2024 FCMN Technical Program

Monday, April 15

Tutorials

2:00 PM – 4:00 PM

**Machine Learning and Its Application to Metrology**

Dragan Djurdjanovic (UT Austin)

**Metrology Techniques**

Alain Diebold (Univ. of Albany) and Paul van der Heide (Imec)

4:30 – 6:30 PM

**Advanced Packaging**

Ofer Adan (Applied Materials)

Reception and Registration

7:00 – 9:00 PM

Monterey Marriott

Tuesday, April 16

**Registration**

7:00 AM – 8:30 AM

**Conference Opening**

9:00 AM

Conference Opening

J. Alexander Liddle, NIST, Conference Co-Chair
Plenary
Session Chairs: J. Alexander Liddle (NIST) and Alain Diebold (Univ. of Albany)

9:15 AM
**Rick Gottscho, LAM Research**, Big Data, Little Data, and Virtual Twins: Accelerating Process Development for Semiconductor Device Fabrication

10:00 AM
Coffee Break and Poster/Exhibit Viewing

10:30 AM
**Arie den Boef, ASML**, Metrology Initiatives at ASML and ARCNL

Emerging Materials and Devices
Session Chairs: Ajey Jacob (Univ. of Southern CA), Usha Varshney (NSF), and Christina Hacker (NIST)

11:15 AM
**Xiaoqin (Elaine) Li, University of Texas-Austin**, Ultrafast Spectroscopy of/for Nanoelectronics

11:45 AM
**Daniel Schmidt, IBM**, In-Line Metrology for Sub-2nm Technology Nodes

12:15 PM – 1:45 PM
Lunch and Poster/Exhibit Viewing

CHIPS Act & Industry Trends
Session Chairs: Paul van der Heide (Imec) and Markus Kuhn (Rigaku)

1:45 PM
**Marla Dowell, National Institute of Standards and Technology**, Advancing Measurement Science for Microelectronics: CHIPS R&D Metrology Program

2:15 PM
**Zhenxin Zhong, TFS**, Latest Developments of Automated TEM Metrology and Analysis for Semiconductor Industry

2:45 PM
**Colin Ophus, Berkeley**, Applications of Machine Learning to STEM and 4DSTEM Characterization

3:15 PM
Coffee Break and Poster/Exhibit Viewing

Microscopies: New Developments in Chemical/Property Characterization
Session Chairs: Markus Kuhn (Rigaku) and Paul van der Heide (Imec)

3:45 PM

4:15 PM

Umberto Celano, *ASU*, Scanning Probe Microscopy: Pushing the Boundaries with Multi-Probes and Reverse Tip Sample Scanning

4:45 PM


5:15 – 6:15 PM

Poster Session (with Drinks and Hors d’oeuvres)

7:00 PM

Banquet at Hotel

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**Wednesday, April 17**

**Registration**

7:45 AM – 8:30 AM

**Advanced Packaging**

Session Chairs: Ehrenfried Zschech (Brandenburg University of Technology Cottbus – Senftenberg, Institute of Physics) and Baohua Niu (Intel)

8:30 AM

Yan Li, *Samsung*, Fault Isolation Approaches for 3D IC Systems

9:00 AM

Matthew Andrew, *ZEISS Innovation Center*, Advances in the Use of AI for X-ray Reconstruction: Applications in Electronics Packaging

9:30 AM

Pooya Tadayon, *Intel*, Title TBD

10:00 AM

Coffee Break and Poster/Exhibit Viewing

**New Developments in Chemical/Electrical Characterization**

Session Chairs: Paul van der Heide (Imec) and Shinichi Ogawa (AIST)

10:30 AM

Claudia Fleischmann, *Imec*, Advances in APT Quantification and Distortion Correction Approaches

11:00 AM

Kento Sasaki, *Univ. of Tokyo*, Arrangement of Nanosized hBN Quantum Sensor Spots by Helium Ion Microscope
11:30 – 1:00 PM
Lunch and Poster/Exhibit Viewing

**Patterning Metrology**

Session Chairs: Ofer Adan (Applied Materials), Alan Brodie (KLA-Tencor), and Shunsuke Koshihara (Hitachi High-Tech Corporation)

