P-MEMS-103 – Selectivity control in cyclic selective epitaxial growth of silicon using batch-type

Kong-Soo Lee [1]

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Recently, cyclic SEG at lower temperature than 800Λhas been focused intensively in semiconductor industry. In spite of the reduced number of stacking faults and micro-twins with batch-type SEG, micro-voids had been observed at the interface between heavily-doped substrate and SEG-Si layer. In this study, the origin of micro-voids is exploited by the speculation of selectivity window of batch-type SEG-Si process on heavily doped silicon substrate.

P-MEMS-104 – Silicon to Silicon Tester Temperature Sensor Chip Technology

Gunter Engelmann [1]

[1] Fraunhofer IZM, Berlin/Germany

In order to characterise the thermal interface materials (TIM), a test stand has been fabricated, which allows localised measurement of thermal current and temperature measurement as close as possible to this interface material. Thin film heaters and sensors are realised on the surfaces of both sides of two silicon chips, allowing a maximum possible temperature drop across the sandwiched TIM under test thus achieving maximum resolution. The chips are solder- and wire-bonded to a ceramic frame.

P-MEMS-105 – Simple manufacturing of micro-sized Au thin film based Mercury sensor

Milija Sarajlic [1]

[1] IHTM, Belgrade/Serbia and Montenegro

Motivation for Mercury sensor development regarding Environmental Protection. Manufacturing details of the Au thin film based sensor. Advantages comparable to the authors previously fabricating the same device. Full measurement cycle including detection and sensor restoration. Graphical and photo representation of the sensor surface and device bonded on housing. Basics of the gas adsorption modeling by Langmuir theory.

P-MEMS-106 – Simulation and experimental investigation of a novel electrostatic microgripper system

Mohsen Hamedi [1], Parisa Salimi [1], Milad Vismeh [1]

[1] University of Tehran, Tehran/Islamic Republic of Iran

Micro-tools for handling and assembling of microparts in manufacturing MEMS is an active area of research. Multi-part gripping of microparts is one of the least investigated subjects in the published literature. In this paper an electrostatic microgripping system that can grip two parts is designed, analytically simulated, fabricated and characterized. In testing the performance, a low activation voltage of 80 volts generated a desirable 40 micrometer displacement of microgripper.

P-MEMS-107 – Stress mapping on the porous silicon microcapsules by Raman microscopy

Valentinas Snitka [1], Denys Naumenko [1], Raul Rodriguez [1], Marta Duch [2], Jaume Esteve [3]

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The aim of this work was to study 3D stress and compositional mapping of crystalline, amorphous and polysilicon regions distributions in Si microcapsules fabricated on Si wafers. Three dimensional (3D) stress distributions in Si as a result of polysilicon porous particle formation are non-destructively characterized and stress contour maps generated at different depths using a nano-positioning actuator of XYZ scanning stage of micro-Raman spectroscopy system.

P-MEMS-108 – Towards Micro Solid Oxide Fuel Cells for Mobile Applications

Kristian Andresen [1], Yunzhong Chen [2], Nini Pryds [2], Rafael Josef Taboryski [3]

[1] DTU Nanotech, Kgs. Lyngby/Denmark, [2] Risø DTU, Roskilde/Denmark, [3] DTU Nanotech, Kongens Lyngby/Denmark

For a μ-SOFC battery replacement, thermal management during heating and cooling cycles presents a challenge. On a silicon platform, there is a mismatch between expansion coefficients. We present comparisons between optical profilometer measurements of deformations during heating with COMSOL models of the same system, which provide stress information. We also present results for impedance measurements in different axial directions for CGO crystal layers deposited at different temperatures.

P-MEMS-109 – Ultra-thin ALD-coating on PMMA resist-pattern

Robert Haehle [1], Uwe Huebner [2], Andreas Ihring [1], Ludwig Fritzsch [1], Hans-Georg Meyer [1]

[1] Institute of Photonic Technology, Jena/Germany, [2] IPHT Jena, Jena/Germany

We investigated ultra-thin, highly conformal and homogenous layers deposited by atomic layer deposition (ALD) for the passivation of patterned PMMA layers. The applications of such structure range from planar nano-tubes, integrated cantilever structures to passivation of resist as function layer. The most important advantages of ALD-films are the defectless layer structure, the highly mechanical stability and the capability to deposit layers with a well-defined thickness.

P-MEMS-110 – Ultrathin ALD ZnO film based SAW device for gas sensing

Denys Naumenko [1], Valentinas Snitka [1], Iuliia Naumenko [1], Kestas Grigoras [2]

[1] RC for Microsystems and Nanotechnology, Kaunas University of Technology, Kaunas/Lithuania, [2] Aalto University School of Science and Technology, Espoo/Finland

We have investigated the influence of atomic layer deposition (ALD) reaction temperature and number of reaction cycles on optical and electrical properties of ZnO films and have preliminary shown the application of ultrathin ALD ZnO layer in gas sensitive SAW devices. The ZnO(8nm)/LiNbO3 SAW devices demonstrates -8dB losses for 54 MHz frequency, as measured at the room temperature in air. The estimate of the sensitivity of fabricated device to ethanol vapour gives the value of 2 Hz/ppm.

P-MEMS-111 – Versatile motherboard enabling substrate independent plug & play microfluidics

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This article presents a versatile modular motherboard, which provides compatibility with all types of substrates and streamlines the efforts with respect to establishing multiple fluidic and electrical interconnections.This rapid, inexpensive, flexible, reliable interconnection strategy will enable faster development of microfluidic devices and lead to efforts in testing complex microfluidic device combinations not possible earlier due to substrate incompatibility.

P-MEMS-112 – Wetting of micro-patterned surfaces

Rafael Taboryski [1], Simon Tylsgaard Larsen [2], Lene Westergaard Sørensen [2], Nis Korsgaard Andersen [2]

[1] Technical University of Denmark, Lyngby/Denmark, [2] Technical University of Denmark, Kgs. Lyngby/Denmark

Surfaces with self cleaning properties, known from the Lotus leaves, can be engineered by making surface structures on the micro- and nanoscale. We demonstrate how the different wetting regimes can be mapped by varying only two lateral geometrical parameters, and the overall surface chemistry. The surfaces were made by microlithography, to form superhydrophobic surfaces or surfaces that induce faceted droplets. Further we present contact angle and slide off angle data for fabricated surfaces

5. Life Sciences

5.1 Micro- & Nanofluidics

P-LIFE-001 – A new technique for ferroelectric microfluidic channels by rolling method

Jinxing Li [1], ran Liu [1]

[1] Fudan University, Shanghai/China

Transparent microfluidic channels have been fabricated by a rolled-up method with large diameter-to-length aspect ratios. The fluid flows in the microchannels can be clearly visualized under an optical microscope. Significantly, we have successfully integrated a poly(VDF-TrFE) ferroelectric polymer in the microchannel by the rolled-up technology. The polymer inside the channels provide a unique opportunity for applications in protein analysis, cell encapsulation, drug delivery, and biosensors.

