

**Plenary Session
Wednesday, June 1, 2016
Room: Kings Garden 4/5**

Session Chairs:

John Hartley, Nuflare, Conference Chair

Pat Watson, Princeton University, Program Chair

8:15 am - 8:35 am **Welcome** John Hartley, Nuflare

8:35 am - 9:20 am **Plenary-1**
Puzzles and Promises in Nanoscale Biology, R. H. Austin, Princeton University

Understanding how biopolymers such as DNA function at the nanoscale is a task for nanotechnology and the tools of a great mix of disciplines. Interesting new phenomena have emerged at the nanoscale that require re-thinking how we look at both biopolymer dynamics and the flow of liquids at the nanoscale. I'll go over both experiments and how we model these phenomena.

9:20 am - 10:05 am **Plenary-2**
Exploring the Universe with Superconducting Detectors, Jonas Zmuidzinas, Caltech

It is not widely appreciated that superconducting detectors are the enabling technology for the world's largest single investment in ground-based astronomy: the ALMA project. This presentation will sketch the history of superconducting detectors, describe their present use and recent developments, and illustrate the future potential for this technology.

10:05 am - 10:50 am **Plenary-3**
Imaging the Dust of Elementary Particles, Sensors and Detectors for the nano-nano-world,
Alessandro Marchioro, CERN

Understanding the most basic properties of the tiniest constituents of matter and the laws governing their interactions, i.e. by definition the "elementary particles", requires physicists to conceive, design and operate huge and highly complex scientific instruments. This talk will address and try to explain the apparent contradiction of this statement.

**Session 1A - Advanced Etching Techniques 1
Wednesday, June 1, 2016
Room: Kings Garden 3**

Session Chairs:

Deirdre Olynick, Lawrence Berkeley National Laboratory

Mark Horn, Pennsylvania State University

1:15 pm - 1:45 pm **1A1 Invited**

Catalyst motion in Metal-assisted Chemical Etching, Owen Hildreth, SEMTE, Arizona State University

Complex 3D geometry can be etched in silicon using Metal-assisted Chemical Etching (MacEtch) by properly controlling catalyst shape, understanding the mechanisms driving catalyst motion, accounting for diffusion timescales, and controlling hole (h⁺) distribution. This seminar details how to fabricate 2D and 3D geometry using MacEtch.

1:45 pm - 2:05 pm

1A2

Fabrication of High Resolution Zone Plates with High Aspect Ratio using Metal-assisted Chemical Etching, K. Li, M. Wojcik*, C. Jacobsen*, R. Divan*, L. Ocola*, B. Shi*, D. Rosenmann*, Northwestern University, *Argonne National Lab

We describe a metal assisted chemical etching process for fabricating zone plates with high absolute efficiency and fine spatial resolution. The process involves e-beam lithography, metal deposition and lift-off and DRIE to thin the wafer substrate to about 15um. We are now adding ALD process to make zone-doubled zone plates.

2:05 pm - 2:25 pm

1A3

Bio-inspired Silicon Nanospikes Fabricated by Metal-Assisted Chemical Etching for Antibacterial Applications, H. Hu, S. M. Gifford, P. Meyer, G. A. Stolovitzky, IBM T. J. Watson Research Center

We present the results of efficient killing of the bacteria E. coli on silicon nanospike surfaces fabricated using a low-cost metal-assisted chemical etching (MacEtch) approach. We discovered the influence of etching time on the morphology of the silicon nanospikes as well as on bactericidal effects.

2:25 pm - 2:45 pm

1A4

Silicon nanowire and hole arrays by a combination of self-assembly, laser ablation, and wet chemical etching, D. Brodoceanu, T. Kraus, R. Elnathan*, N.H. Voelcker*, INM–Leibniz Institute for New Materials, Saarbrücken, *University of South Australia, Adelaide

We present two unconventional particle-based routes for the fabrication of arrays of vertically-aligned nanowires and arrays of well-defined pores with tunable feature sizes on silicon wafers, by a combination of self-assembly, laser ablation, and metal-assisted chemical etching.

2:45 pm - 3:15 pm

1A5 Invited

Overview of Atomic Layer Etching – From the Ion Beam Perspective, L. Berry, T. Lill, K. J. Kanarik, S. Tan, M. Shen, E. A. Hudson, Lam Research Corporation

In 1959 Feynman pondered about a world where we can “arrange the atoms one by one the way we want them”. Atomic Layer Etch (ALE) combined with ALD enables device manufacturing with near atomic precision. This talk will review current ALE technology, and since this is a Beams conference, address ALE from a beams perspective

Session 1B - Optical and EUV Lithography Wednesday, June 1, 2016 Room: Kings Garden 4

Session Chairs:

Shane Palmer, Nikon Research Corp. of America

Mark Schattenberg, Massachusetts Institute of Technology

1:15 pm - 1:45 pm

1B1 Invited

Forecasting Optical Lithography - A Fool's Errand !, D Flagello, Nikon Research Corporation of America

This talk will examine some of the history of technology prediction with an attempt to forecast the future possibilities and scenarios in optical lithography. We will discuss the potential innovations and ideas that may carry us into the future, with a specific concentration on manufacturing possibilities.

1:45 pm - 2:05 pm 1B2

A comparative study of resists and lithographic tools using Lumped Parameter Model, R. Fallica, Y. Ekinici, Paul Scherrer Institute

We present a numerical implementation of the exact Lumped Parameters Model. In addition, a least square fit to experimental CD vs. Dose data (obtained from conventional optical lithography, interference optical lithography, e-beam and ion beam processes carried out on HSQ, PMMA and other resists) is used to validate our model.

2:05 pm - 2:25 pm 1B3

Study on the Dose Performance of EUV Lithography Scanner Using Novel In-wafer Dose Measurement, Jinseok Heo, Insung Kim and Sungsue Kim, Samsung Electronics

In this paper, the dose performance of high-end EUV scanner (ASML NXE 3300) will be analyzed using the novel in-wafer exposure energy measurement and the detailed experimental analysis of dose performance in the EUV scanner will be also discussed.

2:25 pm - 2:45 pm 1B4

Biases in the use of height-to-height correlation to characterize roughness, Chris A. Mack, Lithoguru.com

While previous studies have examined systematic biases in the measurement of power spectral density (PSD) for rough surfaces/features, this paper will explore biases found in the measurement of the height-to-height correlation function (HHCF). Comparison to PSD measurements will be made, and recommendations for best use of HHCF will be given.

2:45 pm - 3:15 pm 1B5 Invited

EUV Lithography for Advanced Nodes, Nicole Saulnier, IBM Research

After more than two decades of fundamental research and development, Extreme Ultraviolet (EUV) lithography is slated to enter the IC manufacturing flow for critical levels in advanced nodes. This talk will focus on advances in the areas of resist materials and computational lithography towards enabling a manufacturable EUV solution.

Session 1C - Nanofabrication and Biology 1

Wednesday, June 1, 2016

Room: Kings Garden 5

Session Chairs:

Shalom Wind, Columbia University.

Saba Ghassemi, University of Pennsylvania

1:15 pm - 1:45 pm 1C1 Invited

Brain on Chip, B. Schurink**, S. Xie**, A.J. Bastiaens*, J.J.F. Sleeboom*, J.P. Frimat*, D.A.M. Mustafa*, J.G.E. Gardeniers**, J.M.J. den Toonder*, R. Luttge*, *Eindhoven University of Technology, **University of Twente

Brain on Chip may provide more relevant physiological tissue models. In this contribution, the combination of microfluidics, tissue engineering and neuroelectrophysiology is presented as a tool to generate a better understanding of both healthy and diseased brain functions. It is the main objective to preserve the cells' three-dimensional morphology.

1:45 pm - 2:05 pm 1C2

Fabrication and characterization of zinc oxide nanowires-based flexible biosensors, Atif Syed, Enrico Mastropaolo, and Vasileios Koutsos, The University of Edinburgh

Novel fabrication process to hydrothermally grow zinc oxide nanowires directly on PDMS substrates for their application in various sensors is presented. The device has been tested as protein biosensor (bovine serum albumin) by monitoring change in electrical resistance. Characterization of the device using AFM and FTIR are also presented.

2:05 pm - 2:25 pm 1C3

A high-throughput nano-electroporation platform for large-scale manipulation and transfection of adult mouse cardiomyocytes, Lingqian Chang, Chiling Chiang, Paul Bertani, Zhaogang Yang, Ly James Lee, Wu Lu, The Ohio State University

We report a high-throughput nanochannel electroporation technique for on-chip manipulation and transfection of large-scale single cells. Our platform, based on a 3D nanochannel array chip, enables massive-parallel delivery of functional cargo into cellular array on the chip. A novel 'dewetting' method is applied to trap cells for electroporation at high-throughput.

2:25 pm - 2:45 pm 1C4

Out-of-plane spatial control at single-molecule resolution on biomimetic surfaces, H. Cai, J. Muller*, D. Depoil**, M. Sheetz, M. Dustin**, S. J. Wind, Columbia University, *NYU School of Medicine, **University of Oxford

A new single-molecule biomimetic platform is presented in which cellular receptors are able to engage ligands at different distances from the cell membrane in order to probe how molecular size affects key cellular processes.

2:45 pm - 3:15 pm 1C5 Invited

Lotus-Leaves-Like tailored surfaces tune the structural configuration of bio-soft matter compounds, A. Accardo, LAAS-CNRS

In this talk I will provide a comprehensive overview of how engineered superhydrophobic devices can be used as a powerful tool to influence the structural configuration of compounds of biomedical relevance (e.g. neurodegenerative peptides and cancer cell exosomes) in a droplet environment, with some recent perspectives on cells/neurons proliferation applications.

Session 2A - Electron Beam Lithography 1

Wednesday, June 1, 2016

Room: Kings Garden 3

Session Chairs:

Tim Groves, SUNY Albany

Rick Bojko, Genisys GMBH

3:35 pm - 4:05 pm 2A1 Invited

Sketch and Peel Lithography, Y. Chen, Q. Xiang, Z. Li, H. Duan, Hunan University

We demonstrate a new patterning concept, termed "sketch and peel" lithography, which can significantly enhance the efficiency of electron-beam direct writing (EBDW) and mitigate the proximity effect of EBDW for fast and reliable fabrication of metallic structures.

