

## 2017 FCMN Program

*Updated 2/28/17*

### Monday, Mar. 20

#### Reception and Registration

5:30 PM – 8:30 PM

Monterey Marriott

### Tuesday, Mar. 21

#### Registration and Breakfast

7:30 AM – 8:45 AM

#### Conference Opening

9:00 AM

Welcome and Introduction

*David Seiler, NIST, Conference Chair*

#### Keynote Talks

Session Chair: David Seiler, NIST

9:15 AM

Semiconductor Metrology: Past, Present, and the Future

*Dan Hutcheson, VLSI Research*

10:00 AM

Beyond CMOS Technologies

*Aaron Thean, VP, National University of Singapore*

10:45 AM

Coffee Break and Poster/Exhibit Viewing

## **TCAD**

Session Chair: Ajey Jacob, GlobalFoundries

11:15 AM

Metrology Requirements and Challenges for Advanced FinFET Technology Based on TCAD Simulation

*Peter Zeitzoff, GlobalFoundries*

## **Microscopy**

Session Chair: Alain Diebold, CNSE, SUNY Polytechnic Institute

11:45 AM

Field Mapping with nm-spatial Resolution in Semiconductor Specimens in a Transmission Electron Microscope

*David Cooper, CEA LETI Grenoble, France*

12:15 PM

Lunch and Poster/Exhibit Viewing

1:45 PM

Quantitative Atom Probe Tomography of Complex Systems

*Devin Giddings, TSMC*

2:15 PM

Opportunities and Challenges for Hybrid Characterization and Metrology for Emerging Technologies

*Markus Kuhn, Intel*

2:45 PM

Hybrid Metrology and Machine Learning to Make a Virtual Fab from a Lab

*Johann Foucher, Pollen Metrology*

3:15 PM

Coffee Break and Poster/Exhibit Viewing

## **Diagnostic Techniques**

Session Chair: Deepak Goyal, Intel

3:45 PM

Fault Isolation in IoT Age - Turning Challenges into Chances

*Christian Boit, Technische Universität Berlin*

4:15 PM

Automated Work Flow for Process Control and Defect Analysis

*Ozan Ugurlu, FEI*

4:45 PM

Examination of Advanced Technologies in Characterization, Diagnostics, and Verification at Different Stages in the Manufacturing Lifecycle of Packaged IC Devices

*Colin Ritchie and Stuart Neches, Advantest*

5:15 – 6:15 PM

Poster Session (with Drinks and Hors d'oeuvres)

6:45 PM

Banquet at Hotel

## **Wednesday, Mar. 22**

### **Registration and Breakfast**

8:00 AM – 8:30 AM

### **Magnetics/Spintronics**

Session Chairs: Scott List, SRC, and Ajey Jacob, GlobalFoundries

8:30 AM

Overview of Magnetics/Spintronics

*Kang Wang, UCLA*

9:00 AM

Nano-Magnetic Metrologies

*Tom Silva, NIST*

9:30 AM

Novel Magnetic Nanoprobes: Imaging of Magnetism, Current Flow, and MRI Signals with Nanometer Resolution

*Christian Degen, ETH Zurich*

10:00 AM

Coffee Break and Poster/Exhibit Viewing

### **Metrology for Patterning**

Session Chair: Amal Chabli, CEA-Leti

10:30 AM

Challenges in Nanotopography Measurements at Die Level

*Carlos Beitia, CEA-Leti*

11:00 AM

Critical Dimension Small Angle X-ray Scattering for the Semiconductor Industry

*Joe Kline, NIST*

11:30 AM

OCD Metrology for Advanced Lithography

*Bernd Boderman, PTB, Berlin*

12:00 PM

Muller Matrix-based Scatterometry

*Alain Diebold, CNSE, SUNY Polytechnic Institute*

12:30 PM

Lunch and Poster/Exhibit Viewing

### **Interface and Gate Stack Metrology**

Session Chair: Zhiyong Ma, Intel

2:00 PM

Chemical and Electrical Profiling of NanoLaminate Gate Stacks on SiGe

*Andy Kummel, UCSD*

2:30 PM

Interfacial Electronic Characterization of Oxides/Metals on High Mobility Semiconductors Using in-situ Synchrotron Radiation Photoemission and the Correlation with the Interfacial Electric Properties

*Mingwei Hong, National Taiwan Univ.*

3:00 PM

Coffee Break and Dedicated Poster/Exhibit Viewing Session

### **Beyond CMOS Characterization and Metrology**

Session Chair: Alain Diebold, CNSE, SUNY Polytechnic Institute

3:30 PM

Electron Optics in Graphene Heterostructures with Nanopatterning

*Scott Dietrich, Columbia*

4:00 PM

Creating an on/off Berry Phase Switch in Circular Graphene p-n Junctions

*Christopher Gutierrez, NIST*

4:30 PM

XPS, STM, LEIS, .... of 2D Materials – Graphene, H-BN, and TMD Materials

*Robert Wallace, UT Dallas*

5:00 – 6:00 PM

Poster Session (with Drinks and Hors d'oeuvres)