P-LIFE-002 – A novel volumetric silicon micropump with integrated sensors

Olivier Fuchs [1]

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We present a novel peristaltic micropump based on piezoelectric actuation and active valves that combines high fluidic performances of a volumetric pump and the integration of sensors. The latter are localized directly on the membranes that consequently are used for pumping as well as for sensing. The fabrication process was adapted in order to integrate photolithography and etching steps on the membranes themselves.

P-LIFE-003 – An insulator-based dielectrophoretic microdevice for simultaneous filtration and focusing of biological cells

Wei-Fu Chen [1], **Chun-Ping Jen** [1]

[1] Department of Mechanical Engineering, National Chung Cheng University, Chia-Yi/Taiwan

Manipulating and discriminating biological cells of interest are currently emphasized in the microfluidic and microTAS due to its potential applications in clinical diagnosis and medicine. Moreover, cellular focusing in microfluidic devices is a prerequisite for medical applications, such as cell sorting, counting or flow cytometry. This work demonstrated the feasibility of simultaneous filtration and focusing cells in the propose microdevice.

P-LIFE-004 – Bringing biological content into Biosensor and Biochip systems: Scaling of multiplexed diagnostic test production using ultra-low liquid volume dispensing

Katrin Welzel [1]

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Miniaturized test formats for multiplexed testing can look very different. Either landing marks or complete areas have to be loaded with biological molecules and the active surfaces can vary from silicone and glass to polymers and metals. Non contact delivery of biological molecules onto these substrates keeps the surface coatings intact and is compatible with electronic (e.g. amperometric, voltage metering) optical and mechanical detection (e.g. cantilevers).

P-LIFE-005 – Condensation of Fluorescent Nanoparticles by DEP Chip with Dot-electrode Array

Yao-Wei Huang [1], **Cheng-Hsin Chuang** [1]

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A microfluidic device with a vertical non-uniform electric field constructed by top and bottom electrode array has been developed for programmable condensation of fluorescent-NPs. In comparison with planar electrodes in the conventional DEP chip, NPs can be successfully trapped on the surface of dot-electrode array by positive DEP force and each electrode can be individually controlled by computer-based program for the controlled experiments in biomedical sensing.

P-LIFE-006 – Design of a disposable hydro-focusing device for individual blood platelet counting

Joris van Leerdam [1], **Giuseppe Melpignano** [2], David Vles [2]

[1] TU/e, Eindhoven/Netherlands, [2] Technical University Eindhoven, Eindhoven/Netherlands

The design of a disposable two-dimensional hydrofocussing device is presented for counting of individual blood platelets. Due to single layer design, a 2.5D machining process can be used for fabrication. Due to the specific geometry, particles will be alligned by hydrofocusing. Counting will be done with an impedance method. Horizontal focusing has been demonstrated. Future work will investigate the vertical focusing with a holographic microscope and investigate the impedance counting technique.

P-LIFE-007 – Detection of triazine herbicides on a capillary electrophoresis microchip

Kamrul Islam [1], Rohit Chand [2], Dawoon Han [1], Sandeep Kumar Jha [1], Yong-Sang Kim [3]

[1] Myongji University, Yongin/Republic of Korea, [2] Dept. of Nano Science and Engineering, Myongji University, Yongin, Gyeonggi/Republic of Korea, [3] Myongji University, Gyeonggi/Republic of Korea

We report an application of CE-AD on a microfluidic chip to detect and separate two triazines: simazine and atrazine. Microfluidic chip was fabricated using standard photolithography. Cyclic voltammetry was conducted which exhibits a characteristic cathodic peak at -0.70V. The electropherogram of simazine and atrazine showed clear single peaks at 59 and 65 seconds of migration time respectively. And the mixer showed separated peaks 55 and 67 seconds respectively.

P-LIFE-008 – Development of a conductivity microsensor considering electric double layer capacity

Jiβ Janouš [1]

[1] Institute of Chemical Technology Prague, Prague/Czech Republic

Formation of the electric double layer and the impact of its capacity on the conductivity measurement is discussed; followed by the description of the sensor development and its specifics. Different approach to the conductivity measurement is suggested, by taking advantage from the additional information contained in the sensor capacity.

P-LIFE-009 – Evaluation of thermal bonding of PMMA microsystems

Artur Dybko [1]

[1] Warsaw University of Technology, Warsaw/Poland

The aim of the work is to present some details on the technology for the preparation of PMMA microsystems. The microchannels were prepared by a precision micromilling machine and then bonded thermally. We have examined the roughness (using a laser confocal scanning microscope) and the deformation (using a microtomograph) of the microchannel after thermal processing.

P-LIFE-010 – Fabrication of large-scale, dense , smooth and vertical sidewalls silicon mould and its application in making SU-8 nanochannels

Xiaojun Li [1]

[1] University of Science and Technology of China, hefei/China

A new method for fabrication large-scale, dense, smooth and vertical sidewalls silicon mould using holographic method combined with wet anisotropic etching . Holographic method can make narrow, dense and multiple continuous lines over centimeter lengths and wet anisotropic etching can Eliminate line-edge-roughness and make the line nearly atomic-scale smoothness. Large-scale, dense and smooth nanochannels will be formed after imprint by silicon mould and an optimized bonding process.

P-LIFE-011 – Fabrication of Size-controllable Micro and NanoChannels by Reversal Thermal Bonding

Liangjin Ge [1]

[1] University of Science and Technology of China, Hefei/China

In this paper, we propose a new method, called reversal thermal bonding (RTB), for the enclosure of the large-area channel by thermal bonding at low pressure using a released polymeric structure layer directly bonded to the bonding substrate. The channel dimension could be well controlled by varying initial polymer layer thickness and polymeric structure configuration.