4:05 pm - 4:25 pm 2A2

Sub-5 nm electron-beam lithography and metrology of poly (methyl methacrylate) using an aberration-corrected scanning transmission electron microscope, V.R. Manfrinato, A. Stein, L. Zhang, E.A. Stach, C.T. Black, Brookhaven National Laboratory

We performed a unified analysis of poly(methyl methacrylate) as positive and negative tone resist, and electron-beam-induced deposition of carbon using an aberration-corrected scanning transmission electron-microscope (STEM) as the exposure tool. We performed STEM resist metrology and we develop an imaging method for the visualization of the exposure process in situ.

4:25 pm - 4:45 pm 2A3

Patterning of non-planar surfaces via electron beam lithography and its challenges, C.M. Eichfeld, L. Zhang*, R.M. Schmid*, W.S.M.M. Ketelaars**, A.C. Zonneville**, The Pennsylvania State University, *Raith America, **Raith

There are challenges that need to be overcome when patterning non-planar substrates compared to conventional flat substrates. Correct pattern placement on non-planar surfaces requires having an accurate height map. In this paper we show how we obtain and use accurate height maps to pattern the surface of non-planar substrates.

4:45 pm - 5:05 pm 2A4

PMMA Stencil Masks for Atom Beam Lithography, D. Shakarisaz, P. Ruchhoeft, University of Houston

Large-area stencil masks consisting entirely of PMMA were fabricated for use with atom beam lithography. The membranes were about one square centimeter in area, were 600 nm thick, and contained patterns with 190 nm openings on a 1 micron pitch.

5:05 pm - 5:25 pm 2A5

Metal Free Adhesion of Au onto Si Native Oxide, G. Lopez, M. Metzler, S. Wood, C. Elliott, G. Kim, A. Thompson*, University of Pennsylvania, *DisChem

Au is typically coupled with a seed layer like Cr when evaporated onto Si. In our work, we present a method to adhere 100nm Au dots onto Si without the use of a seed layer using SURPASS 4000 patterned by EBL and metal lift-off.

Session 2B - Tip-based Lithography

Wednesday, June 1, 2016

Room: Kings Garden 4

Session Chairs:

Josh Ballard, Zyvex Labs

Malcolm Carroll, Sandia National Labs

3:35 pm - 4:05 pm 2B1 Invited

Progress and future of NanoFrazor lithography, Felix Holzner, SwissLitho AG

NanoFrazor lithography was commercialized in 2013 by the startup company SwissLitho. Several NanoFrazor systems have been installed at research facilities all over the world and enabled applications that have not been possible before. This paper summarizes recent advances of the young technology and provides an outlook on future possibilities.

4:05 pm - 4:25 pm 2B2

Atomically Precise Devices: Enabling Fundamentally New Devices at the Ultimate Atomic Limit, Richard Silver, Xiqiao Wang*, Pradeep Nambodiri, Xiao Deng**, and Kai Li
National Institute of Standards and Technology, *University of Maryland, **Tongji University

Atomically precise devices are a key strategic direction as computation architectures move beyond traditional technologies. Controlling the position and electronic or quantum state of individual atoms or

electrons has the potential for broad impact. Deterministic placement of dopant atoms is achieved using hydrogen-based scanning probe lithography.

4:25 pm - 4:45 pm

2B3

Nanolithographic Chemical Patterning on Graphene Using Local Stress and Heat, Shivarajan Raghuraman, Jonathan R. Felts, Texas A&M University

Combined friction force microscopy and thermochemical nanolithography using heated atomic force microscope tips provides quantitative descriptions of the thermochemical and mechanochemical reduction of graphene oxide, where it is proposed that reduction occurs via surface diffusion induced by the local temperature gradient under the tip.

4:45 pm - 5:05 pm

2B4

Tip-assisted Dopant Incorporation Process for Atomic Precision P-in-Si qubit devices, J. H. G. Owen, J. Ballard, U. Fuchs, C. Delgado, J. N. Randall and J. R. Von Ehr, Zyvex Labs

We have performed STM Lithography of phosphine on Si(001). With tip assistance, we are able to drive P incorporation at a substrate temperature around 250°C, below the temperature used to drive P incorporation by thermal annealing alone. This allows us to perform metrology of the P atom position.

5:05 pm - 5:25 pm

2B5

Integration of scanning probe lithography with directed self-assembly of PS/PMMA based block-copolymers, Matteo Lorenzoni, Laura Evangelio, Armin Knoll¹, Colin Rawlings¹, and Francesc Pérez-Murano· IMB-CNM (CSIC), Campus de la UAB, ¹IBM Research - Zurich

Different scanning probe lithographic techniques might offer unique advantages if integrated in the DSA process. We will present how thermal probe lithography (tSPL) has been used to create guiding patterns for BCP and the outcome will be compared to previous work done employing AFM oxidative nanolithography.

Session 2C - Nanoelectronics 1

Wednesday, June 1, 2016

Room: Kings Garden 5

Session Chairs:

Rebecca Cheung, University of Edinburgh

Xiaogan Liang, University of Michigan

3:35 pm - 4:05 pm

2C1 Invited

Toward high-performance nanoelectronics based on carbon nanotubes, S.J. Han, IBM T. J. Watson Research Center

Low-dimensional carbon materials are promising to replace silicon as the channel material for high-performance electronics near the end of silicon scaling roadmap. In this talk, I will cover recent progress within IBM Research as well as the discussion that highlights most significant challenges from technology points of view.

4:05 pm - 4:25 pm

2C2

Metal Cation Motion Induced Resistance Switching in Highly Reliable Hafnium Oxide based Memristive Devices, H. Jiang, L. L. Han, Q. F. Xia, University of Massachusetts, L. L. Han, H. L. Xin, Brookhaven National Laboratory

We developed a Ta/HfO₂/Pt memristive device that has low programming voltage, fast switching speed, robust endurance and reliable retention. We observed the migration of Ta into the HfO₂ layer that formed a conduction channel. Our results suggest reactive metal cations migration also plays an important role for the resistive switching.

4:25 pm - 4:45 pm 2C3

3D Hybrid Memristor/CMOS Circuits with 8 Monolithically Integrated Crossbar Layers, Peng Lin, Miguel Angel Lastras-Montañó*, Hao Jiang, Amirali Ghofrani*, Melika Payvand*, Luke Theogarajan*, Kwang-Ting Cheng* and Qiangfei Xia, University of Massachusetts Amherst, *University of California Santa Barbara

We demonstrated the monolithic integration of up to 8 memristor crossbars layers with foundry-made CMOS chip. The Pt/HfO₂/TiN memristive devices were engineered to be electrically compatible with the CMOS circuits. Reliable switching performance of the memristive devices was achieved in the integrated chips with reset current down to sub-1μA level.

4:45 pm - 5:05 pm 2C4

Fabrication of Ambipolar Nanoelectronic/Microfluidic-Integrated Biosensors for Cycle-Wise Real-time Biomolecule Quantification, H. Nam, B. Oh, P. Chen, K. Kurabayashi, and X. Liang, University of Michigan

We fabricated WSe₂-based ambipolar FET biosensors, which are integrated with PDMS-based microfluidic channels. The integrated microfluidic channels enable a new approach, termed as Incubation-Flushing-Drying-Measurement (IFDM) cycle-wise quantification, for operating FET biosensors and realizing rapid, low-noise, highly specific real-time biomolecule quantification.

5:05 pm - 5:25 pm 2C5

Electron Spin Resonance Characterization of Damage and Recovery of Si/SiO₂ Interfaces from Electron Beam Lithography, J.-S. Kim, A. Tyryshkin, S.A. Lyon, Princeton University

The fabrication of nanoscale quantum devices in silicon relies on electron beam lithography which creates shallow defects at the Si/SiO₂ interface. The creation and subsequent annealing of these defects is characterized using transport and electron spin resonance techniques in large area MOSFETs.

Session 3A - Nanofabrication for Quantum Computing

Thursday, June 2, 2016
Room: Kings Garden 3

Session Chairs:

John Randall, Zyvex Labs

Ivo Rangelov, Ilmenau University of Technology

8:00 am - 8:30 am 3A1 Invited

Donor quantum-dot coupled qubits, M. Carroll, Sandia National Labs

In this talk I will discuss the first experimental demonstration of coherent singlet-triplet (S-T) rotations in a MOS quantum dot and a single donor system. This represents both a new qubit configuration as well as a central demonstration of coherently coupling a buried donor spin with the oxide-silicon interface.

8:30 am - 8:50 am 3A2

Injection of 2D Electron Gas into a Quantum-Dot Organic Light-Emitting Diode Structure on Silicon Substrate, Daud Hasan Emon, Myungji Kim, Mohammad T. Sharbati, Hong Koo Kim, University of Pittsburgh

We present a new quantum-dot OLED structure on silicon substrate, whose junction area is widely scalable down to nanometer range. We observed two-dimensional electron gas (2DEG) injection at the interface between oxide and semiconductor. Our work demonstrates the possibility of scaling a QD-OLED down to single quantum dot level.

8:50 am - 9:10 am

3A3

High density overlapping gate architecture for Si/SiGe quantum dots, J. R. Petta, D. M. Zajac, T. M. Hazard, and X. Mi, Princeton University

We demonstrate an overlapping gate architecture that enables the isolation of single electrons in a Si/SiGe quantum well.

9:10 am - 9:30 am

3A4

Fabrication of High-Coherence Superconducting Qubits, J. L. Yoder, A. Melville, D. K. Kim, P. B. Welander, R. Das, G. Calusine, D. Hover, L. Racz, D. Rosenberg, A. P. Sears, S. Weber, D. R. W. Yost, W. D. Oliver, S. Gustavsson*, F. Yan*, MIT Lincoln Laboratory, *Massachusetts Institute of Technology

Superconducting qubits are a promising candidate for the fundamental logic element of a quantum information processor. A key metric to characterize the qubit performance is device coherence. This work focuses on materials and fabrication developments to prepare high-coherence superconducting qubits, highlighting developments towards retaining high coherence while increasing device complexity.