## **Thursday, Mar. 23**

### **Registration and Breakfast**

8:00 AM – 8:30 AM

### **7-10 NM Metrology and Defect Inspection**

Session Chair: Tuyen Tran, Intel

8:30 AM

State of the Art e-Beam Inspection Technology

*Jack Jau, HMI*

9:00 AM

Extending Optical Inspection to the VUV

*Keith Wells, KLA-Tencor*

9:30 PM

Optical Inspection at 10 nm Node and Beyond: Perspectives and Challenges

*Mehdi VaezIravani, Applied Materials*

10:00 AM

Coffee Break and Poster/Exhibit Viewing

10:30 AM

Current and Future Critical Dimension Metrology Technology Perspectives for Sub-10nm Processes

*Mari Nozoe, Hitachi, Japan*

### **2.5D/3D Packaging Metrology**

Session Chair: Ehrenfried Zschech, Fraunhofer IKTS Dresden

11:00 AM

Metrology and Characterization Challenges for Complex 2.5 D and 3 D Packaging

*Bill Bottoms, Consultant*

11:30 AM

Novel Metrology Solution for Advanced Packaging Based on Multi-energy X-ray Microscopy and Tomography

*Ehrenfried Zschech, Fraunhofer IKTS Dresden*

**Emerging Metrology**

Session Chairs: Wilfried Vandervorst, Imec, and Usha Varshney, NSF

12:00 PM

Future Needs of Characterization and Metrology for Silicon Qubits in Quantum Computing

*Neil Zimmerman, NIST*

12:30 PM

Lunch and Poster/Exhibit Viewing

2:00 PM

Size Dependent Resistivity in Narrow Fins as Probed with Micro-FPP

*Janusz Bogdanowicz, Imec*

2:30 PM

Reflective Small Angle Electron Scattering to Characterize Nanostructures

*Wen-Li Wu, NIST*

3:00 PM

Coffee Break and Poster/Exhibit Viewing

3:30 PM

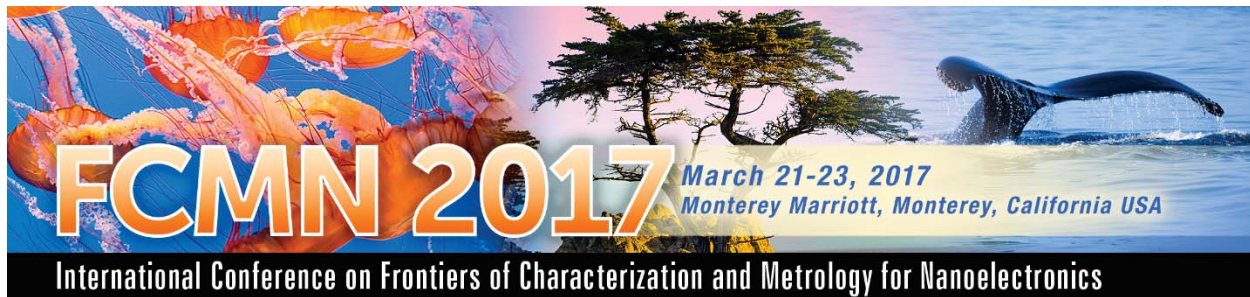
Individual Device Analysis Using Hybrid TEM-Scalpel SSRM Metrology

*Umberto Celano, Imec*

4:00 PM

Super-resolution Single-Molecule Microscopy using Plasmonic Opti-Chip

*Shubhra Gangopadhyay, University of Missouri / NSF*



## 2017 FCMN Posters

### **001, Direct Observation of Alloyed Contact Formation in Nanowire Cross-Section**

*Renjie Chen<sup>1</sup>, Katherine L. Jungjohann<sup>2</sup>, William M. Mook<sup>2</sup>, John Nogan<sup>2</sup>, and Shadi A. Dayeh<sup>1,3,4</sup>*

<sup>1</sup>Dept of Electrical and Computer Engineering, Univ. of CA San Diego, La Jolla, CA

<sup>2</sup>Sandia National Laboratories, Albuquerque, NM

<sup>3</sup>Materials Science and Engineering Program, Univ. of CA San Diego, La Jolla, CA