P-LIFE-012 – Fabrication of size-controllable nanofluidic channels using angled physical vapor deposition

Xiaojun Li [1]

[1] University of Science and Technology of China, hefei/China

This work aims to develop a new approach to achieve nanochannels with well-controlled dimensions in large area by using a combined NIL and angled physical vapor deposition (PVD). The advantage of this process is that the line width can be adjustable simply by controlling the deposition as well as the imprint depth, offering an alternative solution for high-resolution, low-cost, and high-throughput fabrication of nanofluidic channels.

P-LIFE-013 – Gauging contact line friction of droplet shape oscillations by interferometry – In-situ measurement applicable to digital lab-on-a-chips

Johannes Theisen [1], Laurent Davoust [2]

[1] Grenoble-INP / LEGI, Grenoble cedex 9/France, [2] Grenoble-INP / SIMAP-EPM, St Martin d'Hères/France

Here is presented an interferometry technique to quantify damping of electrowetting-induced shape oscillations of a sessile micro-drop. This characterisation method and its devoted chip can be inserted into a microsystem to quantify contact line friction and hence surface ageing in digital electro-wetting applications (lab-on-chips, microfluidic lenses and displays). Here, the contact line friction is proposed as a criteria to distinguish sensor surfaces contaminated by adsorbed bio-molecules.

P-LIFE-014 – Inkjet-printed nanosilver lines on glass substrates with different surface wettabilities

Dong Jun Lee [1], **Je Hoon Oh** [1]

[1] Hanyang University, Ansan, Gyeonggi-do/Republic of Korea

We investigated how the different surface chemical and physical properties affect the inkjet-printed line shape and bulge formation. Two surfaces with the same droplet spreading but different surface characteristics were also prepared and compared in a systematic way. In addition, the effects of printing method, substrate temperature and overprinting on shapes and morphologies of inkjet-printed lines were examined to fabricate well-shaped, relatively thick conductive lines without line bulges.

P-LIFE-015 – Integrated PMMA/Tobacco Mosaic Virus Structures for Nanofluidics

Jose Maria Alonso [1]

[1] CIC-nanoGUNE, Donostia – San Sebastián/Spain

The properties of fluids and flow processes at the nanoscale, especially below 30 nm, are largely unknown. Tobacco mosaic virus (TMV) is a 300 nm long, 20 nm width tube-shaped nanoobject with 4 nm inner diameter, which can be used as a tool to study fluidic processes. We integrated single TMVs in micro- and nanofluidic devices with the aid of electron beam lithography and conducted dynamic fluidic experiments by nanodispensing (NADIS) and environmental SEM (eSEM)

P-LIFE-016 – Interface probing of a Ca(HCO3)2 droplet evaporating on ultrahydrophobic nanostructured surfaces: an in-situ biomineralization process study

Angelo Accardo [1], Manfred Burghammer [1], Francesco Gentile [2], Michael Reynolds [1], Emauela Di Cola [1], Enzo Di Fabrizio [2], Christian Riekel [1]

[1] ESRF, Grenoble/France, [2] IIT, Genova/Italy

SAXS/WAXS (Small and Wide Angle X-ray Scattering) techniques are a powerful tool for revealing phases involved in calcium carbonate precipitation. Furthermore the nanostructured ultrahydrophobic surfaces we are proposing here provide a quasi-contact free environment characterized by homogeneous evaporation rate. CaCO3 was precipitated from Ca(HCO3)2 solution and local information on an ACC layer and individual submicron-size calcite crystallites has been obtained for the first time in-situ.

P-LIFE-017 – Magnetic properties of disoriented and oriented Single Wall Carbon Nanotubes (SWNTs)

Arisbel Cerpa Naranjo [1]

[1] UNIVERSIDAD EUROPEA DE MADRID, Madrid/Spain

In this work we present the magnetic hysteresis loops obtained from disoriented and oriented Single Wall Carbon Nanotubes (SWNTs). Also, we have analyzed the influence of orientation angles in the magnetic susceptibility in the oriented SWNTs.

P-LIFE-018 – Nanowire Position and Orientation Control Using Electro-Osmotic Flow

Pramod Mathai [1], Peter Carmichael [1], Gregg Gallatin [1], Andrew Berglund [1], Benjamin Shapiro [2], **J. Alexander Liddle** [1]

[1] NIST Center for Nanoscale Science and Technology, Gaithersburg, MD/United States, [2] University of Maryland, College Park/United States

Position and orientation of individual nanowires is controlled by manipulating the local fluid flow around the object by using electro-osmosis. Feedback is established by using a CCD camera to capture the nanowire position and orientation.

P-LIFE-019 – New selective plasma treatment solution for streamlining MEMS manufacturing processes

Ulrike Schömbs [1]

[1] SUSS MicroTec, Garching/Germany

The abstract describes a newly developed method to selectively plasma activate wafers and substrates to streamline MEMS manufacturing processes

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P-LIFE-020 – Optimization of the Laser Ablation Process of Soda-lime Glass for the Definition of Deep Microfluidic Channels

Ainara Rodriguez [1], Alexander Arriola [2], Txaber Tavera [2], Noemi Perez [2], Santiago M. Olaizola [2]

[1] CIC-Microgune, San Sebastian/Spain, [2] CEIT and Tecnun, San Sebastian/Spain

Laser micromachining has progressed considerably for the fabrication of glass microfluidic devices. Several groups have studied the laser ablation properties of glasses and have reported a cumulative effect that results in a decrement of the ablation threshold. However, from the fabrication point of view, a constant ablation rate is needed. We present a study of the ablation rate of soda-lime glass as a function of the overlapped pulses to determine the conditions for a constant ablation rate.

P-LIFE-021 – Propose a preparation chip for 3D lab-on-a-CD

hiroki nose [1]

[1] Laboratory of Advanced Science and Technology for Industry, University of Hyogo, hyogo-ken,tatuno-shi/Japan

The lab-on-a-CD is promising for the automation of multiple microreactor systems. The extraction of plasma from whole blood is the first preparative step in many assay protocols and major importance in medical diagnosis . We present a chip for the extraction of blood plasma from whole blood using centrifugal force of spin and capillary force. We expect that this chip can be overall assay with high-efficiency and significantly shorten the analysis time by integrate our proposed 3D lab-on-a-CD.