9:30 am - 9:50 am

3A5

Direct Write Nanofabrication for Quantum Computing in Silicon and Color Centers in Diamond, E. Bielejec, J. L. Pacheco, J. B. S. Abraham, B. Aguirre, M. Singh, R. Camacho, M. P. Lilly, D. R. Luhman, M. S. Carroll, A. Sipahigil*, R. Evans*, D. Sukachev*, H. Atikian*, M. Loncar*, M. Lukin*, M. E. Trusheim**, T. Schroder**, D. Englund**, Sandia National Laboratory, *Harvard University, **Massachusetts Institute of Technology

Direct write nanofabrication creating deterministic single donor devices for quantum computing research and individual color centers in diamond is presented. This work was performed on the SNL nanoImplanter, a 100 kV sub-10 nm resolution focused ion beam implantation system with ion sources including P, Sb, Si, and Li.

Session 3B - Multi-beam Characterization and Lithography

Thursday, June 2, 2016

Room: Kings Garden 4

Session Chairs:

Alan Brodie, KLA Tencor

Mark McCord, PDF Solutions

8:00 am - 8:30 am

3B1 Invited

Multi-electron-beam technology with applications in microscopy, inspection and lithography, P. Kruit, Delft University of Technology

Multi-electron beam technologies for maskless lithography, full-wafer inspection and (bio) scanning electron microscopy will be reviewed from the point of view of an instrument designer. Recent results with the MAPPER lithography tool and the Delft Multi-Beam scanning electron microscope will be presented.

8:30 am - 8:50 am

3B2

Multi-Beam Magnetic Sector Mass Spectrometry Utilizing Spatially Coded Apertures, Z.E. Russell, E.X. Chen, S.T. DiDona, J.J. Amsden, C.B. Parker, S.D. Wolter*, R.M. Danell**, B.R. Stoner***, G. Kibelka****, M.E. Gehm, D.W. Brady, J.T. Glass, Duke University, *Elon University, **Danell Consulting, ***RTI International, ****Xylem OI Analytical

The first demonstration of spatial aperture coding techniques to magnetic sector mass spectrometry presented shows 1D and 2D spatial coding techniques that yield increased mass spectra signal intensity of 10x and 4x (respectively) with no corresponding loss in mass resolution. Application to a Mattauch Herzog mass spectrograph is also shown.,

8:50 am - 9:10 am

3B3

Imaging semiconductor patterns at N10 logic node with a high-throughput multi-beam SEM, J. T. Neumann, T. Garbowski*, S. Halder**, P. Leray**, R. Garreis, D. Zeidler*, Carl Zeiss SMT GmbH, *Carl Zeiss Microscopy GmbH, **IMEC

We use the ZEISS multi-beam SEM to inspect patterns on a semiconductor wafer for process window qualification at N10 logic node. We demonstrate that the multi-beam SEM images the wafer patterns, tracks their variations through the process conditions of the lithography scanner, and finds defects limiting the lithographic process window.

9:10 am - 9:30 am

3B4

Design of a simple add-on to change a single-beam SEM into a multi-beam SEM, M. Scotuzzi, C.W. Hagen, P. Kruit, Delft University of Technology

A simple add-on to change an SEM from single-beam mode to multi-beam mode can be inserted in the electron column via the Variable Aperture port. First order optical calculations shows that a system of 49 beams with a probe size of 1.6 nm, with 50pA current per beam, is feasible.

9:30 am - 9:50 am

3B5

High Throughput Imaging in the Delft Multi Beam SEM, Y. Ren, C. W. Hagen, P. Kruit, Delft University of Technology

Transmission electron imaging system and secondary electron imaging system of our multi-beam Scanning electron microscope with 196 beams will be presented. Design principle and technological challenges will be discussed; recent experimental imaging results will be updated.

Session 3C - Nanophotonics 1

Thursday, June 2, 2016

Room: Kings Garden 5

Session Chairs:

Jack Skinner, University of Montana

Joel Yang, Singapore University of Technology and Design

8:00 am - 8:30 am

3C1 Invited

Optical Antennas Make Fast LEDs, Ming Wu, University of California, Berkeley

Optical antenna can significantly enhance the spontaneous emission rate of nanoscale emitters. In this talk, we will describe the physics behind such enhancement, and present our recent experimental results in optical slot antenna-enhanced III-V (InGaAsP) and monolayer transition metal dichalcogenide nano emitters.

8:30 am - 8:50 am

3C2

Significant Light Extraction Enhancement of Organic Light-Emitting Diodes Using Embedded High-index Deep-Groove Dielectric Nanomesh Fabricated by Large-area Nanoimprint, J. Qi, W. Ding, H. Chen, S. Y. Chou, Princeton University

A new OLED structure using a novel nanopatterned substrate embedding a high-index deep-groove-depth nanomesh, with high light extraction enhancement and large-area nanoimprint fabrication process,

overcomes the key limitation of using nanopatterned substrates for increasing light extraction efficiency of OLEDs and offers new approaches for high performance OLEDs lighting and displays.

8:50 am - 9:10 am

3C3

High-Performance Nanoimprinted Perovskite Nanograting Photodetector, Honglei Wang, Balasubramaniam Balachandran, Ross Haroldson, Anvar Zakhidov, Walter Hu, The University of Texas at Dallas

We report high-performance hybrid organic-inorganic perovskite photodetector with highly crystalline nanograting structure implemented by nanoimprint lithography. The nanoimprinted perovskite nanograting photodetector (nano-PSPD) shows significantly enhanced responsivity and superior photocurrent to dark current ratio compared to non-imprinted devices and commercial Si photodetector.

9:10 am - 9:30 am

3C4

Metrology of Sub-65nm Resist Gratings on Flexible Substrate Made by Jet and Flash Nanoimprint Lithography, Ruichao Zhu, S.R.J. Brueck, Noel Dawson, Tito Busani, Praveen Joseph*, Shrawan Singhal*, S.V. Sreenivasan*, University of New Mexico, *University of Texas at Austin

To ensure a good final result following the etching and deposition processes, it is very important to monitor the quality of resist gratings just after the imprint. Scatterometry is a solution to this problem. It is a fast, in-line, non-contact, non-destructive nanoscale metrology tool.

9:30 am - 9:50 am

3C5

Lab-on-a-fiber Sensors with Nanoimprinted Nanostructures on Fiber Sidewall, Z. Zhu, WD. Li, The University of Hong Kong

In this work, we proposed a fabrication method to create nanostructures on the sidewall of a fiber to demonstrate a new form of "lab-on-fiber" for light-matter interaction. We then used this fiber sensor to detect the environment refractive index. And a theoretical model was developed to explain the experimental phenomenon.

Session 4A – Plasmonics

Thursday, June 2, 2016

Room: Kings Garden 3

Session Chairs:

Chih-Hao Chang, North Carolina State University

Dieter Kern, University of Tuebingen

10:10 am - 10:30 am

4A1

Novel Plasmonic Metamasks for Photopatterning Molecular Orientations in Liquid Crystals, Yubing Guo, Miao Jiang, Chenhui Peng, Oleg D. Lavrentovich, Qi-Huo Wei, Liquid Crystal Institute, Kent State University, Kai Sun, Department of Material Science and Engineering, University of Michigan, Ann Harbor, Oleg Yaroshchuk, National Academy of Sciences of Ukraine

We present a new photopatterning technique for aligning LC molecules in arbitrarily complex orientation patterns by using carefully engineered plasmonic metamasks. Our technique shows high resolution and high throughput, which makes the patterning of LC molecular orientations a repeatable and scalable process for large scale manufacturing.

10:30 am - 10:50 am

4A2

Probing Sub-5 nm Gap Plasmon Using Collapsible Nano-fingers, B. Song, Y. Yao, Y. Wang, H. Liu, Y. Li, W. Wu*, University of Southern California

In this work, we have successfully fabricated gap plasmonic structure with precisely controlled nano-gap by using collapsible nano-fingers. We demonstrated how to define and scale sub-5nm gaps reliably and then we found the optimal gap sizes that give strongest plasmonic enhancement for different gap material.

10:50 am - 11:10 am

4A3

Tilted lithography and pattern transfer for the fabrication of asymmetric 3D plasmonic nanostructures, C. Dreser, D. P. Kern, M. Fleischer, University of Tuebingen

We introduce two fabrication processes for asymmetric 3D plasmonic nanostructures. Tilting the sample during the EBL exposure combined with the evaporation of metals under an angle and the transfer of nano-masks into a gold layer via argon ion milling under a tilting angle enables the fabrication of slanted 3D nanostructures.

11:10 am - 11:30 am

4A4

Self and directed assembly of metallic nanoparticles via PLiD and STEM/ EELS characterization of plasmon-related effects, Yueying Wu, Guoliang Li*, Charles Cherqui**, Nicholas W. Bigelow**, Jon P. Camden*, David J. Masiello**, Jason D. Fowlkes***, Philip D. Rack***, University of Tennessee, *University of Notre Dame, **University of Washington, ***Oak Ridge National Laboratory

The physical properties and liquid dynamics underlying metallic thin film dewetting were investigated for the purpose of understanding how initial boundary conditions facilitate precise assembly. Then the crystalline structure and plasmon effect of resultant nanoparticles were examined using a transmission electron microscope (TEM) and Electron energy loss spectroscopy (EELS).

11:30 am - 11:50 am

4A5:

Patterning large area plasmonic nanostructures on non-conductive substrates using variable pressure electron beam lithography, J. Babocky, J. Fiala*, J. Bok*, Central European Institute of Technology, *TESCAN Brno s.r.o.

Fabrication of plasmonic nano-structures on non-conductive materials in variable pressure which compensates the charging of the sample. The main advantage of our approach is no need of any sample pre-exposure or post-exposure treatment. SEM, transmission spectroscopy and coherence-controlled holographic microscopy techniques were used to characterize these structures.

