

# Wednesday, May 29

## Plenary Session

### 8:00 am – Welcome

Aimee Bross Price, Ohio State University and Wei Wu University of Southern California

### 8:30 am – Micro/nanofabrication Techniques for 3D Functional Mesosystems: From Neural Interfaces to Environmental Monitors, John A. Rogers (Northwestern University)

Complex, three dimensional (3D) micro/nanostructures in biology provide sophisticated, essential functions in even the most basic forms of life. Recent advances in micro/nanofabrication and assembly provide access to diverse classes of electronics in 3D architectures, with characteristic dimensions from nanometers to centimeters, over areas that span square centimeters or more. This talk reviews the key concepts, with applications in electronic mesoscale networks as neural interfaces and in bio-inspired microfluidics as environmental sensing platforms.

### 9:15 am – Understanding and Controlling Charge, Heat, and Spin at Atomically Precise Interfaces, P. S. Weiss (UCLA)

By having developed the "eyes" to see, to record spectra, and to measure function at the nanoscale, we have been able to fabricate structures with precision, thereby controlling the physical, electronic, mechanical, thermal, and chemical connections that materials make to one another and to the outside world.

### 10:00 am – Trends and future directions in logic technologies: research challenges and opportunities, Carlos H. Díaz (Taiwan Semiconductor Manufacturing Company)

Sustainable growth in computing performance supporting expanded functional capabilities of information technology and communication products requires energy-efficiency breakthroughs in underlying technologies. This talk will overview emerging devices and interconnect fabrics, their challenges, and research opportunities aimed to identify viable alternatives beyond those of the projected evolutionary paths of current state-of-the-art logic technologies.

## 1A-Advanced micro/nanolithography 1

### 1:20 pm 1A1 Invited

#### Dry Resist Patterning Progress and Readiness Towards High NA EUV Lithography

Anuja De Silva (Lam Research)

We aim to demonstrate the progress of dry resist development to address specific challenges of high NA EUV lithography. As features scales, resist thickness and interface between resist

and underlayer play a crucial role. The co-optimization of underlayers with dry technology enables tuning of the patterning stack for optimal performance.

### **1:50 pm 1A2 Regular**

#### **Patterning via EHD and inkjet printers**

Niels Wijnaendts van Resandt, Maximilian Mosberg (LAB14, Notion-systems)

Electrohydrodynamic (EHD) printing is a new high-resolution printing technology. We will present a new research and development tool which utilizes proprietary MEMS-based multi-nozzle EHD printheads, enabling print resolutions below 1  $\mu\text{m}$ . This exceeds that of conventional inkjet printing by two to three orders of magnitude.

### **2:10 pm 1A3 Regular**

#### **Intra-Level Mix & Match investigations of negative tone photoresists mr-EBL 6000.5 and maN 1402 for i-line stepper and electron beam lithography**

Christian Helke, Sebastian Schermer, Susanne Hartmann, Anja Voigt and Danny Reuter (Fraunhofer Institute for Electronic Nano Systems (ENAS))

This paper presents the investigation of two negative tone resists mr-EBL 6000.5 and ma-N 1402 for an Intra-Level Mix & Match approach with i-line and electron beam lithography on the same resist layer, providing the advantage of resolving patterns of different dimensions with fewer process steps and shorter processing time.

### **2:30 pm 1A4 Regular**

#### **Thermal scanning probe lithography (t-SPL) enabled high-resolution lift-off process**

M. Käppeli, J. Chaaban, N. Hendricks, E. Çağın (Heidelberg Instruments Nano AG)

Nanoscale structures with a resolution in the 10s of nanometres can be achieved using the NanoFrazor t-SPL tool and its associated processes. A multilayer high-resolution lift-off process post-t-SPL allows the creation of non-repeating structures as small as 20 nanometres. Best practices for high-resolution patterning and lift-off will be presented.

### **2:50 pm 1A5 Regular**

## **Fabrication of Metallic Nanostructure Substrate by Templated Electrodeposition for Laser Desorption/Ionization Mass Spectrometry Detection**

Chuwei Liang, Zhuofei Gan, Menghong Xu, Hongtao Feng and Wen-Di Li (The University of Hong Kong)

We report herein the use of metal nanopillar arrays fabricated by interference lithography and templated electrodeposition as the surface-assisted laser desorption ionization (SALDI) substrate for mass spectrometry (MS)-based small molecule profiling.

## **1B-Directed self-assembly**

**1:20 pm 1B1 Invited**

### **Exploring the Versatility of End-Grafted Polymer Brushes for High-Precision Nanopatterning**

Ricardo Ruiz (Lawrence Berkeley National Laboratory)

We explore end-grafted polymer and peptoid brushes for nanoscale surface modification. Integrated with advanced lithographic techniques, these brushes enable precise adsorption, interfacial tuning, and interfacing between inorganic surfaces and biological matter. We showcase examples ranging from biomimetic polymers for semiconductor/bio interfaces to directed self-assembly for EUV lithography and selective deposition

**1:50 pm 1B2 Regular**

### **Fabricating bimodal pore size membranes as a platform to understand nanoscale aqueous transport behavior**

Wen Chen, Jamila Eatman, Seth B. Darling and Paul F. Nealey (University of Chicago)

We hypothesize that precise nanofabrication of bimodal membranes, rather than those with a continuum of pore sizes, will enable assessment of the impact of structural defects as well as flux partitioning.

**2:10 pm 1B3 Regular**

### **Fabrication of chemical patterns from negative resist for directed self-assembly at resolution limits of lithography**

Kyunghyeon Lee and Paul F. Nealey (University of Chicago)

A new fabrication strategy for high-resolution chemical patterns in DSA is introduced, utilizing a negative tone resist. HSQ patterns, created by e-beam lithography, are transformed into Cr patterns through reactive ion etching and further converted into chemical patterns with sequential polymer brush grafting, reaching a 24 nm full-pitch resolution.

### **2:30 pm 1B4 Regular**

#### **Thin polymer blends films as a tool for creating patterned metals, semiconductors, SAMs and brushes**

Stefan Walheim, Roland Groeger, Cheng Huang, Tobias Heiler, Markus Moosmann, Jonathan Berson and Thomas Schimmel (KIT Karlsruhe Germany)

Polymer phase separation can generate billions of structures in a few seconds during spin coating. These structures can be used as templates to obtain structured metals, semiconductors, SAMs or polymer brushes. The control of the phase behaviour of the polymers by pre-structured substrates allows a controlled geometry of the morphology.

### **2:50 pm 1B5 Regular**

#### **Fabricating 3D Nanostructures Through Colloidal Extreme Ultraviolet Lithography**

Saurav Mohanty, Ethan Fermin Flores and Chih-Hao Chang (The University of Texas at Austin)

This work explores 3D nanopatterning using 30 nm wavelength extreme ultraviolet (EUV) light to surpass optical diffraction limits. Sub-200 nm diameter nanoparticles are used as near field phase mask to perform single shot Talbot lithography exposure. The results demonstrate sub 50 nm resolution patterns, promising for future photonic crystal applications.

## **1C-Nanofabrication for quantum computing**

### **1:20 pm 1C1 Invited**

#### **Single-electron qubits on solid neon**

Xinhao Li, Xianjing Zhou, Christopher Wang, Yizhong Huang, Brennan Dizdar, Xu Han, David I. Schuster and Dafei Jin (Argonne National Laboratory)

We demonstrate the strong coupling between the charge states of single electrons trapped on solid neon with photons in a superconducting resonator. The coherence lifetimes of the

electron qubits achieve 0.1ms scale, outperforming all existing traditional charge qubits. Further development of this novel qubit calls for advancements in quantum nanofabrication.

### **1:50 pm 1C2 Regular**

#### **Exploring electroluminescence and transport of color center light-emitting diodes as candidates for telecom quantum light sources**

Nikki Ebadollahi, Vijin V. Kizhake, Marcelo I. Davanco, Kartik A. Srinivasan, Pradeep N. Namboodiri, Aaron M. Katzenmeyer, Matthew Pelton and Joshua Pomeroy (National Institute of Standards and Technology)

We fabricate color center light-emitting diodes (CC-LEDs) in silicon to assess their electrical and optical properties to assess whether they can be used as telecom O-band quantum light sources. The ultimate goal of our work is to enable on-chip electroluminescence (EL) from CCs.

### **2:10 pm 1C3 Regular**

#### **Robust and Simplified Gate Design in Surface-Gated Quantum Dot Devices for Diagnostic Qubits Fabrication**

Seyed Amirali Arefpour, Adrian Li, Joshua M. Pomeroy and Nikki Ebadollahi (National Institute of Standards and Technology, Gaithersburg, MD)

Our research at NIST focuses on developing robust, simple gate designs for surface-gated quantum dot devices, aiming to produce diagnostic qubits with reduced failure rates. We prioritize compact gate structures and material characterization, exploring the effects of gate shapes on quantum dot functionality and device reliability.

### **2:30 pm 1C4 Invited**

#### **A piezo-optomechanical transducer for quantum entanglement between light and microwaves**

Srujan Meesala (California Institute of Technology)

We will discuss the design and fabrication of piezo-optomechanical devices for transduction between quantum states at microwave and optical frequencies. These devices feature nanoscale photonic, mechanical, and superconducting microwave elements on a single chip.

Recently, we used such an integrated transducer to generate entangled pairs of optical and microwave photons.

## **2A-Atomically precise fabrication**

**3:30 pm 2A1 Invited**

### **Next generation fabrication techniques for top gated qubits in silicon**

James Owen, Joshua Ballard, Ehud Fuchs and John Randall (Zyvex Labs)

We describe two methods to create atomically precise or near atomically precise quantum computer architectures using functionalized scanning tunneling microscope lithography (STM). In one method, patterns are functionalized into 2D delta layers. In the other method, the STM patterns are converted into nanoimprint templates for scalability.

**4:00 pm 2A2 Regular**

### **High resolution metal deposition using focused electron beam with redox chemistry control**

Auwais Ahmed, Peter A. Kottke and Andrei Fedorov (Georgia Institute of Technology)

We present an 'electrochemical lensing' approach for focused electron beam mediated nanomaterial synthesis that locally creates favorable electrochemical environment at the electron beam impingement site, while suppressing unwanted growth in the surroundings. The approach enables rapid creation of high-resolution nanostructures.

**4:20 pm 2A3 Regular**

### **Scanning Probe Atom-by-atom Fabrication of Phosphorus in Silicon Devices**

Jonathan Wyrick, Pradeep Namboodiri, Fan Fei, Brian Courts, Utsav Utsav and Richard Silver (NIST)

We describe use of a scanning tunneling microscope to achieve a measured incorporation yield of 100% for single P atoms imbedded in silicon for quantum devices. We also discuss progress on B imbedding, as well as design and fabrication of fully functioning atomic precision devices.

**4:40 pm 2A4 Regular**

## **Fabricating Atomically Precise Devices to Engineer Unique Quantum Properties**

Rick Silver, Fan Fei, Pradeep Namboodiri, FNU Utsav, Brian Courts, Joshua Pomeroy and Jonathan Wyrick (National Institute of Standards and Technology)

We are using atomically precise manufacturing to fabricate few-donor/quantum dot devices in silicon for use as qubits and arrays of atomic clusters to simulate quantum materials. To scale up we must control atomic fabrication processes with true atomic precision and understand the impact each atom has on device performance.