P-LIFE-022 – Selective concentrating cervical carcinoma cells from peripheral blood utilizing dielectrophoresis in stepping electric fields

Kuang-Hung Chen [1], Ho-Hsien Chang [1], **Chun-Ping Jen** [1]

[1] Department of Mechanical Engineering, National Chung Cheng University, Chia-Yi/Taiwan

Many existing dielectrophoretic approaches for the isolation and characterization of CTCs require large equipment; therefore, the development of portable point-of-care (POC) devices for medical diagnostics and analysis is needed. A handheld device with a dielectrophoretic cellular microchip with circular microelectrodes for the rapid selectively concentrating cervical carcinoma cells from peripheral blood is proposed in the present study.

P-LIFE-023 – Study on Surface Texturing of Microfluidic Channel Devices by an Ultra-fast Laser

Tien-Li Chang [1], Ting-Kai Tsai [1]

[1] National Taiwan Normal University, Taipei/Taiwan

Nowadays, a micro total analysis system (μ-TAS), which integrates sample pretreatment, transportation, separation, reaction and detection on a small chip. Different from convectional micromachining technologies, an ultra-fast laser (<10 ps) is very promising for fabricating microstructures. This study presents the surface texturing of microfluidic glass device by using an ultra-fast laser process.

P-LIFE-024 – Testing fungal thigmotropism with combinatorial microfluidic networks

Radu Mocanasu [1], **Dan Nicolau** [1]

[1] University of Liverpool, Liverpool/United Kingdom

Filamentous fungi have been shown to respond actively to physically heterogeneous environments, navigating micro-confined structures in a parallel-'computing' fashion. Because these contact-stimulated responses are still poorly understood, we designed a combinatorial microfluidics channel network with the aim to examine fungal thigmotropisms. The response of the fungus to the individual shapes should enable the identification of the rules of fungal partition of space through micro-confinement.

P-LIFE-025 – Actin Motility Confinement on Micro/Nanostructured Surfaces

Jenny Aveyard [1]

[1] Liverpool University, Liverpool/United Kingdom

Motility assays are solution-based assays that are used to observe molecular motors such as myosin and kinesin outside of the cell environment. Microfabricated lines with z-nanoscale heights were functionalized to allow attachment of heavy meromyosin (HMM). The motility of fluorescently labeled actin filaments was then monitored to determine if the structured surfaces could 1) support motility 2) contain the filament and 3) control the directionality of the filaments during a motility assay.

P-LIFE-026 – A Magnetic Bead Based Micro-Actuator for Manipulation of Cells in Low-Concentration Immunoassays

Chinthaka Gooneratne [1], Cai Liang [1], Ioanna Giouroudi [1], Jurgen Kosel [1]

[1] KAUST, Thuwal/Saudi Arabia

In this research we propose a micro-chip that includes a unique magnetic micro-actuator to manipulate target cells in low-concentration immunoassays using superparamagnetic beads in the absence of a fluid flow. Superparamagnetic beads are used in order to label the target cells. The magnetic micro-actuator is employed as an external magnetic field generator so as to separate target cells as well as to transport them.

P-LIFE-027 – A Rapid and Portable Sensor Based on Protein-Modified Gold Nanoparticle Probes and Lateral Flow Assay for Naked Eye Detection of Mercury Ion

Fu-Hsiang Ko [1]

[1] NATIONAL CHIAO TUNG UNIVERSITY, HSINCHU/Taiwan

We develop a rapid and portable sensor based on protein-modified gold nanoparticle probes and lateral flow assay for naked eye detection of mercury Ion. This disposable sensor thus provides a low-cost, convenient, rapid, sensitive, and quantitative tool for the detection of contaminated samples. As the AuNP probes migrated through the device, the test line and control line of the sensor produced the characteristic red bands, enabling visual discrimination of mercury ion concentrations.

P-LIFE-028 – Advanced deep reactive-ion etching (DRIE) technology for hollow microneedles for transdermal blood sampling and drug delivery

Yufei Liu [1], Pey Fen Eng [2], Owen James Guy [2], Kerry Roberts [3], Huma Ashraf [3], Nick Knight [3]

[1] Swansea University, SWANSEA/United Kingdom, [2] Swansea University, Swansea/United Kingdom, [3] SPP Process Technology Systems Limited, Newport/United Kingdom

Hollow microneedles with 1mm deep bore in inner diameter of 0.05mm were achieved. SPTS Pegasus was selected for two-stage DRIE process. Narrow bores and needle shapes were etched as hollow-etch and cavity-etch steps. Exposed area (cavity etch step) was over 70% (high load). Data is presented to study relationship between etch-rate, etch depth uniformity and wafer–source separation for Pegasus system. Uniform etch depth control to maintain functional devices across wafers has been achieved.

P-LIFE-029 – Bio-hybrid tactile sensor for the study of the role of mechanoreceptors in human tactile perception

David Cheneler [1], Mike Ward [1], Carl Anthony [1]

[1] The University of Birmingam, Birmingham/United Kingdom

Human tactile perception is a complex multi-scale interaction between physical and biological phenomena whereby external conditions such as texture, shape and movement of surrounding objects evoke changes in the response of the cells within human skin. Here we present a silicon-based bio-hybrid tactile sensor with integrated microfluidics capable of the real-time monitoring of the response of different mammalian cell types to the application of well defined normal and tangential loads.

P-LIFE-030 – Design and analysis of electrostatically actuated 3-axes microcantilevers for cellular delivery and surgery

Arunava Banerjee [1], Richard J. Blaikie [1], Xinyu Liu [2], Wenhui Wang [1]

[1] University of Canterbury, Christchurch/New Zealand, [2] Harvard University, Cambridge, Massachusetts/United States

This paper reports on the design and analysis of a suspended movable high aspect ratio single crystal silicon (HARSCS) microelectromechanical structure (MEMS). This new kind of arrayed architecture will be used for transducing exogenous biological materials like DNA, proteins, nucleic acids, quantum dots among others into an array of cells in parallel with a high throughput rate and flexibility. The design analysis is based on a grid stiffness matrix approach.

P-LIFE-031 – Design, Fabrication and characterization of Resonant Dielectric Nanostructures for Fluorescence Enhancement

Mohamad Hojeij [1]

[1] Paul Scherer institute, Turgi/Switzerland

We investigate the electromagnetic resonance behaviour of dielectric nanorod arrays for field-induced fluorescence enhancement and their application in the optical biosensing technology. A strong fluorescence enhancement has been observed. To study the strong field intensity enhancement, 3-Dimensional simulations and several optical and geometric parameters of ZnO and SiO2 periodic nanopillars were systematically varied and manufactured via innovative lithographic and replication processes.