Session 4B - Novel Imaging and Characterization Techniques

Thursday, June 2, 2016

Room: Kings Garden 4

Session Chairs:

Larry Muray, Keysight Technologies

Abdel Isakovic, Khalifa University – KUSTAR

10:10 am - 10:30 am

4B1

Design and Testing of a Novel Electron Monochromator for High Resolution Imaging and Spectroscopy, M. Mankos, K. Shadman, V. Kolarik*, Electron Optica, Inc., *Delong Instruments

In this paper, we focus on the design and testing of a novel monochromator that can reduce the energy spread of electron sources from the characteristic range of 0.5 - 1 eV into the sub-100 meV range.

10:30 am - 10:50 am 4B2

Atom Eyes: „The NEutral helium Microscope NEMI, Sabrina Daniela Eder

Here we present our focused neutral helium beam microscope NEMI and the first images. As one of the few existing instruments in the novel field of scanning helium microscopy (SHeM), NEMI offers promising possibilities in its unique way of imaging with a focused neutral helium beam.

10:50 am - 11:10 am 4B3

3D Nano Tomography, TEM Lamella Preparation, and Automated Nanofabrication with ORION NanoFab, S. Eyhusen, B. Goetze, Carl Zeiss Microscopy, LLC

First results on 3D nanotomography, TEM lamella preparation, and automated nanofabrication obtained with ZEISS ORION NanoFab, a helium, neon, gallium multibeam instrument.

11:10 am - 11:30 am 4B4

Fiducial Registration and Field Stitching for Multi-Scale Scanning Tunneling Microscope Lithography, S.W. Schmucker, J.B. Ballard, J.H.G. Owen, U. Fuchs, J.N. Randall, Zyvex Labs

Crossing length scales from nanometers to microns while leveraging the atomic precision of hydrogen depassivation lithography and mitigating scaling limitations of STM hardware requires field stitching technologies. We present our progress on the development of automated fiducial finding and field stitching approaches for the development of STM lithography.

11:30 am - 11:50 am 4B5

High-Resolution Compact FESEM with a Magnetic Immersion Objective Lens, J. Spallas, L. Muray, M. Mankos*, Keysight Technologies, *Electron Optica

We have designed, built and tested a prototype ultra-high resolution field emission scanning electron microscope (FESEM) using a Keysight 8500 FESEM fitted with a new magnetic immersion lens. We will present details of the optical and mechanical design and system performance.

Session 4C - Nano-mechanical Systems

Thursday, June 2, 2016

Room: Kings Garden 5

Session Chairs:

Robert Ilic, NIST

David Czapski, Argonn

10:10 am - 10:30 am 4C1

Design and Implementation of Soft Polymer-Based Cantilever Probe for Atomic Force Microscopy, F. Yu*, J. Liu*, A.-L. Lin**, N. Z. Khan*, Y. Pan*, Q. Zou*, and J. Jeon*, *Rutgers, The State University of New Jersey, **Clark University

In this work, we report a polymer-based V-shaped AFM probe, which comprises a soft cantilever with spring constant < 0.01 N/m and a sharp probe tip with a radius of curvature ~ 40 nm.

10:30 am - 10:50 am 4C2

Optomechanical transducer for investigation of frequency fluctuations, Thomas Michels
Vladimir Aksyuk, National Institutes of Standards and Technology

We developed an on-chip cavity optomechanical transducer platform that combines high bandwidth and sensitivity near the standard quantum limit with compactness, robustness, small size, and potential for low cost batch fabrication inherent in MEMS. This transducer allows us to further investigate frequency fluctuations and their origin.

10:50 am - 11:10 am 4C3

Role and characterization of the built-in stress in double clamped beam silicon nanowires, J. Lobet, M. Lorenzoni, F. Perez-Murano. IMB-CNM

Suspended, double clamped silicon nano-beams are fabricated by a combination of focused ion beam exposure and silicon wet etching. Their performance as nanomechanical resonators is characterized. By tuning their geometrical dimensions, the electromechanical response is affected. The presence of built-in stress, characterized by atomic force microscopy, explains this effect

11:10 am - 11:30 am 4C4

Microwave Characterization of Nanocomposite based on Lithographically Defined Nanoparticles, Y.F. Wang, Y.Q. Su, J. Stang, M. Moghaddam, W. Wu, University of Southern California

Top-down lithography is used to fabricate nanoparticles for microwave-absorbing nanocomposites. Our experiments have shown that the nanocomposites based on lithographically defined particles (LDPs) greatly enhance the permittivity/permeability of the composite, leading to much larger microwave absorption efficiency than synthesized-nanoparticle-based nanocomposites.

11:30 am - 11:50 am 4C5

Ultra-Small Hysteresis of Submicrometer Shape Memory Alloys Prepared by Biased Target Ion Beam Deposition for Actuation Applications, H. Hou, R. Hamilton, M. Horn, The Pennsylvania State University

Shape memory alloys can exhibit high work output per unit volume with narrow hysteresis for fast-response, miniaturized actuation applications. This work explores new fabrication of NiTi alloy thin films via biased target ion beam deposition customized with low energy ion beam. Findings confirm ultra-small hysteresis, promising for advancing nanoscale actuation.

Session 5A - Nanoimprint Lithography 1

Thursday, June 2, 2016

Room: Kings Garden 3

Session Chairs:

Stefano Cabrini, Lawrence Berkeley National Laboratory

Qiangfei Xia, University of Massachusetts

1:50 pm - 2:20 pm 5A1 Invited

Full color reflective display based on high contrast gratings, H. Liu, Y. Li, Y. Yao, Y. Wang, W. Wu, University of Southern California

A color reflective display based on stacked tunable "color mirrors" was invented. The "color mirrors" are realized using 2D high-contrast gratings fabricated by combining interference lithography and nanoimprint lithography. The design, fabrication, characterization of the color mirrors, and the color tuning and reconstruction will be presented.

2:20 pm - 2:40 pm 5A2

Overlay improvement in nanoimprint lithography for 1x-nm patterning, K. Fukuhara, M. Suzuki, M. Mitsuyasu, T. Komukai, M. Hatano, T. Kono, T. Nakasugi, Toshiba Corporation, Y. Lim, W. Jung, SK Hynix Inc.,

Nanoimprint lithography (NIL) is becoming a promising technique for fine-patterning with lower cost than other lithography technique. High overlay accuracy is one of the big challenges in NIL. We describe evaluation of NIL overlay performance using the up-to-date NIL tool, and discuss potentials of NIL overlay in the future.

2:40 pm - 3:00 pm

5A3

Replication of Nanostructures on Polyethylene Terephthalate with Laser-Assisted Roller Nanoimprinting, Y.Yajima, K.Nagato, *, M.Nakao, The University of Tokyo, *Research Fellow of Precursory Research for Embryonic Science and Technology (PRESTO), Japan Science and Technology Agency (JST)

We replicated nanostructures on polyethylene terephthalate (PET) films with laser-assisted roller nanoimprinting. In laser-assisted roller nanoimprinting, because only the surfaces of the mold and polymer are rapidly heated and cooled, nanostructures can be replicated before the crystallization. We demonstrated rapid replication of nanostructures on PET films.

3:00 pm - 3:20 pm

5A4

Near field campanile probe fabricated by nanoimprint lithography, G. Calafiore, A. Koshelev, S. Babin, K. Munechika, aBeam Technologies Inc., T. Darlington, N. J. Borys, J. Schuck, A. Weber-Bargioni, S. Cabrini, The Molecular Foundry, Lawrence Berkeley National Laboratory

A novel approach to fabricate 3D Campanile NSOM probes by direct UV-NIL on the facet of commercial optical fibers is presented. This is a high-yield, inexpensive process to manufacture Campanile probes and paves the way to the commercialization of these cutting-edge plasmonic tips.

3:20 pm - 3:40 pm

5A5:

Flat and highly flexible composite stamps for nanoimprint, their preparation and limits, Marc Papenheim, A. Mayer, S. Wang, C. Steinberg, H.-C. Scheer, University of Wuppertal

A method to prepare a flexible 2-layer stamp (20 μm OrmoStamp as top layer and 300 μm PDMS as backplane) being flat at room temperature is given. Imprints with particles on the substrate are performed to identify the limits of the stamp failure (break of top layer).

Session 5B - Atomic Layer Deposition

Thursday, June 2, 2016

Room: Kings Garden 4

Session Chairs:

Golnaz Karbasian, University of California, Berkeley

Ralf Heilmann, Massachusetts Institute of Technology

1:50 pm - 2:20 pm

5B1 Invited

Charged defects mitigation in metal single-electron transistors with tunnel barriers prepared by atomic layer deposition, G. Karbasian, A. O. Orlov, and G. L. Snider, University of Notre Dame

Several native oxide reduction treatments in metal (Ni) single electron transistors featuring ALD tunnel dielectrics (SiO_2 , Al_2O_3) are investigated. It is shown that the combination of anneal and remote plasma in hydrogen ambience results in switching noise suppression indicating abatement of charged defects in the junctions.

2:20 pm - 2:40pm

5B2

Single-digit nanofabrication: ultrahigh density sub-10 nm TiO_2 features via the self-aligned double patterning process, Stefano Dallorto, Daniel Staaks, Simone Sassolini, Adam Schwartzberg, XiaoMin Yang**, Kim Y Lee**, Shuaigang Xiao**, Craig Ward***, Ivo W. Rangelow*, Deirdre L. Olynick, Molecular Foundry, * Ilmenau University of Technology, **Seagate Technology, *** Oxford University

With the goal of achieving nanoimprint masks for Bit Patterned Media at 7.5 nm half-pitch and below, with good mechanical stability, we study different materials, SiO_2 , Al_2O_3 , and TiO_2 . Thermal and plasma

processes are investigated. We demonstrate standing vertical TiO₂ lines with critical dimension below 6 nm can be patterned.

2:40 pm - 3:00 pm

5B3

Atomic Layer Deposition of Ternary Dielectrics for Gate Insulation and Passivation of GaN-based Metal-Insulator-Semiconductor Heterojunction Field Effect Transistors, A. Colon, J. Shi, L. Stan*, R. Divan*, University of Illinois at Chicago, *Argonne National Laboratory

Dielectric materials deposited by Atomic Layer Deposition on InAlN and AlGaIn semiconductors are electrically characterized. Metal-Insulator-Semiconductor Capacitors are fabricated to be measured and characterized.