### **5:00 pm 2A5 Regular**

#### **Fabrication and characterization of 10-nm-diameter nanopore arrays for applications in mask-based metastable atom-beam lithography**

Bhera Ram Tak, Riley Gatensby, Robert O'Meara, Clive Downing and Richard G. Hobbs (School of Chemistry, Trinity College Dublin)

Large-scale pattern generation with 1-nm resolution remains challenging for nanofabrication. Holographic mask-based He\* atom lithography, where He\* passes through nanoscale holes in dielectric membranes offers nanoscale pattern generation. We present 10 nm size nanohole arrays in SiNx membranes, crucial for advancing atom beam lithography.

## **2B-Metamaterials, metasurfaces, and meta-optics 1**

### **3:30 pm 2B1 Invited**

#### **Symmetry and Topology in Photonic Nanostructures**

Abdoulaye Ndao (UCSD)

The quest for smaller, lighter, and more efficient optical components usually comes at the price of reduced functionalities. provide an overview of how topological approaches to control light-matter interaction enable novel photonic devices with unique features and enhanced performance.

### **4:00 pm 2B2 Regular**

#### **Three-Dimensional (3D) Subwavelength-Thick Plasmonic Nano-Tiles on Terraces: Broadband, Omni-Angle, Near-100% Light Trapping and Absorption, Fabricated by a Single Nanoimprint Step over a Large Area**

Stephen Y. Chou (Princeton University)

We propose and experimentally demonstrate (a) a new type of 3D nanoplasmonic light-trapping/absorbing structure, termed "plasmonic nano-tiles on terrace" (PlaNTT), which absorbs light near 100%, broadband, and omni-angle acceptance with a thickness 1/10 to 1/2 of the light wavelength; and (b) a one-step nanoimprint for patterning the 3D structures.

#### **4:20 pm 2B3 Regular**

##### **Broadband spin and angle co-multiplexed six-channel metahologram based on a flat waveguide**

Zeyang Liu, Hao Gao, Taigao Ma, Vishva Ray, Cheng Zhang and L. Jay Guo (University of Michigan, Ann Arbor)

We present a new type of waveguide-based multi-channel metaholograms, which can support six independent and fully crosstalk-free holographic display channels, simultaneously multiplexed by the spin and angle of guided incident light within the glass waveguide

#### **4:40 pm 2B4 Regular**

##### **Bilayer Meta-optics in Visible Wavelengths for Moiré Flatbands**

Suki Gu, Tianzhe Zheng and Andrei Faraon (California Institute of Technology)

A bilayer TiO<sub>2</sub>/air meta-optics is fabricated for demonstrating moiré flatbands in visible wavelengths. The fabrication process combines E-beam lithography and ALD back-filling. This approach enables multilayer visible structures with closely stacked layers and a refractive index contrast of approximately 2.4.

#### **5:00 pm 2B5 Regular**

##### **A binder-free porous medium of interwoven CuO microstructures for energy storage**

Carly Flynn, Alison H. McCarthy, Jason Alexander Röhr and Mohsen Azadi (University of Pennsylvania)

A simple and scalable top-down fabrication method for a binder-free porous interwoven and continuous CuO microstructure medium formed from an underlying Cu substrate for use as anodes in Li-ion batteries. Structures can be covered by a secondary layer of active material, such as Si or Ge to without jeopardizing porosity.



## **2C-MEMS/NEMS and Micro/nanofluidics**

**3:30 pm 2C1 Invited**

### **Nano Injection Molding for Nanofluidic Devices**

Sunggook Park, Michael C. Murphy and Steven A. Soper (Louisiana State University)

Despite recent advancement in nanofluidic devices and applications, their high rate and low cost manufacturing tools are still lacking. This paper will discuss recent progresses on transitioning from NIL, a medium rate fabrication tool, to nano injection molding in the fabrication of nanofluidic devices.

**4:00 pm 2C2 Regular**

### **A Graphene-based Capacitive Monolithic Microphone with Minimized Air Gap Thickness**

Yun Jiang, Graham S. Wood, Michael J. Newton, Peter Lomax and Rebecca Cheung (The University of Edinburgh)

We report a graphene-based microelectromechanical systems (MEMS) capacitive microphone with a 1.5 micrometer air gap and a vent hole. The design, fabrication and characterization of the microphone is introduced.

**4:20 pm 2C3 Regular**

### **Relating Unidirectional and Bidirectional Single Cell Migration with Oxygen Imaging**

Muting Wang and Stella Pang (City University of Hong Kong)

This study investigated the relationship between single cell unidirectional and bidirectional migration and oxygen consumption, using PtOEPK dye as an oxygen sensor. The findings revealed that peaks of oxygen consumption occurred when cells changed their migration direction, offering a crucial groundwork for investigating cell activities and viability in tissue engineering.

**4:40 pm 2C4 Regular**

### **Localization of microparticles by a patterned drying process surface energy techniques**

Yian Cheng and L. Jay Guo (University of Michigan, Ann Arbor)

A microparticle localization technique using the drying patterned drying process surface energy. Created by hydrophobic and hydrophilic patterns with control of the surface tension and geometry, one can successfully localize particles to the center of the pattern.

**5:00 pm 2C5 Invited**

**Pneumatic Enabled Nano-Sieve for Sensitive Detection of Pathogens in Blood**

Ke Du (The University of California, Riverside)

We introduce a miniaturized nano-sieve device featuring a pneumatically-regulated chamber for highly efficient pathogen concentration from blood. Integration of this device with CRISPR assay, an on-chip detection limit of approximately 100 cfu/mL is achieved for antibiotic resistant bacteria. We further show an enhanced nano-sieve by incorporating "micro-grooves" for virus sensing.

# Thursday, May 30

## 3A-Electron and ion beam lithography

**8:00 am 3A1 Invited**

### **What are the Challenges for Creating a Positive Tone Metal-Organic Resist?**

Scott M. Lewis, Luisa Bozano, Guy A. Derose, Barbara Kazanowska, David Castillo-Lozada and Axel Scherer (California Institute of Technology)

We investigate a series of metal-organic nanocomposite positive-tone photoresist materials that are suitable for electron beam lithography. From our initial Monte Carlo studies, the nanocomposite resist performance demonstrated a resolution of 50 nm half-pitch while exhibiting a high resistance achieving a selectivity of  $>1:25$ .

**8:30 am 3A2 Regular**

### **Passive Tuning of Photonic Integrated Circuits by Automated Silicon Ion Implantation**

Venkata Sai Akhil Varri, Shabnam Taheriniya, Frank Brückerhoff-Plückelmann, Ivonne Bente, Daniel Bernhardt, Achim Nadzeyka, Torsten Richter and Wolfram Pernice (University of Münster)

A key challenge in scaling integrated photonic systems is the sensitive nature of the components to fabrication imperfections. Here, we highlight a scalable and non-volatile technique for post-fabrication tuning of photonic computational memories by silicon ion implantation. We precisely align high-quality resonant devices to targeted wavelengths with picometer precision.

**8:50 am 3A3 Regular**

### **Advanced electron-beam grayscale lithography writing strategies using optimized dose gradients in the pattern design**

Kevin Hofhuis, Nazanin Samadi, Christian David, Vitaliy A. Guzenko, Analía Fernández Herrero, Bas Ketelaars and Christiaan Zonneville (Paul Scherrer Institute)

Advancing electron-beam lithography: Implementation of novel dose gradient shaping in Raith EBPG Plus system for precision grayscale lithography writing strategies. The technique enable meticulous control over electron doses, yielding smoother structures. Successful integration enhances flexibility, reduces writing times, and facilitates the creation of intricate 3D patterns.

**9:10 am 3A4 Regular**

**Focused Ion Beam (FIB) Patterning of Surface Nanobubbles**

Anayet Ullah Siddique, Rui Xie and Roseanne Warren (University of Utah)

This research hypothesizes that nanoscale FIB-based patterning can effectively control surface nanobubble position employing chemical heterogeneity through selective removal of a hydrophobic self-assembled monolayer. The hypothesis is confirmed by analyzing bubble formation on silicon surfaces containing line patterns generated by selective FIB removal of octadecyltrichlorosilane (OTS).

**9:30 am 3A5 Regular**

**Poly Acrylic Acid Patterning by Electron Beam Lithography**

Devin K. Brown (Georgia Institute of Technology)

This work presents the first known results of the direct patterning of polyacrylic acid (PAA) hydrogel by electron beam lithography. Hydrogels are being investigated in emerging applications such as drug delivery, biosensors, tissue engineering, and wound healing bandages. Therefore, this work can enable lithographic patterning of PAA for those applications.

**3B-Nanophotonics and plasmonics 1**

**8:00 am 3B1 Invited**

**Super-resolution imaging enabled by metamaterials**

Zhaowei Liu (University of California San Diego)

**8:30 am 3B2 Regular**

**Which way is up? Nanophotonic calibration artefacts for accurate molecular orientation measurements**

James Liddle, Muneesh Maheshwari, Henri Lezec, Dhruv Fomra, kishalay mahato and John Fourkas (National Institute of Standards and Technology)

The polarization state of an optical signal can be altered by its passage through an imaging system, leading to biases in the detected signal. To measure these biases, identify their origin, and correct them, we introduce and demonstrate a nanophotonic calibration artefact and associated methodology.

### **8:50 am 3B3 Regular**

#### **Ultra-high Q Thin Film Lithium Niobate Resonators**

Xinrui Zhu, Yaowen Hu, Shengyuan Lu, Hana K. Warner, Xudong Li, Yunxiang Song, Leticia Magalhaes, Amirhassan Shams-Ansari, Neil Sinclair and Marko Loncar (Harvard University)

Thin-film lithium niobate (TFLN) is a recently emerging versatile platform for integrated photonics. We present our design, fabrication, and characterization of TFLN microresonators with a record-high intrinsic quality (Q) factor of twenty-nine million, corresponding to an ultra-low propagation loss of 1.3 dB/m, further unlocking the potential of this platform.

### **9:10 am 3B4 Regular**

#### **Fabrication of Multilayer Nanolattice Reflectors with Integrated Low-Index Nanolattices**

Vijay Anirudh Premnath, I-Te Chen and Chih-Hao Chang (The University of Texas at Austin)

Our research involves precise fabrication of multi-layer 3D periodic nanolattices with single, double, and triple stacks of Aluminium oxide and Titanium oxide layers. This architecture allows precise control of photonic bandgap and investigates the influence of lattice height in designing the wavelengths for the lattices with near 100% peak reflectance.

### **9:30 am 3B5 Regular**

#### **Shape Memory Micro/Nano-Pillar Arrays for Dynamic and Optical Spectrum Dependent Transmission Control**

Yuanhao Xu and Stella Pang (City University of Hong Kong)

This study demonstrates the dynamic conversion of optical properties using high aspect ratio shape memory polymer (SMP) micro/nano-pillars fabricated by imprinting technology. The SMP structures enable precise control over diffraction patterns and wavelength-dependent transmission, opening avenues for tunable photonic devices and enhanced light manipulation.

## **3C-Industrial highlight**

**8:00 am 3C1 Regular**

### **VPG 300 DI - The Maskless Stepper from Heidelberg Instruments**

Matthias Wahl, Christian Bach and Gregg A. Moore (Heidelberg Instruments, Inc.)

Derived from the VPG+ Volume pattern generator series mask making tools, the VPG 300 DI is specially designed for direct writing high-resolution microstructures in i-line photoresists. It includes all advanced VPG+ system components for high-precision exposures as well as features needed for direct write applications of sub-micron structures.