<sup>4</sup>Dept of NanoEngineering, Univ. of CA San Diego, La Jolla, CA

### **002, Contribution of Luminescence Techniques for the Characterization of Materials and Devices at the Nanoscale**

*C. Licitra<sup>1</sup>, N. Rochat<sup>1</sup>, N. Gambacorti<sup>1</sup>, S. David<sup>2</sup>, G. R. Muthinti<sup>3</sup>, F. Olivier<sup>1</sup>, A. Faujour<sup>4</sup>, and A. Chabli<sup>4</sup>*

<sup>1</sup>Univ. Grenoble Alpes \ CEA, LETI, MINATEC Campus, Grenoble, France

<sup>2</sup>Univ. Grenoble Alpes \ CNRS, LTM, Grenoble, France

<sup>3</sup>IBM Research, Albany, NY

<sup>4</sup>Univ. Grenoble Alpes, INES, F-73375 Le Bourget du Lac, France

### **003, Seeing the Invisible: Metrology for Extended Defects in Beyond-Silicon Semiconductor Device Structures**

*Andreas Schulze<sup>1</sup>, Anna Prokhodtseva<sup>2</sup>, Tomas Vystavel<sup>2</sup>, David Gachet<sup>3</sup>, Jean Berney<sup>3</sup>, Roger Loo<sup>1</sup>, Wilfried Vandervorst<sup>1,4</sup>, and Matty Caymax<sup>1</sup>*

<sup>1</sup>Imec, Leuven, Belgium

<sup>2</sup>Mat. & Struct. Analysis, Thermo Fisher Scientific, Czech Republic

<sup>3</sup>Attolight AG, Lausanne, Switzerland

<sup>4</sup>KU Leuven, Dept. of Physics and Astronomy, Leuven, Belgium

### **004, High Brightness MetalJet X-Ray Technology for Semiconductor Process Metrology**

*J. Hållstedt, U. Lundström, E. Espes, B. A. M. Hansson, O. Hemberg, G. Johansson, M. Otendal, T. Tuohimaa, and P. Takman*

Excillum AB, Torshamnsgatan 35, 164 40 Kista, Sweden

### **005, Nanoelectronics Dimensional Metrology: Understanding the Differences Between Secondary and Backscattered Electron Imaging**

*Michael T. Postek, András E. Vladár, and John S. Villarrubia*

National Institute of Standards and Technology (NIST), Gaithersburg, MD

### **006, High-Throughput X-ray CD Metrology**

*R. Loewen, M. Feser, R. Ruth, and M. Gifford*

Lyncean Technologies, Inc., Fremont, CA

**007, Electrical Property Characterization of Vacuum-Channel Nanoelectronics Via Scanning Capacitance Microscopy**

*Jin Woo Han<sup>1</sup>, Gerald Pascual<sup>2</sup>, Byong Kim<sup>2</sup>, and Keibock Lee<sup>2</sup>*

<sup>1</sup>NASA Ames Research Center, Moffett Field, CA

<sup>2</sup>Park Systems Inc., Santa Clara, CA

**008, Assessing Scanning Electron Microscopy Stereophotogrammetry Algorithms with Virtual Test**

**Samples**

*John S. Villarrubia, Vipin N. Tondare, and András E. Vladár*

National Institute of Standards and Technology (NIST), Gaithersburg, MD

**009, Development of a Nanometer Probe Helium Ion Microscope with Time of Flight Element Identification**

*Viacheslav Manichev<sup>1</sup>, Alexander Livernois<sup>1</sup>, L. C Feldman<sup>1</sup>, T. Gustafsson<sup>1</sup>, D. Barbacci<sup>2</sup>, and A. Schultz<sup>2</sup>*

<sup>1</sup>Rutgers University, Piscataway, NJ

<sup>2</sup>Ionwerks Inc., Houston, TX

**010, Subsurface Nano-Imaging Using Torsional Scanning Probe Microscopy**

*Violeta Navarro, Maarten H. van Es, and Hamed Sadeghian*

TNO, Stieltjesweg 1, 2628 CK Delft, The Netherlands

**011, Engineering Ferroelectric Polymer Memories: Confounding Factors Which Obscure Polarization**

*Vasileia Georgiou<sup>1,2</sup>, Dmitry Veksler<sup>1</sup>, Jason P. Campbell<sup>1</sup>, Dimitris E. Ioannou<sup>2</sup>, and Kin P. Cheung<sup>1</sup>*

<sup>1</sup>National Institute of Standards and Technology (NIST), Gaithersburg, MD

<sup>2</sup>Department of Electrical and Computer Engineering, George Mason University, Fairfax, VA