3:00 pm - 3:20 pm

5B4

UV-Accelerated Detection and Recovery of CH₄ in ZnO Functionalized Multi-walled Carbon Nanotube Sensors, Md Humayun, R. Divan*, L. Stan*, D. Gotszola*, L. Gundel**, P. A. Solomon***, I. Paprotny, University of Illinois at Chicago, *Argonne National Laboratory, **Lawrence Berkeley National Laboratory, ***Environmental Protection Agency

In this paper we present a UV-based recovery technique for the ZnO functionalized multi walled carbon nanotube (MWCNT)-based chemoresistor methane sensor. We were able to reduce the recovery and consequently detection time of functionalized MWCNT-based methane sensor by utilizing strong UV response of ZnO.

3:20 pm - 3:50 pm

5B5 Invited

Area-selective atomic layer deposition using e-beam and photosensitive masking layers, R.H.J. Vervuurt, A. Sharma, Y. Jiao, W.M.M. Kessels, A.A. Bol, Eindhoven University of Technology

In this contribution we report on the area-selective atomic layer deposition of Pt using temperature stable polymers films. The resists used can be patterned using conventional lithography. It will be discussed that the results can also apply to other materials provided the ALD chemistry is unreactive towards the resist surface.

Session 5C - Nanofabrication through Self-Assembly

Thursday, June 2, 2016

Room: Kings Garden 5

Session Chairs:

Anthony Novembre, Princeton

Alex Liddle, NIST

1:50 pm - 2:20 pm

5C1 Invited

Block Copolymer Nanolithography, S. Y. Kim, C.A de Coulomb, Ulsan National Institute of Science and Technology

Application of patterning with block copolymers in thin films will be firstly reviewed and limitations and challenges of the block copolymer lithography will be discussed.

2:20 pm - 2:40 pm

5C2

Selective Directed Self Assembly of Coexisting Morphologies Using Block Copolymer Blends, A. Stein, G. Wright, K.G. Yager, C.T. Black, Brookhaven National Laboratory

We present Selective Directed Self Assembly where careful design of the pitch and duty cycle of a line grating template causes a single block copolymer blend to simultaneously self-assembles into desired spatial arrangements of coexisting line and dot morphologies.

2:40 pm - 3:00 pm

5C3

Fabrication of Multilayer Complex Nanomesh Patterns, A. Tavakkoli K. G., S. M. Nicaise, K. Gadelrab, A. Alexander-Katz, C. A. Ross, K. K. Berggren, MIT

We used orthogonal self-assembly to produce complex multi-layer nanomesh structures without requiring alignment or high-resolution lithographic templating. BCP grating patterns were used to orthogonally self-assemble another layer of a BCP grating with a different period. We fabricated nanomesh patterns in circles, bends, junctions and with multiple local directions.

3:00 pm - 3:20 pm

5C4

Design Strategy for Layout of Sub-Resolution Directed Self-Assembly Assist Features (SDRAFTs), M. C. Tung, J. Doise*, **, J. Ryckaert*, H.-S. P. Wong, Stanford University, *imec, **Katholieke Universiteit Leuven

We propose a method to integrate sub-DSA resolutions assist features (SDRAFTs) into DSA template layouts using a grid of SDRAFTs. The method demonstrates a narrower range of density variation after the SDRAFT assignment, indicating promise to control template overfill.

3:20 pm - 3:40 pm

5C5 :

Multidirectional BCP Alignment by Thermal-Coefficient-of-Expansion Mismatch Shear, S.M. Nicaise, A. Tavakkoli K.G., K. Gadelrab, A. Alfredo-Katz, C.A. Ross, K.K. Berggren, Massachusetts Institute of Technology

Shear-stress alignment of block copolymers has been used to achieve long-range order of nanopatterns. In this work, the mismatch between the thermal-coefficient-of-expansion in a top-coat of silica and silicon substrate produces shear to align PS-b-PDMS polymer cylinders. Alignment is observed over mm distances, with controllable direction and <1-minute annealing.

Session 6 -EIPBN History Thursday, June 2, 2016 Room: Kings Garden 4/5

Session Chairs:

Don Tennant, Cornell University

Theodore Fedynyshyn, MIT Lincoln Labs

4:00 pm - 4:30 pm

6A1 Invited

History of the Three Beams Meeting, M. Schattenburg, MIT Space Nanotechnology Laboratory

The first meeting of the EIPBN conference took place on March 20, 1959. The small group of electron beam welding enthusiasts who met then would be astonished to see what the meeting has become now. I will discuss the early years of the meeting and how it has progressed to the present day.

4:30 pm - 5:00 pm

6A2 Invited

20 Years of Nanoimprint, S. Y. Chou, Princeton University

The talk will present a personal view of the past, present and future of nanoimprint.

Session 7A - Lithographic Materials
Friday, June 3, 2016
Room: Kings Garden 3

Session Chairs:

Karl Berggren, Massachusetts Institute of Technology

Chris Mack, Lithoguru.com

8:00 am - 8:30 am

7A1 Invited

Directed Self-Assembly patterning options for FinFET formation at 7nm node, C Liu,* E Franke,** F Lie,* S Sieg,* H Tsai,*** K Lai,* H Truong,**** R Farrell,** M Somervell,***** D Sanders,* N Felix,* M Guillorn,* D Hetzer,** A Ko,** J Arnold,* S Burns,* M Colburn*, *IBM Research Albany,**TEL Technology Center, America, LLC, ***IBM Research Yorktown Heights, ****IBM Research Almaden, *****Tokyo Electron America

In this work, three DSA options for Fin patterning, i.e. Grapho, Chemo, and Hybrid processes, are compared with the conventional fin-array-plus-cut method and discussed based on placement error and design complexity. Preliminary learning and structural results, as well as the extendibility for devices with smaller pitches will be further discussed.

8:30 am - 8:50 am

7A2

Rule-based patterning of a multi-state system by block copolymer self-assembly, H. Do, H. K. Choi, J. Chang, C. A. Ross, K. K. Berggren, Massachusetts Institute of Technology

We demonstrate that block copolymer cylinders can form a multi-state system with ladder-shaped structures inside a polygonal confinement when bending angle of the confinement is 90° or above. We describe a design rule based on majority rule to determine the individual state by controlling alignment direction of the ladder-shaped structures.

8:50 am - 9:10 am

7A3

Effect of Elastic Modulus of UV Cured Resist on Demolding Force, M. Shirai, K. Uemura, K. Shimomukai, T. Tochino, H. Kawata, Y. Hirai, Osaka Prefecture University

In this paper we report the effect of elastic modulus of UV cured resist on the demolding force measured by an in-situ process using a rheometer. It was found that the demolding force could be reduced by changing the storage modulus of cured resists.

9:10 am - 9:30 am

7A4

High Resolution Organic Resist Materials for EUV and E-beam Lithography Based on Molecular Glasses: A Comparison of Negative Tone and Positive Tone Approaches to Form Robust Cross-linked Polymer Nanopatterns, Brandon Sharp**, Hannah Narcross**, Clifford L. Henderson*, * School of Chemical and Biomolecular Engineering, Georgia Institute of Technology,** School of Chemistry and Biochemistry, Georgia Institute of Technology

We have shown recently that negative tone resists based on cross-linking of functionalized molecular glass cores can yield excellent high resolution resists. In this paper we will present new negative tone resists based on cross-linking mechanisms and compare these with new resists based on depolymerization of dense polymer networks.

9:30 am - 9:50 am

7A5

High resolution, hybrid 3D topography fabrication using grayscale electron beam lithography, R. Kirchner, H. Schift, Paul Scherrer Institut

We present material independent process rules governing the structures obtained in electron beam grayscale patterning using positive tone resist. We demonstrate the universal applicability of selective thermal reflow for such resists. Application examples range from diffractive optics to bio-inspired patterns.

Session 7B - Emerging Fabrication Techniques 1
Friday, June 3, 2016
Room: Kings Garden 4

Session Chairs:

Aaron Stein, Brookhaven National Laboratory

Bo Cui, University of Waterloo

8:00 am - 8:30 am 7B1 Invited

Contamination-free suspended graphene structures by a Ti-based transfer method, A. Matruglio, University of Trieste

A comparison between two graphene transfer methods will be described: one using polymer, which is the most used in literature, and a new one involving a thin Titanium layer, to have a cleaner graphene without defects. Some new applications will be shown, as X-ray photoelectron spectroscopy in liquid.

8:30 am - 8:50 am 7B2

Ionic Liquid Gating effects on a-IGZO Thin Film Transistors: A Novel Method for Amorphous Metal Oxide Activation, P. R. Pudasaini, J. H. Noh, A. Wong, A. V. Haglund, D. Mandrus, P. D. Rack, O. S. Ovchinnikova*, S. Dai*, T. Z. Ward*, University of Tennessee, Knoxville, *Oak Ridge National Laboratory

We report controllable activation of a-IGZO channel using ionic liquid gating effect. We demonstrate a transparent flexible thin film transistor on a polyamide substrate created using this simple technique. This study demonstrates the potential of field-induced activation as a promising alternative to traditional post-deposition thermal annealing for flexible electronic applications.

8:50 am - 9:10 am 7B3

Lithiation of Sn Microspheres: Li FIB vs Electrochemistry, J. J. McClelland, W. R. McGehee, S. Takeuchi, J. L. Schaefer, * T. M. Wilson, K. A. Twedt, ** E. H. Chang, V. P. Oleshko, and C. L. Soles, National Institute of Standards and Technology, *University of Notre Dame, **University of Maryland

Lithiation of tin-microsphere model battery cathode material is carried out by both low-energy Li⁺ FIB implantation and conventional electrochemical methods. Comparison of the two methods is made by FESEM imaging and Ga⁺ FIB cross sectioning. Results suggest Li⁺ FIB implantation can be useful for studying nanoscale battery processes.

9:10 am - 9:30 am 7B4

Stretchable Metal-mesh Transparent Electrodes Fabricated through a Solution-processed Approach, C. Zhang, A. Khan, and W. Li, University of Hong Kong

Our work reports a promising low-cost fabrication method for flexible and stretchable transparent electrodes. The whole processes are solution-based, making it possible for mass production. Our fabricated samples show desirable stretchability and uniformity. We also further developed a template-based metal-mesh transparent electrode fabrication following the original fabrication process.