**8:15 am 3C2 Regular**

### **Algorithmic Patterning Workflow for EBL, a new FIB-SIMS System and massive parallel Laser direct Write – Latest Raith Innovations for Nanofabrication and -Analysis**

Frank Nouvertne, Torsten Richter and Viacheslav Vlasenko (Raith GmbH)

Recent innovations spanning the entire Raith product portfolio will be presented. This includes a new efficient EBL workflow for nanofabrication of metalenses, a multiple laser beam based lithography solution for large area photonic crystals, a new FIB-SIMS system for nanoanalytics, and large area SEM imaging and metrology.

**8:30 am 3C3 Regular**

### **A New Generation in Thermal Scanning Probe Lithography**

Emine Cagin (Heidelberg Instruments Nano AG)

Breakthroughs in throughput and maximum lithography area in thermal scanning probe lithography, made possible by the long-awaited parallelization and smart handling of large designs in software implementation will be demonstrated. Full parallel operation of the NanoFrazor is expected to enable further innovations in nanophotonics, nanoelectronics, and advanced materials research.

**8:45 am 3C4 Regular**

### **An Upgrade Package for SEM-based Metrology and Inspection**

Sven Bauerdick, Philipp Weber, Klaus Gieb, Ulrich Hofmann, Marvin Zai and Roger McCay (GenISys GmbH)

Fabricating nano devices requires SEM imaging for routine calibration and critical structures, while conventional SEM tools cannot address the growing demand for automated metrology. We present an upgrade kit (InSPEC) providing advanced scanning, metrology, and data processing with direct integration to SEM hardware, all combined in a sophisticated software workflow.

### **9:00 am 3C5 Regular**

#### **Mitigating Challenges in Nanofabrication with Novel Electron and X-ray Microscopy**

Sandip Basu (Carl Zeiss Microscopy)

This presentation explores Zeiss' innovative electron and 3D X-ray microscopy solutions for nanofabrication. High resolution scanning electron microscope performance along with novel hardware/software developments enable surface-sensitive microstructural and chemical characterization. The application of 3D X-ray microscopy highlights its potential for improved accuracy and efficiency in advanced device fabrication.

### **9:15 am 3C6 Regular**

#### **Unveiling the future of precise single ion implantation**

Milos Hrabovsky, Jérémie Silvent, Anne Delobbe, Justine Renuad and Morgan Reveillard (ORSAY PHYSICS)

We are going to introduce a new dedicated single ion implantation tool, including an in-situ heating stage, and that can give access to a wide range of species for the implantation application with precise control of the vertical and lateral position of the implanted ion.

### **9:30 am 3C7 Regular**

#### **Advanced Nanopatterning With Cell Projection Electron Beam Lithography**

John Whittey, Mathais Haedrich and Ines Stolberg (Vistec Electron Beam GmbH)

Electron beam lithography (EBL) can accomplish advanced and versatile nanopatterning, due to fine resolution and maskless writing. Vistec offers EBL systems for fast writing on different types of wafer and mask substrates. These systems are used for fabricating masks in mid-range technology nodes, fabrication of nanoimprint templates, and fast prototyping.

## **4A-Optical/EUV lithography and metrology**

**10:20 am 4A1 Invited**

**Metrology driven data intelligence for research and productization of smart glasses and AR technology**

Raja Muthinti (Meta Reality Labs)

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**10:50 am 4A2 Regular**

**Ultra-High Q-Factor Polymer Microring Resonators Fabricated by Two Types of Nanoimprinting Lithography**

Wei-Kuan Lin, Shuai Liu, Sungho Lee, Zhesheng Zhang and L. Jay Guo (The University of Michigan Ann Arbor)

In this work, we present two different types of nanoimprinting lithography to fabricate polymer microring resonators. Based on both methods, we successfully show record levels of Q-factor photonic devices. We also present some unique properties of the nanoimprinted devices, such as residual layer-free and meniscus profiles.

**11:10 am 4A3 Regular**

**Interferometric lithography on curved surfaces**

Bruce Burckel and Mason Risley (Sandia National Laboratories)

We discuss interferometric lithography on curved surfaces and quantify the local radius of curvature limitations on achievable patterning pitch for a fixed illumination wavelength.

**11:30 am 4A4 Regular**

**Single-exposure Millimeter-scale Volumetric Holographic Additive Manufacturing**

Dajun X. Lin, Fei Yang Lyu, Apratim Majumder, Ji-Won Kim, Connor J. O'dea, Kwon Sang Lee, Michael Cullinan, Chih-Hao Chang, Zachariah A. Page and Rajesh Menon (University of Utah)

We demonstrate a single-exposure volumetric holographic additive manufacturing. The millimeter-scale 3D hollow cube can be simultaneously polymerized in UV resin within 1 second exposure time



### **11:50 am 4A5 Regular**

#### **Aperiodic Multilayer Mask Optimization for High-NA and Hyper-NA Extreme Ultraviolet Lithography – Reflectance, Polarization, and Phase**

William E. Maguire and Bruce W. Smith (Rochester Institute of Technology)

As EUVL tools with higher image numerical apertures are introduced, the range of angles at the multilayer mask stack is also increased. We show that inclusion of phase and polarization optimization in aperiodic ML designs can extend 0.55 NA imaging to 14nm pitch, and 0.80 NA to 12nm pitch.

### **4B-Ion beam 1**

#### **10:20 am 4B1 Invited**

#### **Probing Radiation Effects in Gate-All-Around MOSFETs using Focused Particle Beams**

Michael Titze, A. Belianinov, A. Tonigan, S. Su, G. Vizkelethy, W. Wampler, B. Hehr, M. Wang, H. Zhou, V. Narayanan, E. Bielejec, R. Arghavani (Sandia National Laboratories)

The Gate-All-Around (GAA) transistor architecture fundamentally changes the gate and isolation dielectric structures, with unknown impact on radiation performance. Additionally, GAA isolates the active device region from underlying silicon in a way that makes these transistors behave like silicon-on-insulator technology. In this work, we study GAA in surrogate radiation environments.

#### **10:50 am 4B2 Regular**

#### **Microfabrication of cylindrical structures by proton beam writing for photonic nanojets formed in different media**

Kunpisit Kosumsupamala, Nitipon Puttaraksa, Hironori Seki, Hiroyuki Nishikawa, Rikuto Hotta, Akihiro Tsuji and Tatsunosuke Matsui (Shibaura Institute of Technology)

PMMA microcylindrical structures were fabricated by the proton beam writing. The photonic nanojets were generated and characterized by the 532-nm confocal laser scanning microscope system. The profiles of photonic nanojets significantly varied with the optogeometric environment which are suitable for different applications.

#### **11:10 am 4B3 Regular**

#### **Resist exposure with focused ion beams**

Dan Read, Demis John, William Mitchell, Brian Thibeault, Torsten Richter, Achim Nadzeyka, Paul Mazarov, Fabian Meyer, Joel Fridmann and Yang Yu (University of California Santa Barbara)

Exposing resists with focused ion beams may have some advantages over electron beams, including little or no proximity effect. Here we present the details of exposing a variety of resists with a variety of light and heavy ions, including those produced by AuGeSi and GaBiLi liquid metal ion sources.

### **11:30 am 4B4 Regular**

#### **High-resolution imaging, nanofabrication and nanoscale analytics with light and heavy ions from a single source**

Peter Gnauck, Torsten Richter, Alexander Ost, Achim Nadzeyka, Paul Mazarov, Lars Bruchhaus, Fabian Meyer, Olivier De Castro, Jean-Nicolas Audinot and Tom Wirtz (Raith GmbH)

In this presentation we will show different use cases of our liquid metal alloy ion source (LMAIS) based FIB platform in the field of ion imaging, nanofabrication, and nano analytics.

### **11:50 am 4B5 Regular**

#### **Recent Progress in Quantum Applications via the Q-One Single Ion Implantation System**

G. Aresta, K. Stockbridge, K. McHardy, P. Blenkinsopp (Ionoptika Ltd.)

Recent development of the Ionoptika Q-One single ion implantation system in the field of the quantum applications will be reported. Results obtained by the end users at Universities and Research Institute will be discussed together with update on the new systems development undergoing at Ionoptika.

### **4C-Workforce development and outreach**

#### **10:20 am 4C1 Invited**

#### **Workforce Challenges across the "Chips" Industry**

Melinda N. Gomez (SEMI Foundation)

The semiconductor/microelectronics industry is seeing an unprecedented amount of domestic and private investment right now. With a focus on diversity and equity, the SEMI

Foundation is working to build and expand short and long term programs to meet the growing talent gap.

**10:50 am 4C2 Invited**

**Shaping the Future - Intel's Academic Collaborations**

Sowmya Venkataramani (Intel Corporation )

This talk examines Intel's strategy for developing semiconductor talent through educational partnerships, training, and community engagement. It will showcase the Intel Semiconductor Education and Research Program's success in Ohio as a blueprint for building a skilled workforce in the industry.

**11:20 am 4C3 Invited**

**Beyond the Basics: PUIs and the Advanced Training of Semiconductor Professionals**

Nicole Pfiester (Rose-Hulman Institute of Technology)

The benefits of primarily undergraduate institution (PUI) environments for engineering students will be discussed, as well as specific ways that Rose-Hulman Institute of Technology has merged advanced training into the undergraduate curriculum and strategies for weaving relevant high-level skills into the curricula of any institution.

**11:50 am 4C4 Regular**

TBD

**5A-Nanoimprint lithography and scalable manufacturing**

**1:40 pm 5A1 Invited**

**Wet etch, dry etch, and now MacEtch**

Xiuling Li (University of Texas at Austin)

Metal-assisted chemical etching (MacEtch) is an unorthodox semiconductor etching method, that defies the isotropic nature of chemical etch through local catalysis and carrier transport effect and enables site-controlled nanostructure fabrication with unprecedented aspect ratio without plasma related damage. This talk will discuss the mechanism and applications in aggressively scaled devices.

### **2:10 pm 5A2 Regular**

#### **Rose-petal surface fabricated by using moth-eye structure with micro-holes structure and UV nanoimprint**

Kazuki Arai and Jun Taniguchi (Tokyo University of Science)

By adding micro-holes structure to the moth-eye structure, we were able to create a rose petal effect surface. This fabrication method can be used to fabricate various micro-shapes by changing the photomask, and in the future, we will also be able to form water droplet alignment patterns.

### **2:30 pm 5A3 Regular**

#### **The effect of the nanopore shape on resistive pulse sensing of mononucleotides in plastic dual in-plane nanopore sensors**

Hooman Abdolvand, Junseo Choi and Sunggook Park (Louisiana State University)

Investigating the effect of nanopore geometric shapes in plastic dual-nanopore sensors on the RPS signals and identification of mononucleotides. How the pore shape affects the peak amplitude, dwell time, electrical noises of the RPS signals as well as the time-of-flight of the molecules through the nanochannels and resulting discrimination accuracy.

### **2:50 pm 5A4 Regular**

#### **Fabrication of Non-Biofouling Nanochannel Sensor in Dimethacrylate-Based UV Curable Polymers by UV-Nanoimprint Lithography (NIL)**

Junseo Choi and Sunggook Park (Louisiana State University)

We demonstrate the use of di(meth)acrylate-based UV resin such as glycerol 1,3-diglycerolate diacrylate (GDM), epoxy ester 70PA, or 1,3-glyceryl dimethacrylate (GDD), each featuring varying hydroxyl group numbers, for nanochannel sensor development as a viable alternative to a poly(ethylene glycol) diacrylate (PEGDA).