**012, Nanoscale Chemical Imaging with Infrared Photo-Induced Force Microscopy**

*Sung Park, Derek Nowak, and Thomas Albrecht*

Molecular Vista, Inc., San Jose, CA

**013, ALPro System: An Electrical Profiling Tool for Ultra-Thin Film Characterization**

*Abhijeet Joshi and Bulent Basol*

Active Layer Parametrics, Inc., Los Angeles, CA

**014, Precision of Micro Hall Effect Measurements in Scribe Line Test Pads**

*Maria-Louise Witthøft<sup>1</sup>, Frederik W. Østerberg<sup>1</sup>, Janusz Bogdanowicz<sup>2</sup>, Andreas Schulze<sup>2</sup>, Wilfried Vandervorst<sup>2,3</sup>, Henrik H. Henrichsen<sup>4</sup>, Peter F. Nielsen<sup>4</sup>, Ole Hansen<sup>1</sup> and Dirch H. Petersen<sup>1</sup>*

<sup>1</sup>Department of Micro- and Nanotechnology, Technical University of Denmark, Lyngby, Denmark

<sup>2</sup>IMEC, Leuven, Belgium

<sup>3</sup>Instituut voor Kern- en Stralingsfysika, Leuven, Belgium

<sup>4</sup>CAPRES A/S, Scion-DTU, Lyngby, Denmark

**015, Coherent Extreme Ultraviolet Light Reveals the Elastic Properties of Ultrathin Films**

*Travis D. Frazer<sup>1</sup>, Jorge N. Hernandez-Charpak<sup>1</sup>, Joshua L. Knobloch<sup>1</sup>, Begoña Abad Mayor<sup>1</sup>, Kathleen M. Hoogeboom-Pot<sup>1,2</sup>, Damiano Nardi<sup>1,2</sup>, Qing Li<sup>1</sup>, Marie Tripp<sup>2</sup>, Sean W. King<sup>2</sup>, Erik H. Anderson<sup>3</sup>, Weilun Chao<sup>3</sup>, Henry C. Kapteyn<sup>1</sup>, and Margaret M. Murnane<sup>1</sup>*

<sup>1</sup>JILA and Department of Physics, University of Colorado, Boulder, CO

<sup>2</sup>Intel Corporation, Hillsboro, OR

<sup>3</sup>Center for X-Ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA



**016, Thermoelectric Property of Silicon Nanowires Processed by Metal Assisted Directional Chemical Etching**

*David Rodriguez and Yong X. Gan*

California State Polytechnic University, Pomona, CA

**017, Time of Flight Backscattering Spectrometry and Secondary Ion Mass Spectrometry in a Helium Ion Microscope - Chemical Analysis on the nm Scale**

*N. Klingner<sup>1</sup>, R. Heller<sup>1</sup>, G. Hlawacek<sup>1</sup>, P. Gnauck<sup>2</sup>, S. Facsko<sup>1</sup>, and J. von Borany<sup>1</sup>*

<sup>1</sup>Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr. 400, 01328 Dresden, Germany

<sup>2</sup>Carl-Zeiss-Microscopy GmbH, D-73447 Oberkochen, Germany

**018, Atom Probe: Opportunities for CMOS Characterization**

*T.J. Prosa, I. Martin, Y. Chen, K.P. Rice, D.A. Reinhard, and D.J. Larson*

CAMECA Instruments, Inc. Madison, WI

**019, ICS X-ray Source for 3D Nano-Structured Metrology**

*Bradley J Nordell, Sudeep Banerjee, Grigory Golovin, and Donald Umstadter*

Department of Physics and Astronomy, University of Nebraska-Lincoln, Lincoln, NE

**020, Monitoring Accuracy and Robustness in On-Product Diffraction-Based Overlay Metrology**

*Arie den Boef<sup>1</sup>, Kaustuve Bhattacharyya<sup>1</sup>, Marc Noot<sup>1</sup>, Aiqin Jiang<sup>2</sup>, and Martin Jak<sup>1</sup>*

<sup>1</sup>ASML Netherlands B.V., Veldhoven, The Netherlands

<sup>2</sup>ASML, Ballston Lake, NY

**021, Assessing Quantitative Optical Imaging for Realizing In-Die Critical Dimension Metrology**

*Bryan M. Barnes, Mark-Alexander Henn, Hui Zhou, Martin Y. Sohn, and Richard M. Silver*

National Institute of Standards and Technology (NIST), Gaithersburg, MD

**022, Transmission and Reflection-Mode Imaging of Nanostructures with 13nm Illumination via Tabletop Ptychography CDI**

*Christina L. Porter<sup>1</sup>, Michael Tanksalvala<sup>1</sup>, Dennis F. Gardner<sup>1</sup>, Michael Gerrity<sup>1</sup>, Giulia F.*