1:00 PM

**Jonghyeok Park**, Samsung Electronics, Wide-area Delayering Based 3D Tomography Solution as a Window into the Semiconductor Manufacturing

1:30 PM

**Eugen Foca**, *Carl Zeiss SMT GmbH*, 3D Metrology and Inspection of Advanced NAND and DRAM Devices Via Full 3D Characterization with FIB-SEM Tomography

2:00 PM

**Patrick Naulleau**, *EUVTech*, Measuring the Complex Behavior of Phase in the EUV Regime and Implications for Phase Shift Masks

2:30 PM

Coffee Break and Poster/Exhibit Viewing

**Advanced Manufacturing Metrology – Defects**

Session Chairs: Tuyen Tran (Intel), Ye Feng (Intel), and Steve Consiglio (TEL Technology Center)

3:00 PM

**Byoungho Lee**, *Hitachi High-Tech Corporation*, MI(Metrology&Inspection)’s Deliverable Solutions for Next Journey

3:30 PM

**Shay Wolfling**, *Nova*, Advanced and Future Logic Device Architectures: Challenges and Solutions in Materials Metrology

4:00 PM

**Hamed Sadeghian**, Nearfield Instrument, Revolutionizing EUV Lithography Metrology for Sub-3nm Nodes: Validation of a Novel AFM System for Precise 3D Characterization in HVM

4:30 – 6:00 PM

Poster Session (with Drinks and Hors d’oeuvres)

**Thursday, April 18**

**Registration**

8:00 AM – 8:30 PM

**Plenary**

Session Chairs: J. Alexander Liddle (NIST) and Alain Diebold (Univ. of Albany)
8:30 AM


EUV and Advanced Patterning

Session Chairs: Alain Diebold (Univ. of Albany), Christina Hacker (NIST), Jin Zhang (Lam Research)

9:15 AM

Nigel Smith, *Nanometrics*, New Directions for Optical Critical Dimension Metrology

9:45 AM

Christina Porter, *ASML*, Soft X-Ray Scatterometry for 3D CD Metrology on Individual GAA Nanosheets

10:15 AM

Coffee Break and Post3er/Exhibit Viewing

10:45 AM

Guillaume Freychet, *CEA Leti*, Overview Of Critical Dimension Small Angle X-ray Scattering (CD-SAXS) Tomographies: New Developments in 3D Analysis

Session Chairs: Frank de Jong (Thermo Fisher) and Ehrenfried Zschech (Brandenburg University of Technology Cottbus – Senftenberg, Institute of Physics)

11:15 AM

Michael Reisinger, *KAI GmbH*, Understanding the Damage and Microstructural Evolution in Cu Metallizations During Thermomechanical-Fatigue

11:45 AM

Nicolas Gauquelin, *Univ. Antwerp EMAT*, Advances in 3D Tomography and 4DSTEM: Perspectives to Study Semiconductor Devices

12:15 – 1:45 PM

Lunch and Poster/Exhibit Viewing

1:45 PM

Tony Levi, *Univ. of Southern California*, Chip Scan: 3D X-ray Imaging of CMOS Circuits

2:15 PM


Spintronics-Based Devices

Session Chair: Jean-Paul Barnes (CEA-Leti)

2:45 PM


3:15 PM
Coffee Break and Poster/Exhibit Viewing

3:45 PM

**Rafal Dunin-Borkowski, Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons,**
Characterization of Magnetic Textures in Materials for Spintronics-based Devices

4:15 PM

**Siamak Salimy, Hprobe, MRAM End of Line Magnetic Testing: From Single Bit Properties to Full Memory Qualification**
Posters

Lixia Rong, Hao-Ling Tang, Luc Thomas, Hanson Kwok, Michael Phillips, Hongwen Zhou, Qinyi Fu, Lavinia E. Nistor, Jaesoo Ahn, and Mahendra Pakala
Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, CA