### **3:10 pm 5A5 Regular**

#### **Wafer-Scale Fabrication of Ultra-Low Loss Si<sub>3</sub>N<sub>4</sub> Photonic Integrated Chips through Nanoimprint Lithography**

Shuai Liu, Wei-Kuan Lin, Yuheng Zhang, L. Jay Guo and Zheshen Zhang (University of Michigan)

Utilizing nanoimprint lithography and optimized a-Si/SiN hardmask RIE etching approach, we achieve robust and cost-effective wafer-scale fabrication of ultra-low loss SiN photonic integrated chips. Demonstrating intrinsic Q factors up to 15 Millions and efficient combs generation, our work marks the first realization of high-Q SiN PICs via NIL.

## **5B-Ion beam 2**

**1:40 pm 5B1 Invited**

### **Nanofabrication of High-Transition-Temperature Superconductive Electronics with Focused Helium Ion Irradiation**

Shane Cybart (University of California, Riverside)

We utilize helium FIB for the direct patterning of superconducting materials for nanoelectronics. The ion beam induces nanoscale disorder into the crystalline structure which converts the properties of the material from superconductor to insulator. describe process details and highlight applications in quantum sensing, and ultra low-power digital electronics.

**2:10 pm 5B2 Regular**

**TBD**

**2:30 pm 5B3 Regular**

### **High-Resolution FIB and SIMS with a Cesium Low Temperature Ion Source**

Adam Steele, Andrew Schwarzkopf and Brenton Knuffman (NanoTech Corporation)

We present the latest results from focused ion beam and secondary ion mass spectrometry systems equipped with a Cs<sup>+</sup> Low Temperature Ion Source (LoTIS)<sup>1</sup>. LoTIS provides a high-brightness beam which enhances the capabilities of modern FIB and SIMS systems.

**2:50 pm 5B4 Regular**

### **Focused Ion Beams from LMAIS for Surface Imaging, 3D Volume analysis, and SIMS**

Torsten Richter, Alexander Ost and Peter Gnauck (Raith GmbH)

Liquid metal alloy ion source (LMAIS) technology has evolved with the GaBiLi source. This innovation enables 3D imaging without sample tilt using Li<sup>+</sup> and Bi<sup>+</sup> ions. VELION FIB-SEM featuring GaBiLi ion source is explored for 3D imaging, emphasizing the potential synergy with SIMS for comprehensive analytical surface information.

### **3:10 pm 5B5 Regular**

#### **Imaging of SARS-CoV-2 infected Vero E6 Cells by Helium Ion Microscopy**

Natalie Frese, Patrick Schmerer, Martin Wortmann, Matthias Schürmann<sup>1</sup>, Matthias König, Michael Westphal, Friedemann Weber, Holger Sudhoff and Armin Götzhäuser (Physics of Supramolecular Physics and Surfaces)

Helium Ion Microscopy (HIM) images of SARS-CoV-2 infected Vero E6 cells are presented. Interactions between cells and virus, as well as among virus particles, are imaged. The absence of a conductive coating allows a distinction between virus particles bound to the cell membrane and virus particles lying onto the membrane.

## **5C-Nanoelectronics**

### **1:40 pm 5C1 Invited**

#### **Analog computing with high precision and programmability enabled by memristors**

Joshua Yang (University of Southern California)

Analog computing typically has superior energy efficiency and high throughput, but limited precision and programmability. We introduce memristive field-programmable analog arrays (FPAAs) to improve its reconfigurability. We engineer memristor device with 11-bit precision and develop a novel architecture to achieve arbitrarily high precision for vector-matrix multiplications.

### **2:10 pm 5C2 Regular**

#### **Overcoming Challenges in Single-Electron Charge Detection of Nanoscale dipoles.**

Mohammad Istiaque Rahaman, Richard Allen McManus Jr., Daniel Joseph Noronha, Gergo P. Szakmany, Alexei Orlov and Gregory L. Snider (University of Notre Dame)

Single charge detection in nanoscale objects is extremely important towards functional realization of charge qubits. Our study focuses on achieving single charge detection within a

nanoscale single electron box, employing a Single Electron Transistor (SET). The detection results are further validated through comprehensive simulations of the underlying structure.

### **2:30 pm 5C3 Regular**

#### **Scalable Fabrication of Vertically Arranged Bi<sub>2</sub>Se<sub>3</sub> Crossbar Arrays of Memristors towards Neuromorphic Control Applications**

Seungjun Ki, Mingze Chen, Jisoo Kim and Xiaogan Liang (University of Michigan)

The study outlines a method using physical vapor deposition to selectively grow hexagonal Bi<sub>2</sub>Se<sub>3</sub> nanoslates on Au-deposited bottom electrodes, preventing shorted nodes in large-area crossbar arrays. This scalable approach could guide the fabrication of memristive devices for artificial neural networks and neuromorphic sensory devices.

### **2:50 pm 5C4 Regular**

#### **In-house 20k memristor/CMOS monolithic integration and its statistical characterization**

Imtiaz Hossen, William A. Borders, Brian D. Hoskins, Advait Madhavan, Shweta Joshi, Jabez J. McClelland and Gina C. Adam (The George Washington University)

Interest in memristor devices has seen a rapid rise in the past decade due to their electronic programmability, non-volatile storage with years-long retention and small footprint. This work demonstrates the high performance of monolithically-integrated memristors across a large population and the potential for development of larger arrays in the future.

### **3:10 pm 5C5 Invited**

#### **Low Symmetry Van der Waals Photonic Materials**

Han Wang (University of Hong Kong)

I will discuss our work in studying the unique optical properties resulting from their low symmetry crystal lattice will be discussed. I will also discuss our work in studying the interesting mechanical properties of inorganic double helical crystal material SnIP, discovering its record low Young's modulus and high mechanical flexibility.

### **4:30 pm – 6:00 pm Panel Discussion:**

#### **Nanomanufacturing in the AI Era.**

**Moderator:**

Dr. Gina Adam (George Washington University)

**Panelists:**

Dr. Khershed P. Cooper (Program Director, NSF)

Dr. Patrick Jungwirth (Staff scientist, ARL)

Dr. Niels Wijnaendts van Resandt (CTO, LAB14 GmbH)

Dr. Alvin Loke (now at INTEL, former SVP Qualcomm)

Dr. Qiangfei Xia (Professor, University of Massachusetts)



# Friday, May 31

## 6A-Advanced micro/nanolithography 2

**8:00 am 6A1 Invited**

### **At-wavelength metrology and characterization enabling EUV scaling**

Patrick Naulleau (EUV Tech Inc.)

The advancement of extreme ultraviolet (EUV) lithography relies on at-wavelength metrology to understand and control materials for mask and patterning, essential for reducing feature sizes. The presentation will address how phase characteristics in EUV are sensitive to material variations and thin-film interference, complicating the patterning process. Additionally, it explores the significant role of stochastic effects arising during mask manufacturing, which impact the wafer level, emphasizing the need for precise characterization to improve lithographic accuracy.

**8:30 am 6A2 Regular**

### **Direct fabrication of gratings on ridge laser structures using focused bismuth ion beams**

Ben Salmond, Wyn Meredith, Michael Wale, Peter Smowton, Sam Shutts, Dan Read, Demis John, William Mitchell, Brian Thibeault, Torsten Richter, Achim Nadzeyka, Paul Mazarov, Fabian Meyer, Joel Fridmann and Yang Yu (Cardiff University)

Distributed feedback lasers are essential components in long range data communication systems. To create these devices a costly regrowth process that may increase defects is often required. Focused ion beams can be used to directly pattern laterally coupled grating structures, greatly simplifying the fabrication process and potentially improving performance.

**8:50 am 6A3 Regular**

### **Flow Analysis of 2-photon 3D Printing in situ Material Exchange**

Pratyaksh Yemulwar, Man Ho Wong, Josua Zscheile, Fatemeh Rajabasadi and Robert Kirchner (HETEROMERGE GmbH)

We demonstrated the successful fabrication of a cuboidal structure using the MergeOne (HETEROMERGE) exchange system and examined the flow analysis using a 25x immersion

fluorescence microscopy (ZEISS) system. The results of this work helped to understand the real-time exchange happening during the 2PP-based 3D printing process.

### **9:10 am 6A4 Regular**

#### **Reflow transfer: extending planar micro- and nanolithography to 3-dimensional substrates**

Gary Zabow (National Institute of Standards and Technology )

Traditional micro- and nanolithographic approaches are limited to patterning hard, flat surfaces. This talk introduces a new transfer microprinting approach that uses cheap, water-soluble, reflowable materials to extend such patterning to arbitrary material substrates and to truly 3-dimensional microstructures that may include high curvatures and sharp edges [Science 378, (2022)].

### **9:30 am 6A5 Regular**

#### **Field-Emission Scanning Probe Lithography-Based Mix and Match Fabrication of Junctionless FETs**

Taner Altinmakas, Mert Özden, Sina Zare Pakzad, Ivo Rangelow, Arda Deniz Yalcinkaya, Umut Kerimzade and B. Erdem Alaca (Koç University)

The purpose of this study is to fabricate a silicon nanowire (SiNW)-based junctionless field-effect transistor (JLFET) on a silicon-on-insulator substrate using field-emission scanning probe lithography (FE-SPL) followed by cryogenic reactive ion etching (RIE) and characterization of the device. A mix-and-match method is utilized containing both micro and nanoscale fabrication steps.

### **6B-Ion beam 3**

#### **8:00 am 6B1 Invited**

#### **Harnessing Charged Particle Beams to Tailor Defects by Design**

Frances Allen (UC Berkeley)

The helium ion microscope has emerged as a multifaceted instrument enabling a broad range of applications beyond imaging in which the finely focused helium ion beam is used for a variety of defect engineering, ion implantation, and nanofabrication tasks. This talk will focus on discussing the many defect engineering applications.

### **8:30 am 6B2 Regular**

#### **Roadmap for Focused Ion Beam Technologies**

Katja Hoeflich, Gerhard Hobler, Frances Allen, Tom Wirtz, Gemma Rius and Gregor Hlawacek (Ferdinand-Braun-Institut gGmbH)

This roadmap document comprises a review of the current state-of-the-art of advanced focused ion beam (FIB) processing and technology followed by an outlook on required future developments curated by a diverse group of stakeholders.

### **8:50 am 6B3 Regular**

#### **FIB direct patterning of graphene islands for localizing GaN nanowires epitaxial growth**

Dyhia Tamsaout, Jean René Coupdeville, Lucas Labbé, Jean-Christophe Harmand, Maria Tchernycheva, Ali Madouri and Jacques F. Gierak (Centre de Nanosciences et de Nanotechnologies)

Nanowires (NW) are promising candidates for the development of flexible optoelectronic devices, such as LEDs. With this objective, we have investigated the epitaxial growth of GaN nanowires (NWs) on graphene substrates patterned directly with finely and swift focused ion beams.