P-LIFE-032 – Development of immunosensor using magnetic nanoparticles and circular microchannels in PDMS

Shailaja Agrawal [1], Amit Morarka [1], **Dhananjay Bodas** [1], Kishore Paknikar [1]

[1] Agharkar Research Institute, Pune/India

The present study opens up many possibilities of use of microchannels in biological detection and imaging field. It deals with development of an immunosensor chip using circular 3D microchannels fabricated directly with microdimensional metal wire. The chip permits easy and visual detection and quantifiaction of Escherichia coli (E. coli). It provides an inexpensive yet powerful tool to image and quantify pathogens at low concentration with passage of large amount of sample volume.

P-LIFE-033 – Development of simultaneous multi-site ion-conductance microscope for imaging of cell morphology

Takahiro Kawashima [1], Tomoya Matsugase [1], Moeto Nagai [1], Takayuki Shibata [1], Takashi Mineta [2], Eiji Makino [3]

[1] Toyohashi University of Technology, Toyohashi/Japan, [2] Yamagata University, Yonezawa/Japan, [3] Hirosaki University, Hirosaki/Japan

Scanning ion conductance microscopy is a useful technique for understanding structural and functional parameters of a living cell in a solution. This research focused on development of simultaneous multi-site ion-conductance microscope for parallel imaging of biological cells. In this paper, characterization of ion conductance and morphology measurement of a HeLa cell was executed using a glass pipette as a fundamental study. In addition, electrical crosstalk was evaluated for our purpose.

P-LIFE-034 – DNA sensor using PDMS micro-channel based on organic thin film transistor

Jun-Ho Jeun [1], Jung-Min Kim [1], Dong-Hoon Lee [1], Yong-Sang Kim [1]

[1] Myongji University, Gyeonggi/Republic of Korea

Immobilization of DNA molecules on the surface of pentacene, caused a dramatic change in the electrical properties of OTFTs (Fig. 3). ss-DNA and ds-DNA could be successfully differentiated on the OTFT surface. Based on these results, we confirm the possibility of designing a disposable and rapid label-free DNA sensor based on OTFTs, for various biological applications.

P-LIFE-035 – Effect of Magnitude of Shear Stress on Intracellular Calcium Expression in Bone Cell

Ok Chan Jeong [1]

[1] Inje University, Gimhae/Republic of Korea

Micro cell chip was fabricated with a polydimethylsiloxane (PDMS) channel structure and cover glass for investigating the relationship between the magnitude of the mechanical stimulation and the duration of the intracellular calcium responses in MG-63 cells. We found that from temporal responses of fluorescence intensity under the steady fluid flow with various magnitudes, it had multiple peaks like the mechanical vibration. The average period of cells was approximately 154 ± 11 s.

P-LIFE-036 – Electrochemical DNA hybridization biosensor using gold interdigitated arrays of micro- and nano-electrodes

Unai Eletxigerra [1], Ibon Alonso [1], Raquel Bayón [1], Josu Martínez-Perdiguero [1], Santos Merino [1]

[1] Fundación Tekniker, Eibar/Spain

The aim of this work is to develop and characterize a micro sensor based on interdigitated electrodes manufactured by photolithography method able to detect DNA hybridization. Hybridization process is detected by electrochemical techniques such as impedance spectroscopy and potentiostatic-potentiodynamic measurements, supported by Surface Plasmon Resonance. Preliminary results on the fabrication by nanoimprint lithography of submicron width electrodes will be also presented.

P-LIFE-037 – Fabrication and characterization of electromagnetically actuated microcantilevers for biochemical sensing, parallel AFM and nanomanipulation

Konrad Nieradka [1], Daniel Kopiec [1], Michał Zielony [1], Grzegorz Małozi[illegible] [1], Piotr Grabiec [1], Pawel Janus [2], Krzysztof Doma[illegible]ski [1], Andrzej Sierakowski [3], Teodor Gotszalk [1]

[1] Wrocław University of Technology, Wrocław/Poland, [2] Institute of Electron Technology, Warszawa/Poland, [3] Institute of Electron Technology, Warsaw/Poland

Here we present a microcantilever system with a combination of robust Lorentz force-based electromagnetic actuation and very sensitive optical beam deflection (OBD) method. We present wide characteristics of such combination, including static and frequency domain measurements and coupling between them. We propose numerous applications, including biosensing, parallel multicantilever AFM measurements, nanometer range manipulation, and precise application of force on the order of piconewtons.

P-LIFE-038 – Fabrication and electrical characterisation of an all-PMMA single submicron pore electrophoretic flow detector for biomedical applications

Sven Achenbach [1], Manouchehr Hashemi [1], Banafsheh Moazed [1], David Klymyshyn [1]

[1] University of Saskatchewan, Saskatoon/Canada

Single cylindrical submicron pores in PMMA membranes were micropatterned by electron beam lithography and integrated into an all-PMMA resistive-pulse flow sensor (Coulter counter) for biomolecule detection and identification. Unlike previous comparable devices, our sensor is all-polymer based, and therefore combines increased wettability (higher hydrophilicity) with excellent biocompatibility. Initial electro-fluidic testing was performed using a pico-ammeter in a patch clamp configuration.

P-LIFE-039 – Fabrication of a glucose biosensor with oscillator circuit using CMOS-MEMS technique

Ming-Zhi Yang [1], Ching-Liang Dai [1], Cheng-Bei Hung [1]

[1] National Chung Hsing University, Taichung/Taiwan

This study investigates the fabrication of a glucose biosensor integrated with oscillator circuit on-a-chip using the CMOS (complimentary metal oxide semiconductor)-MEMS (microelectromechanical system) technique. The sensitive film is 11-mercaptoundecanoic acid and glucose oxidase. The oscillator circuit is used to convert the capacitance variation of the sensor into the frequency output. Experiments showed that the glucose sensor had a sensitivity of about 1.4 MHz/mM.

P-LIFE-040 – Fabrication of Pneumatically–Driven Tensile Stimulator

Ok Chan Jeong [1]

[1] Inje University, Gimhae/Republic of Korea

This paper presents the pneumatically-driven tensile stimulator for investigating the effect of mechanical strain on the intracellular calcium expression in live cell. In our group, calcium expressions induced by shear and compressive stress were measured and discussed. In this work, we report our new finding on the mechanical strain-dependent intracellular calcium responses using the proposed stimulator.