*Mancini<sup>1</sup>, Xiaoshi Zhang<sup>3</sup>, Galen P. Miley<sup>2</sup>, Elisabeth R. Shanblatt<sup>1</sup>, Benjamin R. Galloway, Charles S. Bevis<sup>1</sup>, Nara Noeur<sup>1</sup>, Robert Karl Jr., Daniel A. Adams<sup>1</sup>, Henry C. Kapteyn<sup>1</sup>, and Margaret M.*

*Murnane<sup>1</sup>*

<sup>1</sup>JILA, University of Colorado, Boulder, CO

<sup>2</sup>Department of Chemistry, Northwestern University, Evanston, IL

<sup>3</sup>KMLabs Inc., Boulder, CO

**023, An FEL Source for CMOS Lithography and Characterization**

*Paul van der Heide, Obert Wood, and Erik Hosler*

GLOBALFOUNDRIES, Malta, NY

**024, Automated AFM for Small-Scale and Large-Scale Surface Profiling in CMP Applications**

*Ardavan Zandiatashbar<sup>1</sup>, Byong Kim<sup>1</sup>, Young-kook Yoo<sup>1</sup>, Keibock Lee<sup>1</sup>, Ahjin Jo<sup>2</sup>, Ju Suk Lee<sup>2</sup>,*

*Sang-Joon Cho<sup>2</sup>, and Sang-il Park<sup>2</sup>*

<sup>1</sup>Park Systems Inc., Santa Clara, CA

<sup>2</sup>Park Systems Corp., Suwon, Korea

**025, Characterization of a Lab Based CD-SAXS Tool**

*W. D. Thompson<sup>1</sup>, R. Joseph Kline<sup>2</sup>, and Osman Sorkhabi<sup>1</sup>*

<sup>1</sup>Lam Research Corporation, Fremont, CA

<sup>2</sup>National Institute of Standards and Technology (NIST), Gaithersburg, MD

**026, Quantum Noise Effects in e-Beam Lithography and Metrology**

*T. Verduin, S.R. Lokhorst, C.W. Hagen, and P. Kruit*

Delft University of Technology, Dept. Imaging Physics, Lorentzweg 1, 2628CJ Delft, The Netherlands

**027, High Resolution EBI for Pattern Fidelity Monitor**

*Fei Wang, Brian Lee, Kevin Liu, and Jack Jau*

HMI, an ASML Company, San Jose, CA

**028, In-line 3D AFM for Critical Dimension and Sidewall Roughness of Si Photonic Waveguide and Correlation with Its Propagation Loss**

*T.-G. Kim<sup>1</sup>, P. Verheyen<sup>1</sup>, P. De Heyn<sup>1</sup>, T. Vandeweyer<sup>1</sup>, A. Miller<sup>1</sup>, M. Pantouvaki<sup>1</sup>, J. Van Campenhout<sup>1</sup>, A.-J. Jo<sup>2</sup>, S.-J. Cho<sup>2</sup>, and S.-I. Park<sup>2</sup>*

<sup>1</sup>Imec vzw., Leuven, Belgium

<sup>2</sup>Park Systems, Suwon, South Korea

**029, Reference Materials to Enable Precise and Accurate Imaging with Electrical Scanning Probe Microscopes**

*J. J. Kopanski, L. You, J. Corona, and Y. S. Obeng*

National Institute of Standards and Technology (NIST), Gaithersburg, MD

**030, Ultra-thin ALD HfO<sub>2</sub> Growth Mechanism Studied By Atomic Force Microscope (AFM)**

*Charles C. Wang, Steven Hung, Naomi Yoshida, Tatsuya E. Sato, and Yuri Uritsky*

Applied Materials, Inc., Santa Clara, CA

**031, Ferroelectricity in Atomic Layer Deposited Hf<sub>1-x</sub>Zr<sub>x</sub>O<sub>2</sub> Nanoscale Films: Characterization By Synchrotron Grazing Incidence X-Ray Diffraction and Polarization Measurements**

*Sonal Dey<sup>1</sup>, Kandabara Tapily<sup>2</sup>, Steven Consiglio<sup>2</sup>, Robert D. Clark<sup>2</sup>, Cory S. Wajda<sup>2</sup>, Gert J. Leusink<sup>2</sup>, Arthur R. Wolf<sup>3</sup>, Pankaj Sharma<sup>4</sup>, Suman Datta<sup>4</sup>, and Alain C. Diebold<sup>1</sup>*

<sup>1</sup>CNSE, SUNY Polytechnic Institute, Albany, NY

<sup>2</sup>TEL Technology Center, America, LLC, Albany, NY

<sup>3</sup>Cornell High Energy Synchrotron Source, Ithaca, NY

<sup>4</sup>Department of Electrical Engineering, University of Notre Dame, Notre Dame, IN