### **9:10 am 6B4 Regular**

#### **A new tool to perform hot ion implantation for the creation of dense NV ensembles in diamond**

Jérémie Silvent, Justine Renaud, Morgan Reveillard, Anne Delobbe, Midrel Ngandeu Ngambou, Ovidiu Brinza, Fabien Bénédict, Jocelyn Achard, Pauline Perrin, Ionut Gabriel Balasa, Alexey Tiranov, Philippe Goldner and Alexandre Tallaire (ORSAY PHYSICS)

Orsay Physics has developed a novel implantation tool utilizing different species for diamond substrate processing, crucial for creating efficient nitrogen-vacancy centers in quantum sensors. Precise ion implantation at 800°C significantly enhances NV photoluminescence emission, allowing higher ion fluences without crystal lattice damage, a key advancement for diamond-based quantum sensor performance.

### **9:30 am 6B5 Regular**

## **Improving Diamond Color Center Yield via Ultraviolet Irradiation during High-Temperature Annealing**

Coleman Burdette Cariker, Jacob Daniel Henshaw, Ed Salvatore Bielejec, Michael Titze, Andy Mounce, Yifan Yao and Andre Schleife (Sandia National Laboratories)

We implant silicon ions in a diamond sample, followed by an annealing procedure where half of the sample is exposed to UV LED irradiation. We then perform photoluminescence spectroscopy on the implant sites, testing recent theoretical calculations which suggest post-annealing under UV irradiation can increase the activation yield of SiV.

## **6C-Applications of nanofabrication 1**

**8:00 am 6C1 Invited**

### **An engineered platform to study the influence of nanotopography on endothelial cell organization**

Shani Tchernier Elad, Rita Vilensky, Noa Ben-Asher, Eyal Zussman and Leeya Engel (Israel Institute of Technology)

Endothelial cells are exquisitely sensitive to ECM topography. We engineered nanopatterned ECM constructs compatible with high resolution electron microscopy by electrospinning aligned and randomly oriented ECM fibers on gold electron microscopy grids. These cell culture supports will enable investigation of the sensitivity of endothelial cells to changes in ECM topography.

**8:30 am 6C2 Regular**

### **Memristor-based Tunable Oscillator for Frequency Hopping Spread Spectrum Technology**

Nishat Tasnim Hiramony, Sushmit Hossain, Zerui Liu, Jiacheng Ye, Zhexiang Tang, Ting-Hao Hsu, Hongming Zhang, Yunxiang Wang and Wei Wu (University of Southern California)

A memristor based tunable oscillator is proposed for FHSS technology. The pseudorandom signals from our PN sequence generator are fed into a digital system that maps each signal to a particular frequency from a look-up table. The digital system then controls the conductance of memristors generating signals with desired frequencies.

### **8:50 am 6C3 Regular**

#### **Sublayer Carbonation of Ni(111) Surfaces from the Boudouard Reaction: An STM Study**

Fang Xu, Jennifer Sanchez and Kevin Sutherland (The University of Texas at San Antonio)

The initial growth of surface carbon on Ni(111) by the Boudouard reaction was studied by STM. The adsorbed C atoms on terraces are weakly bound and those on step-edges induce a reconstruction of the Ni surface to create four-fold coordinates that mediate further carbide formation.

### **9:10 am 6C4 Regular**

#### **Residual Stress in Sputtered Au-Cu Thin Films**

Brent Edgerton, Jaron Vernal Moon, Yangliu Liu and Roseanne Warren (University of Utah)

Thin gold electrodes have been fabricated and characterized based on their stress, morphology, mechanics, and optics. The fabrication mode used is sputtering, which has the ability to alter the work function in the surface material, a finding of great import for energy applications.

### **9:30 am 6C5 Regular**

#### **A WSe<sub>2</sub>-MoS<sub>2</sub> JFET with tunable polarity via back gate voltage control**

Ting-Hao Hsu, Hefei Liu, Hongming Zhang, Han Wang and Wei Wu (University of Southern California)

This study utilizes van der Waals integration to create a high-quality p-n junction in a WSe<sub>2</sub>-MoS<sub>2</sub> JFET. The MoS<sub>2</sub> gate controls carrier concentration in the WSe<sub>2</sub> channel, enabling polarity switching with a back gate. The device demonstrates low leakage current, offering flexibility for diverse circuit applications.

## **7A-Scalable micro/nanomanufacturing 1**

### **10:20 am 7A1 Invited**

#### **Nanoapatite Delivery Platform for Antiviral Therapies**

Jessica Andriolo, Jack Skinner, Marisa L. Pedulla and M. Katie Hailer (Montana Technological University)

Iron-doped apatite nanoparticles are a patented antiviral that exhibits high activity against herpes simplex virus 1 and the human papillomavirus. A nanoapatite delivery vehicle enables safe delivery of the active ingredient to mammalian cells to prevent viral replication in a manner that enables use as a broad spectrum antiviral therapy.

#### **10:50 am 7A2 Regular**

##### **Fabrication of FDTD-based inverse design enables f/0.27 flat microlens array for integral imaging**

Tina M. Hayward, Apratim Majumder, Dajun X. Lin and Rajesh Menon (University of Utah)

We designed, fabricated, and characterized an ultra-low f/# (0.27) micro-MDL array with an extremely short focal length while preserving a large aperture to allow for easy integration onto security offset prints. We fabricated the master pattern (min. feature = 700nm) using grayscale lithography, which was replicated using UV casting.

#### **11:10 am 7A3 Regular**

##### **Investigation of Capillary and Electrostatic Forces in Anti-Dust Nanostructures**

Andrew N. Tunell, Lauren Micklow, Nichole Scott, Stephen Furst and Chih-Hao Chang (University of Texas at Austin)

Investigation of changes in anti-dust performance of nanostructured surfaces as a function of environmental humidity. Low and high humidities cause electrostatic and capillary forces to dominate respectively. We present the contribution of these forces across a range of humidities and investigate transparent surface coatings to tune the response.

#### **11:30 am 7A4 Regular**

##### **Lead Halide Perovskite Pixel Arrays Fabricated by Ultrathin Reusable Metal Mask**

Zhao Sun, Zhuofei Gan, Jianwen Zhong and Wen-Di Li (University of Hong Kong)

In this study, we propose a novel patterning process for perovskite arrays using a high-resolution, large-scale metal mask and spin-coating.

#### **11:50 am 7A5 Regular**

##### **Fabrication of Memristive Network Devices on Nanomembranes**

Mingze Chen, Xiaoqiu An and Xiaogan Liang (University of Michigan)

This work presents a novel nanomanufacturing method for fabricating Bi<sub>2</sub>Se<sub>3</sub> memristive networks on nanomembranes, which could be further transferred onto flexible polymeric substrates.

## **7B-Metamaterials, metasurfaces, and meta-optics 2**

**10:20 am 7B1 Invited**

### **Structural colors: toward AI design and low-cost fabrication**

Weijie Feng, Anwasha Saha, Taigao Ma, Haozhu Wang and L. Jay Guo (The University of Michigan, Ann Arbor)

Structural colors based on layered structures can be mass-produced and have been applied in industrial applications. Such structures can now be designed using machine learning algorithms. Environmental-friendly chrome-like coating can be designed this way and made by PVD process. Solution process was explored as low-cost alternative to make layered structures.

**10:50 am 7B2 Regular**

### **Implementation of Nanopillar Metasurfaces for the Sensitive Detection of Antibiotic Signatures**

Jacob Thomas Waitkus, Ke Du, Shuai Feng, Theodore Ndukaife and Sui Yang (University of California at Riverside)

Fabrication of unique silicon nanopillars allows for production of intricate metasurface geometries, capable of producing a desirable double-peak reflectance spectrum for the sensitive and specific detection of bound analytes. The facile fabrication workflow coupled with an antibiotic-gold nanoparticle assay, allows for plasmonic detection in the presence of the antibiotic signatures.

**11:10 am 7B3 Regular**

### **Thin-Films for Metastructures, Meta-Optics, and Surface Nanofabrication**

Dominic Bosomtwi, Neal Raney, Md Sakibul Islam, Aaron Holzer and Viktoriia Babicheva (University of New Mexico)

We analyze thin films, metastructures, and surfaces with multipolar coupling and bound states in the continuum, leading to strong and narrow resonances. We show that we can control nanostructure parameters and enable directional scattering from the metastructure. Improved quality of the thin film results in enhanced electronic and photonic functionalities.

### **11:30 am 7B4 Regular**

#### **Enabling Nanofabrication of a 1mm<sup>2</sup> Metalens in less than a Minute by innovative algorithmic EBL Patterning Strategies**

Frank Nouvertne, Guido Piaszenski, Jana Münchenberger, Christoph Aulbach and Volker Boegli (Raith GmbH Dortmund)

By exploiting the algorithmic description of a metalens pattern and directly translating it into an EBL job with pixel stream generation "on the fly", the throughput for nanofabrication of a 1mm<sup>2</sup> metalens was enhanced by a factor of 10 resulting in a total patterning time of less than a minute.

### **11:50 am 7B5 Regular**

#### **The Grayscale Nanoassemble Fabrication and ultra-realistic imaging of Height Gradient Nanostructures**

Ruhao Pan and Junjie Li (Institute of Physics, Chinese Academy of Sciences)

A grayscale nanoassemble fabrication method based on the e-beam lithography and atomic layer deposition is proposed with the capacity of individually controlling the height of high aspect nanostructures, which have been used in ultra-realistic imaging of both high-resolution grayscale and color pictures.

## **7C-Personalized healthcare and nanofluidics**

### **10:20 am 7C1 Invited**

#### **iMOST (instant Mobile Self-Test) -- Intelligent Nanostructures Enabling Accurate, Broad, Instant, Mobile Health Self-Test**

Stephen Y. Chou (Princeton University)

The talk will present a new test platform: iMOST™ (instant Mobile Self-Test), which uniquely uses intelligent nanostructures to achieve rapid sample preparation and enable accurate,



instant, simple, low-cost, mobile health self-tests, hence overcoming the major barriers in tests in self-tests or and offering a solution to the unmet needs.

**10:50 am 7C2 Regular**

**Nanoparticle-assisted, Portable Detection of African Swine Fever Infection**

Seyedsina Mirjalili, Yeji Choi, Carmina Gallardo, Marisa Arias Neira and Chao Wang (Arizona State University)

We propose and demonstrate a novel nanoparticle-based, rapid, in-solution assay for ASF detection. This assay does not require washing, amplification, or labeling, lowering test costs. Our design concept introduces a novel signal transduction for antigen- and antibody-sensing, based on antigen-antibody binding induced metal nanoparticle aggregation and subsequent plasmonic color change.

**11:10 am 7C3 Regular**

**Rapid, Electronic, and Accessible Detection of COVID-19**

Yeji Choi, Seyedsina Mirjalili, Md Ashif Iqbal, Sean McClure and Chao Wang (Arizona State University)

Conventional diagnostics (PCR, ELISA) are slow and personnel-demanding; RATs have low sensitivity. We present a cost-effective, miniaturized system to detect SARS-CoV-2 antibodies/antigens from body fluids, achieving high sensitivity (aM), rapid results (15-30 min), and low cost (few dollars). Performance evaluation showed ultra-low LoD for antibody and antigen detection, outperforming ELISA.

**11:30 am 7C4 Regular**

**Passage of Nasopharyngeal Carcinoma Cells through Narrow Channels**

Xiao Hong, Yuanhao Xu and Stella Pang (City University of Hong Kong)

Microwells with connecting channels and nanoholes at the bottom were fabricated to investigate the passage of nasopharyngeal carcinoma cells. Traversing probability of cells through narrow channels decreased with nanoholes patterned at the bottom, which is correlated to the reduced cell motility caused by the F-Actin rearrangement.