P-LIFE-041 – Fluctuations of the Mass Adsorbed on Microcantilever Sensor Surface in Liquid-Phase Chemical and Biochemical Detection

Ivana Jokic [1], Zoran Djuric [1], Milos Frantlovic [1], Katarina Radulovic [1], Predrag Krstajic [1]

[1] ICTM – University of Belgrade, Belgrade/Serbia and Montenegro

We present the simple theory of the adsorbed mass fluctuations in microcantilever sensors operating in liquids, taking into account the transfer process of the analyte molecules from a solution to a sensor surface. The results show that mass transfer significantly influences the fluctuations spectrum. The theory is useful for study of the limiting performance of cantilever sensors and for characterization of molecular binding-unbinding interactions using measured fluctuations in a sensor signal.

P-LIFE-042 – Intracellular Calcium-Expression-Display (ICED) Operated by Compressive Stimulation

Ok Chan Jeong [1]

[1] Inje University, Gimhae/Republic of Korea

In this paper, microcell chips were fabricated and the compressive stress induced intracellular calcium expression of those cells was observed. Experimental results showed that the intracellular calcium expression of such cells had multiple peaks, similar to mechanical oscillation, with a period of about 130 s. A sevensegment-type of intracellular calcium-expression-display was fabricated to demonstrate the 'twinkling phenomenon' in intracellular calcium expression of cells.

P-LIFE-043 – Methodology for Investigating Duration of Intracellular Calcium Expression in Single Cell to Mechanical Stimulation

Ok Chan Jeong [1]

[1] Inje University, Gimhae/Republic of Korea

This paper presents themethodology for investigating the duration of the intracellular calcium expression in single cell. Micro cell chip with the two dimensional cell-matrix having various densities of cells was fabricated with a polydimethylsiloxane (PDMS) channel and cover glass. We found that under the steady fluid flow, the average periods of the multiple calcium peaks in MG-63 cells (human osteoblast-like bone cell line) was approximately 128 ± 4 s for 1Pa and 164 ± 20 s for 2 Pa.

P-LIFE-044 – Micromolded ceramic microneedle arrays for delivery and sampling

Regina Luttge [1], Michel Verhoeven [1], Sevtlana Bystrova [1], Louis Winnubst [1]

[1] University of Twente, Enschede/Netherlands

Several microneedle array systems are under development for the delivery of pharmaceuticals to the upper layer of the skin, as a painless and efficient alternative for intramuscular and subcuteneous injections using standard needles and syringes. Novel nanoporous microneedlers have been developed with an average pore diameter of 100 nm from alumina, an accepted biomaterial. These microneedles are promising candidates for interstitial fluid sampling and delivery of especially vaccines.

P-LIFE-045 – Pneumatically-Driven Cell Trap : Effect of Mechanical Stimuli on Live Cell

Ok Chan Jeong [1]

[1] Inje University, Gimhae/Republic of Korea

This paper presents the influence of the mechanical trapping using the pneumatic cell trap on the intracellular calcium expression in a dynamic single cell. The single particle and live cell were successfully trapped in the trap zone by taking advantages of the geometrical symmetry of the vibrators. The calcium response of a single cell during mechanical cell trapping was observed in order to nvestigate the effect of the mechanical stimuli on the live cell.

P-LIFE-046 – Polymide/PDMS-based soft array for cell mechanotaxis detection

Gianmichele Epifani [1], Antonio Qualtieri [2], Francesco Rizzi [1], Massimo De Vittorio [1]

[1] Istituto Italiano di Tecnologia, Iecce/Italy, [2] Instituto Italiano di Tecnologia, Arnesano/Italy

Here we demonstrate a technological platform for integration of mechanical microstructures in soft mechanoreceptive substrates. A soft waterproof stretchable substrate embedding a strain gauge circuitry and able to sense any transversal or longitudinal deformation has been fabricated. The mechanosensing array will easily visualize many cellular processes offering enormous potential for significant new developments in disease diagnostics.

P-LIFE-047 – Proper Spectral Response Adjustment of a-Si:H Multispectral Photodiodes with Multivariate Methods of Analysis

Christian Merfort [1], Konstantin Seibel [1], Andreas Bablich [1], Krystian Watty [1], Markus Boehm [1]

[1] Siegen University, Siegen/Germany

Until now with common color sensors it is barely possible to analyze optical characteristics, for example, to identify the potential danger of whitish powder samples. The main reason for this is that the reproduction of the fundamental color matching curves (DIN 5033-6) by technical systems provides good results for a colorimetric classification but not for an unequivocal optical description. Optimized a-Si:H multispectral photodiodes open up new possibilities for material and chemical analysis.

P-LIFE-048 – Undoped AlGaN/GaN HEMT based two terminal structure for H+ and OH- ion detection

Mastura Shafinaz Zainal Abidin [1], Abdul Manaf Hashim [1]

[1] Universiti Teknologi Malaysia, Skudai/Malaysia

Gallium Nitride (GaN) is a non-toxic and chemically stable semiconductor with high internal spontaneous and piezoelectric polarization which makes it as a promising material for highly sensitive and robust ion, gas and polar liquid sensors [1-4]. In this paper, the sensing response of fabricated two-terminal structures for H+ and OH- ion sensing in aqueous solution is reported. The possible sensing mechanism is also described.

P-LIFE-049 – Vertically Stacked Silicon Nanowires/ Fin-Type Structures for Bio-sensing Applications

Elizabeth Buitrago [1], Montserrat Fernandez-Bolaños, [1], Adrian Ionescu [2]

[1] EPFL STI IEL NANOLAB, Lausanne/Switzerland, [2] EPFL, Lausanne/Switzerland

30-40 nm Si-NW arrays of 10x8 NWs have been successfully fabricated to create highly sensitive 3D FETs for biosensing applications. Compact model device simulations have been done in conjunction with the optimization of the fabrication process for up to three channels. The output current increases with the number of sensing channels as found through our simulation results. This may allow for higher signal-to noise-ratios to be achieved.