9:30 am - 9:50 am 7B5

Double-Gate Organic Micro-Electro-Mechanical Relay for Ultralow-Power Flexible Large-Area Electronics, Y. Pan, J. Jeon, Rutgers, The State University of New Jersey

In this work, we propose and demonstrate a polymer-based double-gate micro-electro-mechanical (MEM) relay as a potential alternative to organic thin-film transistors in order to enable ultralow-power flexible large-area electronics.

Session 7C - Focused Beam Induced Processing
Friday, June 3, 2016
Room: Kings Garden 5

Session Chairs:

Todd Hastings, University of Kentucky

Ulrich Hofmann, Genisys GMBH

8:00 am - 8:30 am **7C1 Invited**

Laser Assisted Focused Ion Beam Processing, P. D. Rack, J. D. Fowlkes, University of Tennessee

In this presentation we will introduce a new technique for mitigating sub-surface focused He⁺ and Ne⁺ ion beam damage via a pulsed laser assist process. Specifically we will demonstrate experimentally and simulations that silicon amorphization and peripheral damage in graphene can be mitigated via pulsed laser assisted focused ion beam induced processing.

8:30 am - 8:50 am **7C2**

Focused Electron Beam Induced Processing in ultra-high vacuum: new routes for the fabrication of clean metallic nanostructures and the reduction of proximity effects, Fan Tu, Martin Drost, Luisa Berger, Florian Vollnhals, Hubertus Marbach, University of Erlangen

Currently we were able to expand the family of FEBIP techniques with the exploration of Electron Beam Induced Surface Activation (EBISA). In this two step process the surface is first chemically activated via irradiation with electrons and after that "developed" with precursor molecule yielding a clean metallic deposit.

8:50 am - 9:10 am **7C3**

Ultra-fast nano-fabrication using Xe-plasma FIB-SEM and its Cu milling applications using the Rocking-stage, S. Sharang, A. Benkouider, T. Hrnčíř, J. V. Oboňa, J. Jiruše, E. Principe*, TESCANA ORSAY HOLDING, *TESCAN USA

In this work we show a novel method using Xe-plasma FIB-SEM and the Rocking-stage for an ultra-fast nano-fabrication of electronic devices and its applications for Cu milling.

9:10 am - 9:30 am **7C4**

Monte-Carlo Simulations of Ion Beam Sputtering in Compounds, K. Mahady*, P. D. Rack* **, S. Tan***, R. Livengood***, A. Raveh***, Y. Greenzweig***, *University of Tennessee, **Center for Nanophase Materials Sciences Oak Ridge National Laboratory, *** Intel Corp.

9:30 am - 9:50 am **7C5**

Focused ion beam nano-trench shape dependence on target material, Y. Greenzweig, Y. Drezner, Z. Malamud, A. Raveh, Intel Israel (74) Ltd.

Shapes of narrow vias etched by gas-assisted focused ion beam (FIB) several tens of nanometers into dielectric and filled by E-beam deposition were studied. Measurements by transmission electron microscopy demonstrated marked differences between the widths of vias etched through targets of PECVD oxide versus FIB induced deposition oxide.

Session 8A - Nanoimprint Lithography 2
Friday, June 3, 2016
Room: Kings Garden 3

Session Chairs

Hao Chen, Intel

Wei Wu, University of Southern California

10:10 am - 10:30 am 8A1

Impact of template stiffness during peeling release in nanoimprint lithography, Florian Chalvin^{1 2}, Naoto Nakamura¹, Takamitsu Tochino¹, Masaaki Yasuda¹, Hiroaki Kawata¹, and Yoshihiko Hirai¹, ¹Osaka Prefecture University, ²Ecole Nat. Sup.de l'Electronique et de ses Applications

Impact of the template stiffness is investigated in both computational and experimental works. For soft template, the release force decreases due to the small area being gradually detached; however the induced stress in the resist increases due to deformations caused by the template bending.

10:30 am - 10:50 am 8A2

Nanoimprinted Perovskite Micro- Nanostructures for Photovoltaics, Bala Balachandran, Ross Haroldson, Yixin Ren, Honglei Wang, Julia Y. Chan, Anvar Zakhidov, Walter Hu, The University of Texas at Dallas

We report the use of nanoimprint to pattern perovskites into ordered micro and nanostructures with improved crystallinity and light absorption for photovoltaics applications. Nanoimprint significantly increases the crystallinity in perovskite nanograting and nanopores as shown in XRD spectrum. Solar cells using perovskite nanogratings have shown large enhancement in photocurrent.

10:50 am - 11:10 am 8A3

Nanoimprint-induced orientation of localized wrinkles with SU-8, C. Steinberg, M. Runkel, M. Papenheim, S. Wang, A. Mayer, H.-C. Scheer, University of Wuppertal

The impact of a pre-patterned SU-8 layer on the orientation of localized wrinkles after a VUV-treatment is investigated. The pre-pattern is realized by nanoimprint. The type of pre-pattern and the initial layer thickness of SU-8 influence the wrinkling alignment and the anisotropy obtained.

11:10 am - 11:30 am 8A4

Printed Active Photonic Crystals in High Refractive Index Functional Materials for Visible Light Applications, C. Pina-Hernandez*, A. Koshelev*, G. Calafiore*, M. Sainato**, S. Dhuey**, K. Munechika*, S. Cabrini**, *aBeam Technologies, **The Molecular Foundry, Lawrence Berkeley National Laboratory,

We present the first printed active photonic crystals with embedded quantum dots, fabricated by the direct printing of high refractive index materials for visible light applications. Arrays of photonic crystals nanocavities with high quality factors were obtained. This work represents a powerful route for the development of novel nanophotonic devices.

11:30 am - 11:50 am 8A5

Surface confined equilibration for super-smooth surfaces, N. Chidambaram, R. Kirchner, M. Altana*, S. Neuhaus**, M. Kristiansen**, H. Schiff, Paul Scherrer Institute, *Heptagon Oy, **University of Applied Sciences and Arts Northwestern Switzerland

A novel mastering strategy with 2 photon polymerization for refractive micro optical devices is accomplished. Super smooth surface finish is realized applying a surface sensitive exposure followed by

thermal reflow while retaining the complex 3D profile. For this purpose master structures were imprinted into PMMA through PDMS intermediate reproduction.

Session 8B - Emerging Fabrication and Characterization Techniques 2
Friday, June 3, 2016
Room: Kings Garden 4

Session Chairs:

Sergey Babin, Abeam

Elizabeth Dobisz, Spin Transfer Technologies

10:10 am - 10:30 am 8B1

Fabrication of cylindrical neural probes with integrated conductor wiring, A. Awale, P. Motwani, M. Gheewala, R. Kusko, T.-A. Tisa, W.-C. Shih, J. Wolfe, G. Purushothaman*, J. A. Dani**, V. Dragoi***, University of Houston, *Parallon, **University of Pennsylvania, ***University of Texas-Houston Medical School

Our objective is to fabricate probes on optical fiber substrates for optogenetic studies in the cortex of macaques. Probe design calls for 28 staggered electrodes on each of 4 sides of the probe. Fabrication relies on helium atom beam lithography, a conformal plasma polymerized resist, and an indirect alignment scheme.

10:30 am - 10:50 am 8B2

Systematic study of high throughput fabrication of nano holes and nano pillars in polymer foils by roll-to-roll-extrusion coating., S.Murthy^{1,2}, H. Pranov¹, H. Pedersen², R.Taboryski², ¹InMold A/S, Denmark; ² Technical University of Denmark

This paper investigates a novel roll-to-roll (R2R) process for large area nanostructuring, known as roll-to-roll extrusion coating (R2R-EC), having productivity rates, potentially, exceeding 5m²/s. Significantly higher than current R2R methods. This will enable large area nanostructuring of functional biomimetic surfaces such as superhydrophobic, anti-reflective, structural colors etc..

10:50 am - 11:10 am 8B3

Ion Beam Injector based on High Current LMIS, P. Laufer, D. Bock, W. Pilz, L. Bischoff*, M. Tajmar, Dresden Technical University, *Helmholtz-Zentrum Dresden-Rossendorf

An ion source injector module based on high current LMIS is presented for the use of different mon - or polyatomic ions in the 100 μ A range for large area applications. An asymmetric Einzel lens forms a nearly parallel beam and the desired ions were selected by an ExB filter

11:10 am - 11:30 am 8B4

Multiscale Porous Structure Enabled by Variable Voxel Stereolithography, Yuanrui Li, Huachao Mao, Yuhan Yao, He Liu, Yifei Wang, Boxiang Song, Yong Chen, Wei Wu, University of Southern California

We proposed building multiscale porous structures by using variable voxel stereolithography which is realized by two lasers and an optical filter based on high contrast gratings that were fabricated by nanoimprint lithography. The object-size-to-resolution ratio can reach 10³ which is one order of magnitude higher than current technology.

11:30 am - 11:50 am 8B5

Characterization of Nanofabricated Electron Transmission Gratings with Electron Diffraction, Y. Yang, R. G. Hobbs, C. S. Kim, O. T. Celiker, A. Agarwal, W. Li, K. K. Berggren, Massachusetts Institute of Technology

Here we report a nanofabricated two-dimensional mesh transmission gratings for electron beams and its characterization with electron diffraction in a TEM with various electron energies. Nanofabricated electron transmission gratings can be used as diffractive electron beam splitters, of which the splitting ratio is tunable by material-imposed electron phase-shift.

Session 8C - Nanophotonics 2
Friday, June 3, 2016
Room: Kings Garden 5

Session Chairs:

Joel Wendt, Sandia National Labs

Martin Feldman, Louisiana State University

10:10 am - 10:30 am 8C1

Sub-10-nm Three-Dimensional Plasmonic Probes fabricated using a Helium Ion Microscope, G. Calafiore, A. Koshelev, K. Munechika, aBeam Technologies Inc., F.I. Allen, P. Lum, Biomolecular Nanotechnology Center, UC Berkeley, J. Schuck, A. Minor, S. Cabrini, The Molecular Foundry, LBNL

We report the fabrication of high-resolution 3D NSOM tips on a AFM probe by Helium Ion Microscope with superior plasmonic performance.