**12:00 pm 7C5 Invited**

## **Nanoparticle-Supported, Rapid, Electronic Detecting System for Accessible Infectious Disease Diagnosis**

Chao Wang (Arizona State University)

To address the need for highly sensitive yet accessible tests to curb infectious diseases, we propose and demonstrate a new approach, termed nanoparticle-supported, rapid electronic detection (NasRED), as a modular sensing platform with a high analytical sensitivity as low as atto-molar range for a variety of infectious antigens.

## **8A-Scalable micro/nanomanufacturing 2**

**1:30 pm 8A1 Invited**

### **Parallel Nanoscale 3D Printing with Nonlinear Initiation Depletion**

Venkata Kalyan Vadlamudi, Shih Hsin Hsu, Jinwoo Kim, Teng Chi, Zihao Liang, Paul Somers, Bryan Boudouris, Xianfan Xu and Liang Pan (Purdue University)

We report parallel 3D nanoprinting based on a one-photon nonlinear photopolymerization process by controlling the depletion and diffusion processes. We demonstrated 120nm resolution by using a compact low-cost diode laser of milliwatt power at a scanning speed of 100s-1000s  $\mu\text{m/s}$ . We constructed a multiphysics model to understand the process.

**2:00 pm 8A2 Regular**

### **Full-Wafer Nanoimprint Patterning for CMOS Pilot Line Development and Manufacturing**

Matt Traub, Myriam Willegems, Steve smout, Pau Guell I Grau, Silvia Lenci, Mohamed Saib, Eleonora Storace, Aurelie Humbert, Bogumila Kutrzeba Kotowska, Igor Turovets and Joey Hung (imec)

This talk presents on-going results on the incorporation of nanoimprint lithography (NIL) into a 300 mm CMOS pilot line, including handling of non-traditional glass substrates, high-selectivity etch processes, and full wafer metrology. The combination of large area NIL patterning with CMOS precision opens new possibilities for scalable nanofabrication.

**2:20 pm 8A3 Regular**

## **Automation of Pattern Driven Metrology for Photonic Devices Utilizing a FESEM for Process Monitoring**

Chad Eichfeld, Bangzhi Liu, Michael Labella, Guy Lavallee, Marvin Zai, Klaus Gieb and Sven Bauerdick (Pennsylvania State University)

In this paper we present methods and results for utilizing our FESEM (Zeiss Gemini) to acquire pattern driven automated images in combination with measurements using an integrated software upgrade kit for metrology (GenISys InSPEC). A special focus is on photonic devices like large area gratings, photonic crystals, meta lenses, etc.

Xiaohui Tang, Meng Yu, Xiaoqun Fu, Chang Chen and Sijia Xie (Shanghai Industrial  $\mu$ Technology Research Institute)

Addressable titanium nitride-based microelectrode array with the electrode density of 11 million sites/cm<sup>2</sup> can be realized via our developed MEMS technological processes. The corresponding morphology and elemental distribution are examined through SEM and EDS analysis, respectively. Its potential in high-throughput parallel DNA synthesis is verified via Cy3-labelled phosphoramidite coupling experiments.

### **2:40 pm 8A4 Regular**

#### **High-quality 3D Printing of Micro-Optical Elements with 3D two-photon grayscale lithography (2GL®)**

Matthias Blaicher, Andrea Bertocini, Roman Reiner, Mareike Trappen, Stephan Dottermusch, Nicole Lindenmann, Philipp Rayling, Kai Sandfort, Benjamin Richter, Tobias Hoose and Michael Thiel (Nanoscribe GmbH & Co. KG)

3D generalization of Nanoscribe's two-photon grayscale lithography (2GL®) process, 2GL® is, a method that uses a fast laser power modulation to avoid layer-discretization artifacts thus resulting in smooth surfaces even for a large spacing between exposure layers. Our approach achieves a ten-times speedup compared to traditional layer-based two-photon lithography.

### **3:00 pm 8A5 Regular**

#### **Self-Aligned Fabrication of Vertical, Fin-Based Structures**

Joshua A. Perozek and Tomás Palacios (Massachusetts Institute of Technology)

Modern power devices have realized 3-D, vertical designs offer many benefits for power density and reliability. However, fabrication techniques have historically relied on 2-D

processes for lateral features. In this work, we present how multiple steps of angled depositions can be used for scalable, self-aligned fabrication of vertical, fin-based devices.

## **8B-Simulation, modeling, and design tools for nanofabrication**

**1:30 pm 8B1 Regular**

### **Characterizing profile tilt of nanoscale deep-etched gratings using Mueller matrix spectroscopic ellipsometry**

Shiva Mudide, Nick Keller, Alexander R. Bruccoleri, Ralf K. Heilmann and Mark L. Schattenburg (Massachusetts Institute of Technology)

We introduce a fast, nondestructive optical method to measure tilt in high-efficiency, critical-angle transmission gratings for x-ray astronomy, using Mueller matrix spectroscopic ellipsometry. We ultimately aim to improve grating fabrication for telescopes, ensuring high diffraction efficiency and resolving power by optimizing the angle of incident x-rays.

**1:50 pm 8B2 Regular**

### **Closed-loop Simulation, Image processing and Data Preparation for Large Scale Structural Color Printing by EBL**

Dengyang Lu and David S. Barth (University of Pennsylvania)

We introduce a closed-loop design method for printing large-scale, arbitrary color images with structural colors in metasurfaces. This involves FDTD simulation, RGB color mapping, image processing, and data preparation, allowing the easy fabrication of centimeter-scale color patterns in a fully programmatic process.

**2:10 pm 8B3 Regular**

### **Experimental and Numerical Analysis of Nanofluid Dynamics in Microchannels**

Negin Bahadori and Yun Chen ( Louisiana Tech University)

This study examines the use of nanotechnology in oil recovery, focusing on how silicon oxide nanoparticles in nanofluids affect oil mobilization in micromodels. Through experiments and simulations, we assess wettability changes and compare the performance of nanofluid with traditional methods, aiming to improve multi-phase flow dynamics in oil recovery.

**2:30 pm 8B4 Regular**

**Dielectrics in the Boundary Element Method (BEM) solver of the General Particle Tracer (GPT) code**

Sebastiaan van der Geer and Marieke de Loos (Pulsar Physics)

Here we present a new extension to the well-established GPT simulation code that allows isotropic dielectric materials to be included in the hierarchical Boundary Element Method (BEM) solver. The extensions allows particles to be tracked with nanometer precision through demanding electrostatic field configurations such as lens arrays.

**2:50 pm 8B5 Regular**

**Multi-Photon Exposure Strategy and its Combination with Single-Photon Direct Laser Writing Technology**

Benedikt Stender, Willi Mantei and Christian Pies (Heidelberg Instruments Mikrotechnik GmbH)

We will discuss TPP exposure strategies for topographies like microlens arrays and gearwheels. Combining TPP with UV direct laser writing demonstrates the compatibility with respect to application, materials as well as process steps and highlight the potential for innovative applications in fields ranging from micro-optics to micromechanics among others.

**8C-Nanobiology, nanomedicine and implantable devices**

**1:30 pm 8C1 Invited**

**Nano- and micro-structured aptamer-field-effect transistors for implantable and wearable biomarker sensing**

Anne Milasincic Andrews and Chuanzhen Zhao (University of California, Los Angeles)

We fabricate aptamer-coupled transistors on hard and soft materials. We produce multiplexed implantable and wearable sensing devices for animals and humans to improve understanding of behaviorally relevant information encoded by chemical modulators.

**2:00 pm 8C2 Regular**

**Design, Fabrication and Test of a New Technology for MRI-Compatible Deep Brain Stimulation (DBS) Implants**

Francesca Marturano, Aditya Tummala and Giorgio Bonmassar (Harvard Medical School)

Patients with deep brain stimulation (DBS) implants may face MRI safety issues. We propose a metamaterial-based technology for fabricating MRI-compatible DBS leads that reduces RF-induced current and Specific Absorption Rate. Preliminary experimental tests show that our wires present significantly lower tip heating at both 1.5T and 3T than standard wires.

### **2:20 pm 8C3 Regular**

#### **Rapid TNF-Alpha Quantification Using Gold Nanoparticles Towards Cytokine Monitoring in Inflammatory Diseases**

Mohammad Altarfa, Maziyar Kalateh Mohammadi, Md Ashif Iqbal and Chao Wang ( Arizona State University)

We propose an innovative approach making use of plasmonic gold nanoparticles (AuNPs) to rapidly and accurately quantify TNF- $\alpha$  in the presence of anti-TNF- $\alpha$  Abs and ADA to improve disease treatment efficacy.

### **2:40 pm 8C4 Regular**

#### **Merging Femtosecond Laser-based 3D Printing and Soft-lithography: a Hybrid Fabrication route for Organ-on-Chips**

Gulden Akcay and Regina Luttge (Eindhoven University of Technology)

Organ-on-Chips (OoC) model organ function and their disease. These models often employ polydimethylsiloxane microfluidic architectures sealed with a flat microscope glass slide. We patterned fused silica as a sealing substrate utilizing 3D printing enabled by FEMTOprint to offer additional microfluidic capabilities for OoCs by this hybrid fabrication technique.

### **3:00 pm 8C5 Regular**

#### **From Lab to Field: Integrating Graphene Biosensors into Autonomous Systems for Real-Time Environmental Monitoring**

Thomas Alava (CEA-LETI, Université de Grenoble Alpes)

Advancing graphene sensors from lab to field, we emphasize the importance of sensor integration into autonomous systems for effective on field operability. We will insist on strategic selection of biological target of interest, , and leveraging the advantages of relying on commercial SGFET technology, for enabling reliable sensing.

## **9A-Resists and materials**

### **3:40 pm 9A1 Invited**

#### **Nanoscale layers of ferroelectric BaTiO<sub>3</sub>: From growth to fabrication**

Jayakanth Ravichandran (University of Southern California)

BaTiO<sub>3</sub> is a prototypical ferroelectric material with promise for memory and ferroelectric neuromorphic devices. Despite years of research, several outstanding challenges in the growth and fabrication of ultrathin nanoscale BaTiO<sub>3</sub> layers remain. outline the advances achieved in my group to address these challenges.

### **4:10 pm 9A2 Regular**

#### **Hot on the trail of ultrathin films of patternable polyethylene**

Sandra A. Gutierrez Razo, Andrew Madison, Daron Westly, Kalman B. Migler, Adam L. Pinter and Samuel M. Stavis (National Institute of Standards and Technology)

We are in hot pursuit of ultrathin films of low-density polyethylene (LDPE) that are sufficiently uniform for nanofabrication. We introduce a systematic study of hot spin-coating of LDPE films and develop an electron-beam lithography process to pattern LDPE nanostructures, enabling the creation of nanoplastic standards and other novel devices.

### **4:30 pm 9A3 Regular**

#### **STUDY OF TETRAETHYLAMMONIUM HYDROXIDE AS AN ALTERNATIVE FOR TMAH DEVELOPER IN ELECTRON BEAM AND PHOTOLITHOGRAPHY**

Kavya Dathathreya, Aimee Price, Justin Wirth, Chris Staudt and Dave Hollingshead (The Ohio State University)

Considering the dermal toxicity hazard of TMAH it would be desirable to find a less toxic metal-ion-free developer for photon and electron beam lithography (EBL). We compared developer based on the less toxic tetraethylammonium hydroxide (TEAH) to TMAH for broadband contact and direct write laser lithography and EBL.