**032, Helium Ion Microscopy for Si Materials With Less Mechanical Damage**

*Shinichi Ogawa<sup>1</sup>, Nobuaki Tarumi<sup>2</sup>, Tomohiko Iijima<sup>1</sup>, Yumiko Shimizu<sup>2</sup>, and Yuji Otsuka<sup>2</sup>*

<sup>1</sup>Nanoelectronics Research Institute, National Institute of Advanced Industrial Science and Technology (AIST) West 7A, 16-1 Onogawa, Tsukuba, Ibaraki 305-8569 Japan

<sup>2</sup>Toray Research Center Inc., 3-3-7 Sonoyama, Otsu, Shiga 520-8567 Japan

**033, Reference-Free In-Depth Characterization of Nanoscale Layer Systems Using a Combined Grazing Incidence X-Ray Fluorescence and X-Ray Reflectometry Approach**

*Philipp Hönicke<sup>1</sup>, Blanka Detlefs<sup>2</sup>, Janis Eilbracht<sup>1</sup>, Yves Kayser<sup>1</sup>, Uwe Mühle<sup>3</sup>, Beatrix Pollakowski<sup>1</sup>, and Burkhard Beckhoff<sup>1</sup>*

<sup>1</sup>Physikalisch-Technische Bundesanstalt (PTB), Berlin, Germany

<sup>2</sup>CEA-LETI/ESRF, Grenoble, France

<sup>3</sup>Fraunhofer IKTS, Dresden, Germany

**034, From Large Research Instruments to an Industrial Control: X-Ray Photoelectron Spectroscopy Characterizations of Advanced Technology Gate Stack**

*L. Fauquier<sup>1,2,3</sup>, B. Pelissier<sup>2,3</sup>, J. Avila<sup>4</sup>, M.-C. Asensio<sup>4</sup>, D. Le Cunff<sup>1</sup>, D. Doloy<sup>1</sup>, C. Beitia<sup>2,5</sup>, and T. Baron<sup>2,3</sup>*

<sup>1</sup>STMICROELECTRONICS, Crolles, France

<sup>2</sup>Univ. Grenoble Alpes, Grenoble, France

<sup>3</sup>CNRS, LTM, MINATEC Campus, Grenoble, France

<sup>4</sup>Synchrotron SOLEIL, Saint Aubin, Gif-sur-Yvette, France

<sup>5</sup>CEA, LETI, MINATEC Campus, Grenoble, France

### **035, XPS/ARXPS in Thin Film and Nanomaterial Process Control**

*Chris Moffitt<sup>1</sup>, Simon Hutton<sup>2</sup>, and Sarah Coultas<sup>2</sup>*

<sup>1</sup>Kratos Analytical, Inc., Chestnut Ridge, NY

<sup>2</sup>Kratos Analytical, Ltd., Wharfedale, Manchester, UK

### **036, Evaluations of Graphene to Graphene Contacts**

*Jia-Bin Chen and Dung-Ching Perng*

National Cheng Kung University, Tainan, Taiwan

### **037, Nanoscale Analysis of Conductance Switching Dynamics and Current Hysteresis in (GeTe)<sub>2</sub>/Sb<sub>2</sub>Te<sub>3</sub> Superlattice Films Using Scanning Probe Methods**

*Leonid Bolotov, Tetsuya Tada, Yuta Saito, Noriyuki Miyata, and Junji Tominaga*

Nanoelectronics Research Institute, Nat. Inst. of Advanced Industrial Science and Technology (AIST),

Tsukuba, Ibaraki, Japan

### **038, Thermal Cooling of High-Power Electronics Using SiO<sub>2</sub> Nanoparticle Packings**

*Anil Yuksel<sup>1</sup>, Eric J. Tervo<sup>2</sup>, Baratunde A. Cola<sup>2</sup>, Paul S. Ho<sup>1</sup>, Michael Cullinan<sup>1</sup>*

*Zhuomin M. Zhang<sup>2</sup>, and Jayathi Murthy<sup>3</sup>*

<sup>1</sup>The University of Texas at Austin, Austin, TX

<sup>2</sup>Georgia Institute of Technology, Atlanta, GA

<sup>3</sup>University of California, Los Angeles, CA

### **039, An Electromechanical Spectroscopy for Determining the Atomic-Configuration of Single-Molecule Devices**

*Joshua Hihath*

Department of Electrical and Computer Engineering, Davis, CA

### **040, Pico-Second Laser and Broad Argon Beam Tools for Characterization of Advanced Packages and Devices**

*Y. Wang, C. Spence, S. Coyle, J. Hunt, and M. Hassel Shearer*

Gatan Inc., Pleasanton, CA

### **041, Examination of Advanced Technologies in Characterization, Diagnostics, and Verification at Different Stages in the Manufacturing Lifecycle of Packaged IC Devices**