10:30 am - 10:50 am 8C2

Fabrication of Au lamellae nanostructure for high sensitive biosensor applications, Sichao Zhang, Yifang Chen, Bingrui Lu, Jianpeng Liu, Jinhai Shao, Chen Xu, Fudan University

We have developed a novel process based on alternated development/dissolution and electroplating to explore the sensing capability of gold Morpho butterfly wing scales as SPR and SERS. The process developed in this work is of application prospects in multidisciplinary areas.

10:50 am - 11:10 am 8C3

Optical Properties of "Air-Like" Ordered 3D Thin-Shell Nanolattice Materials, X. Zhang, A. Bagal, E. Dandley, J. Zhao, C. Oldham, G. Parsons, C. Chang, North Carolina State University

A new class of low-index nanolattice materials with periodic architecture is demonstrated. The fabrication technique combines three-dimensional nanolithography and atomic layer deposition. Compared with random architectures in conventional low-index materials, the periodic order design enables designable refractive index from 1.3 to 1.025, improved mechanical stability and reduced optical scattering.

11:10 am - 11:30 am 8C4

Subwavelength Focusing of Light with a Slanted-Nanoaperture-Array Metal Lens, M. Kim, Y. S. Jung, Y. Xi, Y. Shi, H. K. Kim, University of Pittsburgh

We have investigated the radiation pattern of nano aperture transmission as a new degree of freedom in shaping transmission wavefronts for negative angle directions. By employing a vertical dipole concept of nano aperture transmission we demonstrate negative-angle refraction and sub wavelength focusing of light with a slanted-nanoaperture-array metal lens.

11:30 am - 11:50 am 8C5

Fabrication of an optomechanical resonator with a two-interface surface plasmonic structure for the wavelength detection, R. Koemtani, M. Goto, E. Maeda: The University of Tokyo

An optomechanical resonator with a two-interface surface plasmonic structure was fabricated in order to detect the wavelength. An optomechanical resonator and a two-interface surface plasmonic structure were made from Au, Ti and SiO₂. As a result, the wavelength resolution for unpolarized light with wavelength of 1550-1562 nm was 0.92 pm.

**Session 9A - Focused Ion Beam Lithography
Friday, June 3, 2016
Room: Kings Garden 3**

Session Chairs:

Shida Tan, Intel

Jabez McClelland, NIST

1:20 pm - 1:50 pm 9A1 Invited

Focused Helium Ion Beam Josephson Junctions and Nanowires, S. A. Cybart, E. Y. Cho, R. C. Dynes, University of California San Diego

Focused helium ion beams provide a new approach for sub-ten nanometer process control. This is important for Josephson junctions: the basic building block of superconducting electronics whose properties are governed by quantum mechanical tunneling. I will present recent results in the area of helium ion direct-write lithography of Josephson junctions.

1:50 pm - 2:10 pm 9A2

Focused ion beam milling of optical films with complex surfaces at the subnanometer scale, K.-T. Liao*, **, J. Schumacher*, H. J. Lezec*, S. M. Stavis*, *National Institute of Standards and Technology, **University of Maryland

We demonstrate the focused ion beam milling of submicrometer films of silicon dioxide and silicon nitride with subnanometer vertical resolution. Our new patterning capability enables the rapid prototyping of complex surfaces in dielectric materials with novel structure–property relationships for optical applications.

2:10 pm - 2:30 pm 9A3

Ga+ Focused Ion Beam Lithography as a Viable Alternative for Multiple Fin FinFET Prototyping, A. Leonhardt, F. H. Cioldin, M. V. P. dos Santos, J. A. Diniz, L. T. Manera, L. P. B. Lima*, University of Campinas (UNICAMP), *IMEC

This work presents the Ga+ FIB lithography as a viable alternative for obtaining sub-100nm wide fins for FinFET prototypes with good repeatability and reduced processing time. The method relies on shallow cuts on Si upper layer of the fin structure and plasma etching to produce the fins.

2:30 pm - 2:50 pm 9A4

Focused helium-ion induced direct write engineering of 2D materials, Michael G. Stanford, Pushpa Raj Pudasaini, Alex Belianinov, Nick Cross, Michael Koehler, David G. Mandrus, Gerd Duscher, Philip D. Rack, Alex Belianinov*, Adam J. Rondinone*, University of Tennessee, *Oak Ridge National Laboratory

Recent work has realized the potential of ion beams as a tool for processing 2D materials. Here, we utilize a focused He+ beam for direct-write patterning and electrical tuning of 2D materials. Direct-write patterning is enhanced by use of synchronized laser and electrical tuning is achieved by controlling defect density.

2:50 pm - 3:10 pm

9A5

Nanopores in Silicon Nitride Membranes, Graphene and CNM: Milling and Imaging Techniques at the Helium Ion Microscope, D. Emmrich, A. Beyer, A. Götzhäuser, A. Nadzeyka*, S. Bauerdick*, J. Kotakoski**, Bielefeld University, *Raith GmbH, **University of Vienna

Helium ion microscopy was employed for both milling nanopores in free standing membranes as well as for the inspection of nanopores. Three different membrane types were investigated: 30 nm thick silicon nitride, graphene and 1 nm thick carbon nanomembranes made from aromatic self-assembled monolayers by electron-induced cross-linking.

Session 9B - Nanofabrication and Biology 2

Friday, June 3, 2016

Room: Kings Garden 4

Session Chairs:

Regina Luttgé, Technical University of Eindhoven

Reginald Farrow, New Jersey Institute of Technology

1:20 pm - 1:50 pm

9B1 Invited

Micro-fabricated elastomeric pillar arrays for studies of cellular sensing of extracellular matrix rigidity, H. Wolfenson, M. P. Sheetz, S. Liu, J. Hone, Columbia University

Cellular mechanosensing is a fundamental biological phenomenon that is essential for the proper response of cells to features of their environment such as extracellular matrix rigidity. In my talk I will present our work using micro-fabricated elastomeric pillar arrays on cellular rigidity sensing and its potential implications in understanding cancer.

1:50 pm - 2:10 pm

9B2

Probing Breast Cancer Cell Response to Heterogeneous Rigidity at the Nanoscale, J. Liao, A. Guzman, L. Kaufman, S. J. Wind, Columbia University

Surfaces with patterned micro- and nanoscale rigidity are used to develop new insight into the differences in rigidity sensing between different breast cancer cell lines,

2:10 pm - 2:30 pm

9B3

Multiplexed Molecular Assays Using Nanoelectronically Barcoded Beads, P. Xie, X. Cao, Z. Lin, M. Javanmard, Rutgers University

We introduce the concept of electronically barcoded micron-sized beads, which to the best of our knowledge, is the first time an impedance based barcoding technique for beads has been used with the potential of achieving high barcode density.

2:30 pm - 2:50 pm

9B4

Fabrication of Hollow-Core Nanoparticles for Drug Delivery and Imaging, D. Shakarisaz, P. Ruchhoeft, University of Houston, Department of Electrical and Computer Engineering, C. Park, T. Randall Lee, University of Houston Department of Chemistry

Atom beam lithography is used for high-throughput patterning of gold hollow-core nanoparticles that can potentially carry a payload for drug delivery or imaging. We were able to coat the particles with a thermal sensitive polymer that can encapsulate the payload.

2:50 pm - 3:10 pm

9B5

Micro- and Nano-structured, Biofunctional Block Co-Polymer Interfaces for High-Avidity Bacteria Capture, Ryan R. Hansen, Mohammadali Masigoul, Department of Chemical Engineering, Kansas State

University, Brad S. Lokitz, Scott T. Letterer, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory

A synthetic biointerface that utilizes micro- and nano-structured, bio-functional polymer films for microbe capture is reported. These polymers modify interface chemistry in order to cluster lectin proteins together at high-densities, driving multi-valent binding interactions with bacterial exopolysaccharides. Optimization of this platform will allow for sensitive detection of microbial contamination.

Session 9C - Nanoelectronics 2
Friday, June 3, 2016
Room: Kings Garden 5

Session Chairs:

Diego Scarabelli, Columbia University

Shu-jen Han, IBM

1:20 pm - 1:50 pm

9C1 Invited

From Nanodevices to Nanosystems: The Carbon Nanotube Case Study, M. M. Shulaker, H. S. P. Wong, S. Mitra, Stanford University

In this talk, I will describe how to transform carbon nanotubes from solely a scientifically-interesting material to working nanosystems. This is enabled through a combination of new carbon nanotube processing and circuit design solutions. I will also discuss how carbon nanotubes are naturally suited for enabling new systems architectures, such as monolithically-integrated three-dimensional (3D) integrated circuits, as well as show recent experimental demonstrations.

1:50 pm - 2:10 pm

9C2

A New Opportunity to Fabricate Multi-Bit Transistor Memories Using Mechanically Exfoliated Multilayer WSe₂ Flakes, M. Chen, H. Rokni, N. Shepherd, W. Lu, and X. Liang, University of Michigan

We previously presented that a multilayer MoS₂ flake, after plasma doping, has a rippled top layer, which can serve as a memory channel and enable data storage. Here, we further report that an as-exfoliated multilayer WSe₂ flake can enable multi-bit data storage with no need of plasma doping.

2:10 pm - 2:30 pm

9C3

Suspended two-dimensional MoS₂ transistor, R. Zhang, A. Bunting, V. Koutsos*, R. Cheung, Scottish Microelectronics Centre, The University of Edinburgh, *Institute for Materials and Processes, The University of Edinburgh

2:30 pm - 2:50 pm

9C4

Direct Write Electron Beam Lithography for Top-down Fabrication of sol-gel based ZnO micro-nano FETs, N. Tiwale, Y. Alaverdyan, M. E. Welland, University of Cambridge

Using sol-gel precursors as negative tone resists for e-beam direct nano-patterning of ZnO can provide precise positioning of ZnO nano-devices; while achieving enhanced sensing response due to their nano-crystalline nature. We report ZnO micro-nano FETs fabricated using zinc neodecanoate and zinc naphthenate with improved linear mobility.