5.3 Cell Interfaces & Biofunctional Surfaces

P-LIFE-050 – A dry etch process with fluorine chemistry to create well-defined titanium surfaces for biomedical studies

Ronny Löffler [1], Monika Fleischer [1], Dieter Kern [1]

[1] University of Tübingen/Institute of Applied Physics, Tübingen/Germany

In order to understand the influence of micro- and nano-structured material surfaces on adjacent biosystems, a broad investigation of cellular reactions and material surfaces is needed. The process presented here makes well-defined Titanium surface topographies available, which allow for focusing on a few characteristic parameters of a biomaterial which can be conveniently varied in a systematic fashion.

P-LIFE-051 – Beam induced deposition of 3D electrodes to improve electrical coupling to cells

Luigi Martiradonna [1], Luca Quarta [2], Leonardo Sileo [1], Andreas Schertel [3], Massimo De Vittorio [1]

[1] IIT – Italian Institute of Technology, Arnesano (Lecce)/Italy, [2] Università del Salento, Lecce/Italy, [3] Carl Zeiss NTS GmbH, Oberkochen/Germany

Nanostructuring of conventional neuroprobes with mushroom-, ball- or tip-shaped protrusions can induce neurons to tightly engulf such sensors, greatly improving the amplitude of the recorded extracellular synaptic signal. Fabrication of three-dimensional Pt electrodes for the detection of synaptic events, based on beam induced deposition, is here proposed. IBID/EBID approach allows a systematic study on shape and dimensions of nanoprotrusions in order to optimize cell/sensor coupling.

P-LIFE-052 – Cell impalement on transparent arrays of vertically aligned nanowires

Florian Mumm [1], Kai Beckwith [1], Pawel Sikorski [1]

[1] Norwegian University of Science and Technology, Trondheim/Norway

In this project, we fabricate arrays of vertically aligned nanowires on a transparent, cell-friendly surface with the aim to non-invasively transport cargo such as DNA, RNA, or proteins attached to the nanowires into cells by impalement. The arrays are aimed at applications for reverse transfection as an alternative to traditionally used functionalized glass slides. At the conference, we will show the procedure, how to make the arrays and discuss different approaches for attaching the cargo.

P-LIFE-053 – Cell Rolling Model for an Antibody-Based Microfluidic Screening System

Giuseppina Simone [1], **Gerardo Perozziello** [2], Edmondo Battista [3], Francesco de Angelis [4], Francesco Gentile [5], Natalia Malara [6], Patrizio Candeloro [1], Rosanna La Rocca [5], Ennio Carbonea [6], Paolo Netti [3], Enzo Di Fabrizio [5], Andreas Manz [7]

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P-LIFE-054 – Fabrication of 3D high throughput cell screening topographies using plasma polymerised gradients as a secondary etch mask

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We present gradients of plasma polymerised hexane (ppHex) for use as etch masks, enabling asymmetric etching and the fabrication of grooves of variable depth. This gradient of groove depth is created orthogonal to a further gradient of groove pitch, allowing a multidimensional analysis of cellular response to two distinct surface parameters: feature depth and pitch. The localisation of favourable cellular response to the surface is a high throughput technique for optimising surface parameters.

P-LIFE-055 – Gallium Arsenide passivation method for HEMT application in liquid environment

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We report on passivation of Gallium Arsenide against oxidation in cell culture medium, for application in High Electron Mobility Transistors (HEMT) based neural signaling transducers. Deposition of a layer of polymerized (3-mercaptopropyl)trimethoxysilane (MPT) demonstrated to be effective in preventing GaAs corrosion in physiological solution kept at 37°C during a two week period of time, which is the typical period of incubation of a neuron cells culture.

P-LIFE-056 – Generation of Protein Patterns and Gradients on PDMS Surfaces Using Simple Passive Microfluidics

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Micro-channels etched into silicon are used as a simple microfluidics to deposit line patterns of proteins onto PDMS-coated coverslips. Depending on the protein concentration and the channel dimensions the formation of uniform coatings or of gradients in protein concentration are favored. Porcine Aortic Endothelial cells cultured on surface patterns of VEGF proteins were found to exclusively adhere to the specific protein patterns.

P-LIFE-057 – Humido-Responsive Nanostructures Prepared by Nanoimprinting

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Polymers capable of stimulus-responsive movements have attracted great attention, because they can rapidly change their shapes under the influence of stimulus, such as heat, electricity, light and moisture. In this work, the nanoimprinting approach is introduced to fabricate nanostructures on this stimulus-responsive polymer. The shape variations of the nanostructures in response to moisture stimulation show potential applications for optical detection of the external stimulation.

P-LIFE-058 – Rapid replication of nano-scale surface topographies for in vitro cell studies

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Micro- and Nano-fabrication continues to evolve and its capabilities have begun to attract the attention of other disciplines, e.g. microbiology. To further exploit microfabrication for life science applications, methods are needed that enable the easy, low-cost production of experimental devices. We demonstrate the fabrication of samples for in vitro cell growth studies. We compare the fabrication scheme to other processes and elaborate on its compatibility with microbiological applications.

P-LIFE-059 – The Configurable Multiplexed Biomolecular Patterning Controlled by Surface Potential

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Biomolecular patterning techniques play an essential role in the biosensor and biochip research fields. However, previous works cannot achieve high-resolution and high-efficiency patterning simultaneously. In this work, we utilized the change of surface hydrophobicity, controlled by surface potential following applied voltage on the electrodes of the device, and finished a micro-scale multiplexed biomolecular patterning efficiently. Also, nano-scale patterning is possible with this technique.

P-LIFE-060 – Tip Based Printing of Functionalized Hydrogels Microscale Patterns

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In this report we present a novel method for the construction of chemically functional hydrogel microscale patterns. We use a tip based lithography method to directly deposit the hydrogel precursors at defined location and polymerize them to form hydrogels. This method allows for rapid fabrication of high resolution patterns.

P-LIFE-061 – Conformal electrodes on Cylic-Olefin Polymer microfluidic channels for biological sensing

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In this work we present the possibility to produce COP microfluidic devices with electrodes that completely integrates into the channels for its use in high precision impedance spectroscopy of cells and beads. By using standard cleanroom techniques we have developed a microfluidic device with integrated micro-electrodes that follow the shape of the channels even when these have vertical walls. The device have been succesfully tested for counting 3 µm polystyrene beads in suspension.