*Colin Ritchie<sup>1</sup>, Scott West<sup>1</sup>, Stuart Neches<sup>1</sup>, Eiji Kato<sup>2</sup>, and Masaichi Hashimoto<sup>2</sup>*

<sup>1</sup>Advantest America, Inc., San Jose, CA

<sup>2</sup>Advantest Corporation, Matsubara, Kamiyashi, Aoba-ku, Sendai Japan

### **042, Characterization and Control of the Surface of the Topological Insulator Bi<sub>2</sub>Se<sub>3</sub>**

*Avery J. Green<sup>1</sup>, Lee A. Walsh<sup>2</sup>, Wesley Nolting<sup>1</sup>, Carl A. Ventrice Jr.<sup>1</sup>, Chris L. Hinkle<sup>2</sup>, and Alain C. Diebold<sup>1</sup>*

<sup>1</sup>CNSE, SUNY Polytechnic Institute, Albany, NY

<sup>2</sup>Materials Science and Engineering, University of Texas at Dallas, Richardson, TX

**043, Strain and Composition Monitoring in Various (Si)Ge Fin Structures Using In-Line HRXRD**

*Andreas Schulze<sup>1</sup>, Roger Loo<sup>1</sup>, Liesbeth Witters<sup>1</sup>, Hans Mertens<sup>1</sup>, Nadine Collaert<sup>1</sup>, Naoto Horiguchi<sup>1</sup>, Matthew Wormington<sup>2</sup>, Paul Ryan<sup>3</sup>, Wilfried Vandervorst<sup>1,4</sup>, and Matty Caymax<sup>1</sup>*

<sup>1</sup>Imec, Leuven, Belgium

<sup>2</sup>Bruker Semiconductor Division, Santa Barbara, CA

<sup>3</sup>Bruker Semiconductor Division, Durham, UK

<sup>4</sup>KU Leuven, Dept. of Physics and Astronomy, Leuven, Belgium

**044, In-Line Stress/Contamination Metrology for Advanced Semiconductor Device Using Micro Raman and Photoluminescence Measurements**

*Jae Hyun Kim<sup>1,2</sup>, Chang Whan Lee<sup>1</sup>, Hyung Won Yoo<sup>1</sup>, Byoung Ho Lee<sup>1</sup>, and Seung Min Han<sup>2</sup>*

<sup>1</sup>SK hynix, Inc., Icheon-si, Gyeonggi-do, Korea

<sup>2</sup>Korea Advanced Institute of Science and Technology, Daejeon, Korea

**045, Advanced Defect Classification By Optical Metrology**

*Jacques van der Donck, Esther Kramer, Peter van der Walle, Wouter Mulckhuysse, Jacqueline van Veldhoven, Loek Nijsten, Felipe Bernal Arango, Helma Spruit, and Diederik Maas*

TNO Stieltjesweg 1, 2628 CK, Delft, The Netherlands

**046, Automatic Detection of Dislocations in Strained SiGe With HCl Etch and Brightfield Inspection**

*Ralf Buengener and Jody Fronheiser*

TD Research, GLOBALFOUNDRIES USA, Albany, NY

**047, Inline X-ray Metrology of Epitaxial Thin Film for Gate-All-Around Structures**

*B. Mendoza<sup>1</sup>, P. Gin<sup>2</sup>, K.M. Matney<sup>2</sup>, M. Wormington<sup>2</sup>, J. Wall<sup>3</sup>, P. Ryan<sup>3</sup>, R. Chao<sup>1</sup>, and J. Gaudiello<sup>1</sup>*

<sup>1</sup>IBM STR Albany, Albany, NY

<sup>2</sup>Bruker Semi Division, Santa Barbara, CA

<sup>3</sup>Bruker JV UK Ltd., Durham, UK

**048, Nano-Particle Detection, Identification and Concentration Determination in Liquids for sub-10 nm Technology Nodes**

*Basil G. Eleftheriades<sup>1</sup>, Steve A. Rutledge<sup>1</sup>, Manuchehr Ebrahimi<sup>1</sup>, Emily E. Storey<sup>1</sup>, Marie Tripp<sup>2</sup>, Bhagrava Ravoori<sup>2</sup>, Tuyen K. Tran<sup>2</sup>, and Amr S. Helmy<sup>1</sup>*

<sup>1</sup>Department of Electrical and Computer Engineering, University of Toronto, Toronto M5S 3G4, Canada