2:50 pm - 3:10 pm

9C5:

Repetitive Nanoprinting Technique for Producing Vertically Stacked Transition Metal Dichalcogenide Heterostructure Arrays and Photo-Response Devices, S. Wi, D. Li, M. Chen, B. Ryu, and X. Liang, University of Michigan

We present an upscalable nanofabrication technique capable of producing uniform multilayer TMDC heterostructure arrays into device sites. Specifically, using this technique, we have demonstrated the fabrication of uniform WSe₂/MoS₂ heterostructure arrays. Such heterostructures can be used for making photo-response devices.

Session 10A - Advanced Etching Techniques 2
Friday, June 3, 2016
Room: Kings Garden 3

Session Chairs:

Jim Thackeray, Dow Electronic Materials

Gerald Lopez, University of Pennsylvania

3:30 pm - 4:00 pm

10A1 Invited

Pattern-generation and pattern-transfer for sub-10nm devices, Ivo W. Rangelow^a, Marcus Kaestner^a, Yana Krivoschapkina^a, Ahmad Ahmad^a, Tihomir Angelov^a, Tzvetan Ivanov^a, Steve Lenk^a, Claudia Lenk^a, Burkhard Volland^a, Elshad Gulyiev^a, Ivaylo Atanasov^a, Alexander Reum^{a,b}, Valentyn Ishchuk^a, Zahid Durrani^d, Mervyn Jones^d, Deirdre L. Olynick^b, Daniel Staaks^{a,b}, Stefano Dallorto^{a,b}, Mathias Holz^{a,c}, Nikolay Nikolov^c, ^aIlmenau University of Technology, ^bLawrence Berkeley National Laboratory, ^cNano Analytik GmbH, ^dImperial College London, ^eMikrosistemi Ltd.

Today, high resolution lithographic techniques are typically linked with high capital investment in equipment. We present a relatively low cost, fast sub-10nm Scanning Probe Lithography based on Fowler-Nordheim electron emission from a scanning tip. This is combined with cryogenic etching as an approach to control feature-profiles at the nanometer scale.

4:00 pm - 4:20 pm

10A2

SiO₂ plasma etching using SF₆ with O₂/Ar mixtures down to cryogenic temperatures, S. Rangnekar^{1,2}, D. Tierno^{1,3}, D. Staaks^{1,3}, M. Kocsis⁵, I. Rangelow⁴, A. Goodyear⁶, C. Ward⁶, D. Olynick¹, ¹Lawrence Berkeley National Laboratory, ²UC Berkeley, ³IMEC, ⁴Ilmenau University of Technology, ⁵Inpria Corp., ⁶Oxford Instruments

We test the utility of SF₆ at cryogenic temperatures when etching sub-100 nm features in silicon oxide for applications such as nanoimprint template formation. We use two etching masks, hafnia and chromium, and complementary gases, Ar and O₂. The effect of power, pressure, gas mixtures and temperature will be discussed.

4:20 pm - 4:40 pm

10A3

Fabrication Process for 200 nm-Pitch Polished Freestanding Ultra-High Aspect Ratio Gratings, A. R. Brucoleri, Izentis LLC, R. K. Heilmann and M. L. Schattenburg, Massachusetts Institute of Technology

A fully integrated fabrication process has been developed to fabricate freestanding, ultra-high aspect ratio gratings with KOH-polished sidewalls. The gratings have a pitch of 200 nm, a depth of 4 μm, and the bars are polished via KOH. The finished gratings span an area of approximately 10 by 30 mm.

4:40 pm - 5:00 pm

10A4

Computational study on novel proximity lithography for deep stepped substrate by Built-in Lens Mask (BILM), Toshiki Tanaka, Hisao Kikuta, Masaaki Yasuda, Hiroaki Kawata, Masaru Sasago, and Yoshihiko Hirai

Novel optical lithography for stepped substrate is newly proposed using built in lens mask (BILM). The pattern is divided into small seed elements and the BILM is obtained by superposition for seed patterns. Fine pattern having around 1 μm linewidth is successfully imaged on 40 μm step height.

5:00 pm - 5:20 pm

10A5

Development of a Nanocrystalline Diamond (NCD) Membrane for Vacuum Pressure Separation and Patterned Electron Beam Image Transfer, D. Akemeier, Z. E. Russell, R. Edgington, Y.T. Cheng, L. Galambos, W. F. Aitkenhead, L. Hesselink, Stanford

We have developed a freestanding diamond membrane that acts as a lossless electron transparent window separating clean UHV from lower pressure environments and is compatible with patterned or multibeam applications. The production process and optimization results as well as its intended use in a patterned X-ray system will be described.

Session 10B - Micro and Nano Fluidics

Friday, June 3, 2016

Room: Kings Garden 4

Session Chairs:

Wu Lu, The Ohio State University

Walter Hu, University of Texas, Dallas

3:30 pm - 4:00 pm

10B1 Invited

Microfluidic devices: merging technology and biology, J.M.J. den Toonder, Eindhoven University of Technology

In microfluidics, engineering and life sciences merge. Fluid manipulation principles found in biology can be adopted in microfluidic devices through 'biomimetic design'. The other way around, microfluidic devices can be used to control and understand biological processes. This lecture will show examples of both: artificial cilia, responsive surfaces, and cancer-on-a-chip.

4:00 pm - 4:20 pm

10B2

Nanofluidic Liquid Cell with Integrated Electrokinetic Pump for In Situ TEM, Christopher H. Ray, B. Robert Ilic, Renu Sharma, Glenn Holland, Vladimir Aksyuk, Samuel M. Stavis, J. Alexander Liddle, National Institute of Standards and Technology

We have developed a nanofluidic cell with an integrated electrokinetic pump to enable high-resolution imaging of reactions occurring in liquid in the transmission electron microscope. We describe the fabrication process and operation of the cell.

4:20 pm - 4:40 pm

10B3

Replicating Natural Environments: Soil-inspired Microfluidic Architectures, J. Aufrecht, M. Doktycz, S. Retterer, Oak Ridge National Laboratory and The University of Tennessee

Microfluidic architectures were designed to replicate the physical parameters of sand samples in order to study the emergent phenomena of microbial communities in their natural habitat. The devices were fabricated using a granular media generator, standard photolithography, and poly-dimethylsiloxane molding and characterized with COMSOL Multiphysics simulations and particle velocimetry.

4:40 pm - 5:00 pm

10B4

Ultra-Compact Microfluidic Valves Using Magnetorheological Fluid Patterned on an Elastomeric Membrane, Azam Gholizadeh, Mehdi Javanmard, Rutgers University

We present a novel method for magnetically actuating microfluidic valves while maintaining an ultra-compact system footprint. Our magnetically actuated valves use Magnetorheological (MR) fluids patterned on elastomeric PDMS membranes, and are capable of dynamically opening and closing microchannels with an applied magnetic field.

5:00 pm - 5:20 pm

10B5

FIB Deposition of Platinum Micropillars in Microchannels for Diffusion Control in Microfluidic devices, Salomão M. S. Junior¹, Alfredo R. Vaz, Maria H. O. Piazzeta², Jacobus W. Swart¹, and Stanislav Moshkalev¹, ¹UNICAMP, State University of Campinas, ²Brazilian Nanotechnology National Laboratory

Focused Ion Beam Induced Deposition (FIBID) using organometallic precursors is frequently employed for deposition of metals. In this work was used Pt deposition to create micropillars in microfluidic devices for to increase of lowering liquids to improve the control of mass diffusivity to enhance the mixture of different fluids.

Session 10C - Electron Beam Lithography 2

Friday, June 3, 2016

Room: Kings Garden 5

Session Chairs:

Ming Lu, Brookhaven National Laboratory

Rich Tiberio, Stanford University

3:30 pm - 4:00 pm

10C1 Invited

The Impact of Parallelism on Data Volumes for a Multibeam Mask Writer, N. Chaudhary, Y. Luo, S. A. Savari, Texas A&M University

Future mask writers must transmit terabits of information per second and handle petabytes of data to handle upcoming throughput and resolution challenges. We will examine how parallelism affects the total beam compressed data for one idealized multibeam architecture inspired by the IMS Nanofabrication multibeam mask writer series eMET.

4:00 pm - 4:20 pm

10C2

Dense metasurface with high efficiency dense metasurface for broadband optical vortex by high resolution electron beam lithography, B.-R. Lu, C. Xu, Y. Chen, Fudan University

Metasurface generated optical vortex beams suffer from drawbacks of low efficiency and narrow waveband, hindering the practical use. We use high density subwavelength nano antenna array of the metasurface to achieve broadband efficiency enhancement in visible frequency. This metasurface can find applications in communication encryption, optical microscopy and optical tweezers.

4:20 pm - 4:40 pm

10C3

Fabrication of 3 Dimensional Photonic Crystals with Waveguides for visible Light, S. Dhuey, A. Testini, N. Borys, M. Melli, P.J. Schuck, C. Peroz, S. Cabrini, Molecular Foundry, Lawrence Berkeley National Lab

In this work we demonstrate 3D photonic crystals for the visible light regime fabricated by electron beam lithography. They are made with silicon nitride wires, with a nanoporous resist as the interstitial, forming woodpile structures, some of which contains defects for waveguiding.

4:40 pm - 5:00 pm

10C4

Electron beam lithography using grafted polystyrene monolayer brush, F. Aydinoglu, R. K. Dey, B. Cui, University of Waterloo

Polystyrene terminated with -COOH was grafted onto a substrate and used as negative e-beam resist. Pattern transfer into silicon was obtained by utilizing an intermediate Al hard mask layer, onto which the mono-layer polystyrene brush was grafted. The process can be employed to carry out nanofabrication on irregular (non-planar) samples.

5:00 pm - 5:20 pm

10C5

Large Area Three Dimensional Structure Fabrication using Multi-layer Electron Beam Lithography,
R.K. Bonam, SUNY Polytechnic Institute

Three dimensional nanostructures are of great interest in photonics and sensor communities. In this work, we describe a method that exploits intrinsic resolution and dose control of electron beam lithography systems combined with the penetration depth of high energy electron beams ($>100\text{keV}$) and tailored photoresist contrasts, tones.