P-LIFE-062 – Fabrication of a lab on chip for Single-Cell Electroporation with microfluidic and dielectrophoretic modules

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We report an improved fabrication process for lab-on-chip for single-site cell electroporation with controlled delivery of transfectants and cell addressability. The innovation keys consist of: i) a hollow structure for the microelectrodes allowing gene transfection on single cell; ii) the implementation of high density microelectrodes; iii) a modular approach including microfluidics for gene delivery and microelectrodes for dielectrophoresis. to direct cells on the electrodes.

P-LIFE-063 – Lab on a chip automates in vitro cell culturing

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This work presents the development of an automated microfluidic cell culturing device based on a disposable microfluidc chip system. Prototyping of the system has been performed with the help of laser ablation in polymeric materials. The device allows fully automated biomimetic and dynamic culturing of embryonic cells. The medium is automatically controlled to a flowrate up to 20 microliters per hour and six IVF chips can be controlled simultaneously, all in a separated, single compartment.

P-LIFE-064 – Low DC voltage electroporation by using fluidic microelectrodes

Isabella Guido [1], Chunyang Xiong [1], Jing Fang [1]

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A novel device for cell electroporation is developed. It is a simple microfluidic system able to permeate different cell types without using metal electrodes for applied electric field and pulse duration control. By using low dc voltage the system is able to yield great transfection efficiency and high cell viability. It was applied to yeast and Jurkat cells. The results of the experiments show the method is as suitable for cell electroporation as the established electroporation techniques.

P-LIFE-065 – Microfluidic capillary Integration and Optical Interconnects using CO2 Laser Technology

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Fluidic interconnections to the peripherical devices using capillaries become difficult because of high death volumes and sealing problems at high pressure. Recent results will be presented overcoming these problems by CO2-laser fusing of glassy capillaries to the reactor or chip elements. Additionally optical integration has been enabled by a very precise laser forming technology to shape/bend the capillaries. The procedure was tested with a variety of optical glasses.

P-LIFE-066 – Microfluidic system for high throughput cell mechanics analysis

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A newly developed microfluidics-based device for analyzing mechanical properties of cells and their mechanical changes caused by a pathology is presented here. The microsystem is able to provide label-free, time saving, and high-troughput characterization of the deformation behavior of single cells by using dielectrophoresis. Based on a relatively small number of cells, this method showed to be able to yield reliable data which allow unambiguous distinguishing cells according to their stiffness

P-LIFE-067 – Multi Stacked Centrifugal Microfluidics For ENZYME-LINKED IMMUNOSORBENT ASSAY

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The lab-on-a-CD is promising for the automation of multiple microreactor systems,we propose a new type lab-on-a-CD concept based on three-dimensional microchannel network. By stacking multiple layers of lab-on-a-CD, it can compactly be integrated microreactor systems. It is also notable that the use of three-dimensional structure enhances the performance of modules. For example, it can be realized to improve the sensitivity of ELISA by increasing surface area for the immobilization of antibody.

P-LIFE-068 – Optimization of Microfluidic Systems for IRMS real Time Monitoring of Living Cells

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In this paper we present the development of a microfluidic system based on CaF2 transparent windows, for IR micro-spectroscopy on living cells. Surface functionalization with sputtered Si is used to overcome surface compatibility with adherent cells and to improve fabrication protocols. IR transmission, sealing protocols and bio-compatibility are discussed; IR spectra and bio-chemical images are presented on MCF-7 cells after 24h of culturing inside our micro-fludiic devices.

P-LIFE-069 – Phosphopeptide Enrichment in Polymeric Microchip with Porous TiO2 Stationary Phase Deposited by Wet or Flame-Pyrolysis Methods

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We fabricated a TiO2 affinity chromatography micro-column on 2 mm PMMA plates, and compared the phosphopeptide trapping and separation performance using two methods for deposition of the TiO2 stationary phase: 1) liquid phase precipitation and, 2) flame aerosol technology. The micro-fabricated chromatographic column of PMMA can be used several times with repeatable results. Both methods of deposition wet and dry are promising.

P-LIFE-070 – QuickFix Interconnects: Universal fluidic and electrical connections for lab-on-chip applications.

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Practical concerns related to reliable and robust world-to-chip interconnections hamper the wider adoption of μTAS devices. In this paper, we demonstrate a novel spring-actuated adaptor compatible with fluidic and electrical connections. QuickFix interconnects provide a simple solution based on spring-based combined actuation and sealing mechanism to form self aligned, multiple, rapid, adhesive free, high density, reversible fluidic and electrical interconnections to LOC devices.

P-LIFE-071 – Separation and detection of cysteine and homocysteine on a microfluidic platform

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Thiols are compounds of main interest due to their importance in biological processes. We fabricated a CE-AD chip for electrochemical analysis using gold electrodes placed within microchannel. The CE-AD process was performed in the microchannel, separating the thiols within an electric field. Amperometric detection was performed by using 3 in-channel electrodes. The i-t curve of cysteine, and homocysteine can easily differentiate between these chemicals based on their migration patterns.

P-LIFE-072 – Single cell isolation in droplet-based microfluidic device

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We reported a droplet-based microfluidic device to collect the single cell droplet for the further cell assay. After integrating the microelectrode into the microfluidic device, the droplets without cell or with more than one cell could be directed to the waste channel with the electrostatic force, and the droplets containing single cell could be isolated by using hydrodynamic force to the collecting channel without electric field. Good cell livability could be obtained in the proposed method.

P-LIFE-073 – Strategies to handle autofluorescence of lab-on-a-chip device materials

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We study autofluorescence of materials used for lab-on-a-chip devices, and discuss strategies to reduce it. Due to adsorption of organic substances from the atmosphere, inorganic materials exhibited increased autofluorescence after storage. Thermal treatment in oxygen reduced autofluorescence by a factor of 3. Besides pre-bleaching of organic material devices, addition of absorber dye can quench autofluorescence. For SU-8, autofluorescence was reduced by a factor of 6, compared to bleaching.

P-LIFE-074 – Transparent heater based on an ITO replacement paste

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The aim of the work was to develop a transparent microheater on a glass plate for application in a microbioreactor. A commercially available paste was used (ELX-ITO-R, Electra). The paste was diluted with ethanol and spincoated on a microscopic glass, and dried. A thin layer heater was obtained with the following parameters: a thickness of the layer appox. 0.2 um, a thickness of the metallic conductors approx. 2 um, the heater can be powered from 9 V at 80 mA to obtain 37 oC.