### **4:50 pm 9A4 Regular**

## **Exploring the use of Aberration-Corrected Electron-Beam Lithography with Novel Metal-Based Electron-Beam Resists**

Fernando Camino, Nikhil Tiwale and Mohammad S. M. Saifullah (Brookhaven National Laboratory)

Recently, a low molecular mass metal-based resist produced patterns of the order of 4nm (approx. the probe size of the commercial e-beam writer used). Here, we present results on a novel negative-tone zinc-based resist patterned with a SEM and an aberration-corrected STEM, both equipped with a pattern generator.

### **5:10 pm 9A5 Regular**

#### **Enhanced contrast and high-resolution patterning of PMMA on insulating substrates under ambient gases**

Deepak Kumar, Cooper Meyers, Robert Lewis Smith Jr. and Todd Hastings (University of Kentucky)

To our knowledge, these are the first studies of molecules other than water for EBL in gaseous environments. VP-EBL of PMMA under helium yields higher sensitivity, contrast (12.5) and the highest resolution (25-nm half-pitch dense lines and spaces) demonstrated to date for EBL on insulating substrates in a gaseous environment.

## **9B-Nanophotonics and plasmonics 2**

### **3:40 pm 9B1 Invited**

#### **Multi-dimensional Optical Field Manipulation Based on Dielectric Metasurfaces: Materials, Fabrication, and Applications**

Cheng Zhang (Huazhong University of Science and Technology)

present a few of our recent works on multi-dimensional optical field manipulation based on dielectric metasurfaces

### **4:10 pm 9B2 Regular**

#### **Fabrication of A Nanodiamond Monolayer for Local Temperature Sensing of Plasmonic Gold Nanoparticles**



Chengyuan Yang, Huirong Sun, Aliko Sofia Rotelli, Raphael Antonio Liboro Romasanta, Aaron Sean Zhenjie Tan, Steve Qing Yang Wu, Vignesh Suresh, Ee Jin Teo and Andrew Anthony Bettiol (National University of Singapore)

This work demonstrates a method of fabricating a nanodiamond monolayer on top of a layer of gold nanoparticles for localized thermal sensing and imaging of the gold nanoparticles under different conditions of optical excitation.

#### **4:30 pm 9B3 Regular**

##### **Narrow linewidth surface lattice resonances in plasmonic aluminum nanoantenna arrays**

Bhera Ram Tak, Kamonpan Chumpol, Robert O'Meara, Nebras Alattar and Richard G. Hobbs (Trinity College Dublin)

Plasmonic metal nanoparticles amplify optical fields, but suffer from low quality factor resonances. Surface lattice resonances (SLRs) in periodic arrays offer higher quality factors, crucial for applications like emitters and lasing. Here we report aluminum bowtie nanoantennas with narrow linewidth SLRs in the blue-green spectrum for potential strong coupling studies.

#### **4:50 pm 9B4 Regular**

##### **Optical Microcavities: From sensing single molecules with WGM microlasers to applications in synthetic biology**

Frank Vollmer (University of Exeter)

This talk discusses our latest results for whispering-gallery mode microcavities as biosensors, enhanced by plasmonic nanorods for single-molecule detection. It explores prospects in enzyme kinetics, thermo-optoplasmonic sensing, and single-molecule detection on microlasers, offering insights into biosensing advancements and applications in synthetic biology.

#### **5:10 pm 9B5 Regular**

##### **Fabrication of spatially thickness-varying film by grayscale plasma etching**

Shubin Huang, Zhao Sun, Zhuofei Gan, Jianwen Zhong, Zijie Jiang and Wen-Di Li (The University of HongKong)

In this work, a grayscale plasma etching is demonstrated to fabricate spatially thickness-varying layer with a nickel mask which is fabricated by a hybrid method. The layer thickness can be manipulated by changing the filling ratio of the pattern on the shadow mask.

## **9C-Applications of nanofabrication 2**

**3:40 pm 9C1 Invited**

### **Hot Electrons and Integrated Photonics for Electron Emitters**

Rehan Kapadia (University of Southern California)

we will discuss some of our recent work on how hot electrons and integrated photonics can be used to fabricate electron emitters with improved performance metrics.

**4:10 pm 9C2 Regular**

### **Memristor-based Analog Optimization Solver for Safety-critical Control**

Sushmit Hossain, Ryan M. Bena, Zerui Liu, Buyun Chen, Pan Hu, Yunxiang Wang, Quan Nguyen and Wei Wu (University of Southern California)

A novel hybrid analog-digital architecture enhances safety-critical controllers in embedded systems, utilizing memristor-based analog computing for quadratic programming. This approach, applied in a micro-quadrotor UAV's flight control, significantly cuts processing times for collision avoidance, demonstrating the system's efficiency and effectiveness in real-world safety applications.

**4:30 pm 9C3 Regular**

### **Fabrication and Catalytic Performance of Electrospun HPA Supported in Pt-TiO<sub>2</sub> Nanofibers for Hydrodeoxygenation**

Amos Taiswa, Jessica Andriolo, Jack Skinner, Randy L. Maglinao and Sandeep Kumar (Montana Technological University)

Electrospinning is used to fabricate catalytic nanofiber scaffolds for biofuel conversion. The catalytic scaffolds produced were functionalized with TiO<sub>2</sub> and Pt nanoparticles (NPs) and tungstosilicic acid crystals (Pt-TiO<sub>2</sub>-HPA). The performance was evaluated on a batch reactor using phenol as the feed. A 29% conversion and 100% benzene selectivity was recorded.

#### **4:50 pm 9C4 Regular**

##### **Crossflow Electrospinning**

Harold Pearson, Cody Baumstarck, Jessica Andriolo and Jack Skinner (Montana Technological University)

This abstract presents an adaptation of the handheld electrospinner to employ ionized air orthogonal to the direction of fiber creation to produce electrospun fibers. The crossflow ES system incorporates ionized airflow to direct nanofibers through the barrel with charged air, disrupting electrostatic forces accumulating at the walls of the apparatus.

#### **5:10 pm 9C5 Regular**

##### **Decreasing Resistance of Aluminum based Single Electron Transistors as Quantum Charge Sensor**

Runze Li, Pradeep Namboodiri, Nikki Ebadollahi and Joshua Pomeroy (National Institute of Standards and Technology)

Aluminum-based single electron transistors were fabricated under lower oxidation duration and with larger tunnel junction area. With the lower resistance we will get higher SNR and bandwidth from these devices which could then be integrated to quantum dot devices as charge sensors

## **Posters**

### **P-1. Q-learning algorithm for solving Traveling salesman problem**

Author: Hmayak Mkhitarian, Lusine Tumanyan, Irina Minasyan and Liparit Hovhannisyan

### **P-2. 3D bidirectional deformation nanostructures by focused ion beam bidirectional origami method for multichannel chiral metasurface**

Author: Ruhao Pan and Junjie Li

### **P-3. Wide-Field and High-Resolution Low-Voltage Scanning Electron Microscopy with Correction of Beam-Image-Shift-Induced Deflection Chromatic Aberration**

Author: Shun Kizawa, Daisuke Bizen, Kohei Suzuki, Shunsuke Mizutani, Ryota Watanabe, Yuji Kasai and Yuzuru Mizuhara

### **P-4. Soft and hard trimming techniques of imprint resists to fabricate silicon nanodisk arrays with different circularity**

Author: Naoki Takano, Hiromasa Niinomi, Tomoya Oshikiri and Masaru Nakagawa

### **P-5. Accurate Endpoint Detection for Ion Beam Nanohole Milling**

Author: Symphony Hsiao-Yuan Huang

### **P-6. Thermal Analysis with High Accuracy of Multi-beam Aperture**

Author: Yanjun Zhang and Zhuming Liu

### **P-7. Nanoscale Fabrication and Application Using Single GeV Ions**

Author: Guanghua Du, Jinlong Guo, Hongjin Mou, Lei Zhang, Baobei Li and Linyan Fu

### **P-8. Plasmonic imaging for single extracellular vesicle characterization**

Author: Mohammad Sadman Mallick and Wei-Chuan Shih

**P-9. Simulation of "Spectral Ghosts" Generated by Imperfectly Fabricated Diffraction Gratings**

Author: Cecilia R. Fasano, Casey T. DeRoo, Keri Hoadley, Edwin F. Cruz Aguirre, Jared Allen Brown Termini, Fabien Grise, Jake McCoy and Randall McEntaffer

**P-10. High Resolution 3D Printing of Copper with Tunable Porosity Through  $\mu$ CLIP and Nanoporous Copper Powders**

Author: Natalya Kublik, Luyang Liu, Xiangfan Chen and Bruno Azeredo

**P-11. Vertical Trench Etching by Repetitive Dry and Wet Anisotropic Etching and 3D Self-aligned Sidewall Nano-patterning**

Author: Yasser Pordeli, Céline Steenge, Andrea Migliorini, Erwin J.W. Berenschot, Ray J.E. Hueting, Stuart S.P. Parkin and Niels R. Tas

**P-12. Fabrication of Polymer Optical Waveguides using Imprint Technology and Roll Press Coating**

Author: Chishu Mori, Joji Maeda, Fumi Nakamura, Kenta Suzuki, Taro Itatani and Takeru Amano

**P-13. Similarity effect of polymerizable functional groups of monomers and adhesive agents on liquid advancement in UV nanoimprinting**

Author: Ryota Inagawa, Akiko Onuma, Hiromasa Niinomi, Tomoya Oshikiri and Masaru Nakagawa

**P-14. A Simulation Study of Proximity Effects in the CD SEM**

Author: Delong Chen, Yanjun Zhang and Zhuming Liu

**P-15. Affordable Homemade Lab-scale UV Imprinting Device**

Author: Tzu-Yu Huang, Hsiang-Yu Liao and Hung-Yin Tsai

**P-16. A Wien filter to separate beams of ionic liquid ions**

Author: Alex Storey, Aydin Sabouri, Usama Ahmed and Carla Perez Martinez

**P-17. Assessing Feasibility of Nanoporous Copper Powders and Hybrid Feedstocks with Copper Nanoparticles for Laser Powder Bed Fusion**

Author: Laura Duenas Gonzalez, Natalya Kublik and Bruno Azeredo

**P-18. A Highly Integrated Correlative Microscopy Platform**

Author: Kerim T. Arat, Afshin Alipour, Hamed Alemansour, Andreas Amann, Jost Diederichs, Luis Montes, Brent Colvin, Jeff Gardiner, William K. Niels, Stefano Spagna, Chris H. Schwalb, Hajo Frerichs, Sebastian Seibert, Lukas Stühn and Marion Wolf

**P-19. Electro-liquefaction of Cr Thin Films for Application in Scanning Probe Lithography**

Author: Swapnendu Ghosh and Santanu Talukder

**P-20. Mechanical Modeling of Polymeric Stamp During Large-Area Electrochemical Metal-Assisted Chemical Imprinting**

Author: Emmanuel Dasinor, Bruno Azeredo and Aliaksandr Sharstniou

**P-21. Magnetic coupling between single-domain nanomagnets fabricated by focused electron beam induced deposition**

Author: Heinz Wanzenboeck

**P-22. Electrophysiologic recording of heart muscle cells on a microchip with 3-dimensional nanoelectrodes**

Author: Heinz Wanzenboeck

**P-23. Direct writing of Liquid Metals for Printed Electronics**

Author: Navid Hussain, Tongtong Fu, Gabriel Marques, Chittaranjan Das, Torsten Scherer, Uwe Bog, Lukas Berner, Irene Wacker, Rasmus R. Schröder, Jasmin Aghassi-Hagmann and Michael Hirtz