<sup>2</sup>Intel Corporation, Hillsboro, OR

**049, Image Processing Software Assisted Quantitative Analysis of Various Digital Images in Process Monitoring, Process Control and Material Characterization**

*Woo Sik Yoo, Toshikazu Ishigaki, and Kitaek Kang*

WaferMasters, Inc., San Jose, CA

**050, Optical Critical Dimension Metrology for the 7 nm Node and Beyond Using a Near-Field Metalens**

*Jinlong Zhu<sup>1,2</sup>, Yating Shi<sup>2</sup>, Shiyuan Liu<sup>2</sup>, and Lynford L. Goddard<sup>1</sup>*

<sup>1</sup>Photonic Systems Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL

<sup>2</sup>State Key Laboratory of Digital Manufacturing Equipment and Technology, Huazhong University of Science and Technology, Wuhan, China

**051, Enhanced Defect Detection in Patterned Wafers Using a Plasmonic Waveguide Metalens Array**

*Jinlong Zhu, Sanyogita Purandare, and Lynford L. Goddard*

Photonic Systems Laboratory, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign, Urbana, IL

**052, Combining Nano-Scale Inert-Gas Ion Microscopy and Secondary Ion Mass Spectrometry**

*Sybrein Sijbrandij<sup>1</sup>, John Notte<sup>1</sup>, David Dowsett<sup>2</sup>, Jean-Nicolas Audinot<sup>2</sup>, and Tom Wirtz<sup>2</sup>*

<sup>1</sup>Carl Zeiss Microscopy, LLC, Ion Microscopy Innovation Center, Peabody, MA

<sup>2</sup>Advanced Instrumentation for Ion Nano-Analytics (AINA), MRT Department, Luxembourg Institute of Science and Technology (LIST), Belvaux, Luxembourg

**053, Analyzing Post-CMP Surface Topography from White Light Interference Microscopy**

*A.F. Bello, Jusang Lee, Shinichiro Kakita, and Nicholas Pieniazek*

Advanced Module Engineering, GLOBALFOUNDRIES, Malta, NY

**054, Characterization of Doping Distribution in Fin Field Effect Transistor (FinFET) Structures Representative for 14nm CMOS Technology and Beyond**

*M.J.P. Hopstaken<sup>1</sup>, M. Saccomanno<sup>1</sup>, M. Ebrish<sup>2</sup>, and O. Gluschenkov<sup>2</sup>*

<sup>1</sup>IBM T.J. Watson Research Center, Yorktown Heights, NY

<sup>2</sup>IBM Research Albany Nanotech Center, Albany, NY

**055, Optical Properties of Pseudomorphic  $\text{Ge}_{1-x-y}\text{Si}_x\text{Sn}_y$  on Ge**

*Nalin S. Fernando<sup>1</sup>, Ryan Hickey<sup>2</sup>, John Hart<sup>2</sup>, Ramsey Hazbun<sup>2</sup>, Dainan Zhang<sup>2</sup>, James Kolodzey<sup>2</sup>, and Stefan Zollner<sup>1</sup>*

<sup>1</sup>Department of Physics, New Mexico State University, Las Cruces, NM

<sup>2</sup>Department of Electrical and Computer Engineering, University of Delaware, Newark DE

**056, In-situ TEM Observation of Nickelide Contact Formation in InGaAs Nanowire Channels**

*Renjie Chen<sup>1</sup> and Shadi A. Dayeh<sup>1,2,3</sup>*

<sup>1</sup>Dept of Electrical and Computer Engineering, Univ. of CA San Diego, La Jolla, CA

<sup>2</sup>Materials Science and Engineering Program, University of CA San Diego, La Jolla, CA

<sup>3</sup>Dept of NanoEngineering, Univ. of CA San Diego, La Jolla, CA

**057, High Precision Optical Characterization of Carrier Diffusion Length**

*Will Chism<sup>1</sup> and Michael Current<sup>2</sup>*

<sup>1</sup>Xitronix Corporation, Austin TX

<sup>2</sup>Current Scientific, San Jose, CA

**058, Crack Evolution In Cu/Low-K Stacks And Crack Stop Evaluation Using In-Situ Micro-DCB In A Nano-XCT Tool**

*Kristina Kutukova, Jürgen Gluch, Yvonne Standke, and Ehrenfried Zschech*

Fraunhofer Institute for Ceramic Technologies and Systems, Maria-Reiche-Str. 2, 01109 Dresden, Germany

**059, New Frequency Domain Fiber Optic Interferometry for Advanced Wafer, Micro- and Nanostructure Metrology**

*Wojtek J. Walecki, Alexander Pravdivtsev, Jae Ryu, Nikos D. Jaeger, Yuen Lim, and Ann Koo*

Frontier Semiconductor, San Jose CA