**P-24. Area Selective Chemical Vapor Deposition of Gold by Electron Beam Seeding**

Author: Aleksei Tsarapkin, Krzysztof Mackosz, Chinmai S. Jurreddy, Ivo Utke and Katja Hoeflich

**P-25. Correlative AFM-SEM Platform Enabling Unique Characterization of Samples**

Author: Hamed Alemansour, Jost Diederichs, Sam Mitchell, Afshin Alipour, William Neils, Jeff Gardiner, Stefano Spagna, Chris Schwalb, Hajo Frerichs, Lukas Stühn and Marion Wolff

**P-26. Simulation of Planar Microshutter Array for Multi-object Spectroscopy**

Author: Jason Clark, Yingsong Han, Li Jiang, Naga S. Korivi and Huafeng Liu

**P-27. Varied double-grooved meta-structures by using near field holography**

Author: Shiyang Liu and Shuhu Huan

**P-28. Scalable fabrication approach for single pixel microlens arrays**

Author: Jens Bonitz, Christian Helke, Nils Dittmar, Sebastian Schermer, Micha Haase, Lutz Hofmann and Danny Reuter

**P-29. Superconducting Materials and Process Exploration for Quantum Devices**

Author: Aidar Kemelbay, Arian Gashi, Ed Barnard, Shaul Aloni and Adam Schwartzberg

**P-30. Fabrication of Implantable Microcoils for Ultra-Focal Stimulation of Neurons with Selectable Orientation**

Author: Yizhe Zhang, Francesca Marturano, Egemen Bostan, Ilknur Ay, Giorgio Bonmassar and Jiangdong Deng

**P-31. Mechanical Testing of Silicon and Sapphire Nanopillar Structures**

Author: Mehmet Kepenekci, Kun-Chieh Chien and Chih-Hao Chang

**P-32. Identification of BCl<sub>x</sub> Fragments on Si(100) Surfaces During APAM Processing Through a Combined STM/DFT Approach**

Author: Jeffrey A. Ivie, Quinn Campbell, Shashank Misra, Azadeh Farzaneh and Robert E. Butera

**P-33. Nanowire Field Emitters Fabricated Using Helium Ion Microscopy Methods**

Author: Ewelina Gacka, Krzysztof Kwoka, Tomasz Piasecki, Bartosz Pruchnik, Teodor Gotszalk, Gregor Hlawacek, René Hübner, Andrzej Sierakowski and Paweł Janus

**P-34. Artificial Intelligence for SEM Imaging and Metrology**

Author: Andras Vladar

**P-35. Tip-Induced Nanopatterned Polymer Brushes for Directed Self-Assembly of Polymer Blends and Transfer into Silicon Structures**

Author: Stefan Walheim, Roland Groeger, Tobias Heiler and Thomas Schimmel

**P-36. Surfactant-Driven water-oil droplets in Microfluidics for Water Purification**

Author: Kritik Saxena and Yun Chen

**P-37. Atomic Scale Devices in Silicon Fabricated using Scanning Tunneling Microscopy**

Author: Pradeep Namboodiri, Jonathan Wyrick, Fan Fei, Brian Courts, FNU Utsav and Rick Silver



**P-38. Towards Automated Defect Classification in Atomic-Resolution Images Via Image Augmentation**

Author: Shashank Venkatesan, Michael Baldea and Michael A. Cullinan

**P-39. Fabricating Sapphire Nanostructures by Near-Field Focusing of Ultrafast Laser**

Author: Kun-Chieh Chien, Joshua Cheung and Chih-Hao Chang

**P-40. Influence of Thickness of PS-PMMA Block Copolymers on the Pattern Formation of Directed Self-Assembly**

Author: Xiaolei Tong, Mohit Patel, Pat Watson and Gyuseok Kim

**P-41. Electrical switching behaviors in Two-dimensional flake of BaTiS<sub>3</sub>**

Author: Hongming Zhang, Nan Wang, Jiangbin Wu, Huandong Chen, Jian Zhao, Ting-Hao Hsu, Jayakanth Ravichandran, Han Wang and Wei Wu

**P-42. 2.5D-Patterning of photonic structures by electron beam and i-line stepper based grayscale lithography processes**

Author: Christian Helke, Sebastian Schermer, Susanne Hartmann, Jens Bonitz, Micha Haase, Eike Linn, Mathias Hädrich, Andy Zanzal, Patrick Reynolds, Stephen DeMoor, Anja Voigt and Danny Reuter

**P-43. Nanoimprinting-induced strain engineering of MoS<sub>2</sub>-based field effect transistors fabricated by stencil lithography**

Author: Jianwen Zhong, Han Li, Zhao Sun, Zhuofei Gan, Chuying Sun, Yi Wan, Lain-Jong Li and Wen-Di Li

**P-44. Progress on an Intra-Level Mix-and-Match approach of the chemically amplified positive-tone photoresist AR-P 7200.1 series for EBL and i-line stepper lithography**

Author: Markus Gottwald, Susanne Hartmann, Christian Helke, Mandy Sendel, Harry Biller, Matthias Schirmer and Danny Reuter

**P-45. Enhanced Stability of Hydrogen Silsesquioxane (HSQ) through Stabilizer-Incorporated Variant**

Author: Harry Biller, Maik Gerngroß, Mandy Sendel, Matthias Schirmer and Frank Heyroth

**P-46. Detection efficiency enhancement for deterministic single ion implantation**

Author: Kristian Stockbridge, David Cox, Gianfranco Aresta, Roger Webb, Steven Clowes and Ben Murdin

**P-47. Live-Cell Analysis Devices (LCAD) for Delivery and Sampling of Biomolecules**

Author: Liliana Stan

**P-48. Plasma focused ion beam species effects in cross-sectional metrology of EBL resist sidewall profiles**

Author: Bernadeta R. Srijanto and Steven J. Randolph

**P-49. Unusual Nanostructuring and Morphology-tuning by FIB: Self-Organization, Self-Assembly and Site-Specific Defect Engineering on the Functional Surfaces**

Author: Bhaveshkumar Kamaliya, Raviej Uppu, Nabil Bassim and Thomas Folland

**P-50. Iridescent Structural Color from Ultra-low Refractive Index Aerogel as Optical Cavity Dielectric**

Author: Jennie Paik, Wei-Jie Feng, Sean Clark, Hyeonwoo Kim and L. Jay Guo

**P-51. Synergistic Approach for Efficient Water Harvesting using LiCl-PVA Hydrogel and Nanofiber membrane**

Author: Donghee Kang and L. Jay Guo

**P-52. Comparing Josephson Junction Fabrication Techniques for Superconducting Qubits**

Author: Bethany Niedzielski Huffman, Alexander Melville, Gregory Calusine, Michael Gingras, Hannah Stickler, Ali Sabbah, Felipe Contipelli, Duncan Miller, Jonilyn Yoder, William D. Oliver, Mollie Schwartz and Kyle Serniak

**P-53. Flow Evaluation of Traditional and Electrospun Enhanced Filtration Media**

Author: Luke J. Suttley, Sowmya Sudhakar, Jessica Andriolo, Dennis James Moritz, John J. Borkowski and Jack Skinner

**P-54. Thin-Films for Metastructures, Meta-Optics, and Surface Nanofabrication**

Author: Dominic Bosomtwi, Neal Raney, Md Sakibul Islam, Aaron Holzer and Viktoriia Babicheva

**P-55. Adhesion and Excitation Lifetime of Perovskites on Modified Substrates**

Author: Xavier T. Vorhies, Jessica Andriolo, Erik M. Grumstrup, David F. Bahr, Joseph J. Thiebes, Emma K. Orcutt K. Orcutt and Jack Skinner

**P-56. Effects of Lithographic and Pattern Parameters on Stability of Feature-Edge Location in Electron Beam Lithography**

Author: Soo-Young Lee

**P-57. Portable Electrospinning for Orthopedic Wound Treatment**

Author: Cody Baumstarck, Harold Pearson, Jakob T. Nielsen, Jessica Andriolo and Jack Skinner

**P-58. Nanopore Diameter Impact on DNA Methylation Detection Using Methyl Binding Domain Protein Tags**

Author: Nimarpreet Kaur Bamrah, Radhika Vattikunta, Liangxiao Chen, Deeksha Satyabola and Chao Wang

**P-59. Device Fabrication for Optical Lever Measurement of Torsional Motion**

Author: Tina M. Hayward, Dongchel Shin, Ethan Zentner, Brian Baker, Rajesh Menon and Vivishek Sudhir

**P-60. Neural Networks Implemented on Memristive SoC chip for Prompt Detection of Heart Attack**

Author: Zihan Wang, Daniel Wang Yang, Zerui Liu and Wei Wu

**P-61. Optical Metasurface Fabricated Using 3-D Nanoimprint Lithography**

Author: Jiacheng Ye, Yunxiang Wang, Zhexiang Tang, Zerui Liu, Hongming Zhang and Wei Wu

**P-62. Semiconductor Traceability: Die Annotations Patterning by Maskless Exposure Technology**

Author: Garrett Oakes, Ksenija Varga, Thomas Uhrmann, Roman Holly, Tobias Zenger, Andreas Spitzer and Frank Bögelsack

**P-63. Crossflow Electrospinning**

Author: Harold Pearson, Cody Baumstarck, Jessica Andriolo and Jack Skinner

**P-64. Sapphire Supported Aluminum Nitride Nanopore towards Stable and Low-Noise Biomolecule Sensing**

Author: ABDULLA AL Mamun, Pengkun Xia, Md. Ashiqur Rahman Laskar, Nimarpreet Kaur Bamrah and Chao Wang

**P-65. 3D Printing of Microstructured Metallic Thin-Films**

Author: Jiawei Zuo, Scott Clemens, ABDULLA AL Mamun, Dongyao Wang, Chao Wang and Yu Yao

**P-66. Multiplexed Bioreceptors NanoPatterning Using Thermal Scanning Probe Lithography**

Author: Hashem Nasralla, Alexander Wright, Rahul Deshmukh, Davood Shahrjerdi and Elisa Riedo

**P-67. Characterization of ZEP520A Resist Response at EUV Wavelength**

Author: Ethan Fermin Flores, Saurav Mohanty, Andrew N. Tunell and Chih-Hao Chang

**P-68. Investigation of Contrast Degradation due to Varying Incident Angles in Phase-Shift Lithography**

Author: Kwon Sang Lee, Luis A. Aguirre, Barbara Groh, I-Te Chen, Dajun X. Lin, Rajesh Menon, Michael A. Cullinan and Chih-Hao Chang

**P-69. Fabrication of Microstructure Devices on Porous Nanolattice Films**

Author: Nayoung Kim, Saurav Mohanty, Vijay Anirudh Premnath and Chih-Hao Chang

**P-70. Functional Two-Photon Multi-Materials 3D-Printing of Lateral Micro-Optics**

Author: F. Rajabasadi\*, M.-H. Wong\*, T. Saxena\*, J. Zscheile\*, R. Kirchner

**P-71. Buried nanochannels and texturized surfaces fabricated by focused helium ion implantation**

Author: S. Mo, D. O. Byrne, F. I. Allen