002, Complementary Field-Effect Transistors (CFET): Metrology Challenges and Solutions
1imec, Kapeldreef 75, 3001 Leuven, Belgium
2Nova Ltd., 5 David Fikes St., Rehovot 7632805, Israel
3Hitachi High-Tech Corp., 552-53, Shinkocho, Hitachinaka-shi, Ibaraki, Japan
4Physikalisch-Technische Bundesanstalt (PTB), Abbeestr. 2-12, 10587 Berlin, Germany
5Ghent University, Department of Solid-State Sciences, Krijgslaan 281, building S1, 9000 Ghent, Belgium

003, Asymmetry of Junction Line Defect Distribution in WS2-WSe2 Lateral / Vertical Hetero-structures Revealed by TERS Imaging
Andrey Krayev, A. Edward Robinson, Peng Chen, Xidong Duan, Zhengwei Zhang, and Xiangfeng Duan
1HORIBA Scientific, 359 Bel Marin Keys Blvd, Novato, CA94949, USA
2Southern University of Science and Technology, Shenzhen, China
3Department of Applied Chemistry, Hunan University, China
4Department of Chemistry and Biochemistry, University of California, Los Angeles, USA

004, Atom Probe Tomography Using an Extreme Ultraviolet Pulsed Light Source
Luis Miaja-Avila, Benjamin W. Caplins, Jacob M. Garcia, Ann N. Chiaramonti, and Norman A. Sanford
National Institute of Standards and Technology, Boulder, CO, USA

005, Merging Integrated Photonics and Electron Beams: μE-V Electron-Spectroscopy and Single-Particle Heralding
1Department for Ultrafast Dynamics, Max Planck Institute of Multidisciplinary Sciences, Göttingen, DE
2IV. Physical Institute – Solids and Nanostructures, University of Göttingen, Göttingen, DE
3Institute of Physics, Swiss Federal Institute of Technology Lausanne, Lausanne, CH
4Center for Quantum Science and Engineering, EPFL, Lausanne, CH

006, Characterization of 2D Transition Metal Dichalcogenide Layers by Combined TOF-SIMS and in-situ AFM
Rita Tilmann, Stefan Heiserer, Valentina Spampinato, Yuanyuan Shi, Jill Serron, Albert Minj, Benjamin Groven, Georg S. Duesberg, Thomas Hantschel, Paul A.W. van der Heide, and Alexis Franquet
1IMEC, Kapeldreef 75, 3001 Leuven, Belgium
2University of the Bundeswehr Munich & Center for Integrated Sensor Systems (SENS), Institute of Physics, EIT2, Neubiberg, Germany
3Università degli Studi di Catania, Dipartimento di Scienze Chimiche, Viale A. Doria 6, Catania, Italy
4School of Microelectronics, University of Science and Technology of China, Hefei, China

007, Hard X-ray Photoelectron Spectroscopy (HAXPES) in Material Development
008, Analysis of Alternative Dopants for Organic Light-Emitting Diodes Layers Using a Correlative TOF-SIMS & XPS Protocol
C. Guyot, J.P. Barnes, O. Renault, and T. Maindron
Univ. Grenoble Alpes, CEA, Leti, F-38000 Grenoble, France

009, Spatially Resolved Chemical Metrology on EUV Resist
Komal Pandey1, Quentin Evrard2, Albert M. Brouwer2, C.B. Chuang1, Maarten van Es1, and Diederik J. Maas1
1TNO, Stieltjesweg 1, 2628CK, Delft, The Netherlands
2University of Amsterdam, Science Park 904, 1090 GD Amsterdam, The Netherlands

010, Development of a Double Mirror CC-Cs-corrector for Low-Voltage SEM
Diederik Maas1,2, Maurice Krielaart1, Léon van Velzen1, and Pieter Kriut1
1Delft University of Technology, Applied Sciences, Lorentzweg 1, Delft, 2628 CJ, The Netherlands,
2Netherlands organisation of Applied Science (TNO), Stieltjesweg 1, Delft, 2628 CK, The Netherlands

011, Dopant and Thin Film Metrology using Laboratory-Based Micro-XRF in the Low Z and Low Energy Range
Benjamin Stripe, Frances Y. Su, Michael Lun, Tinch Leung, Ian Spink, Sylvia Lewis, and Wenbing Yun
Sigray, Inc., 1590 Solano Way, Suite A, Concord, CA, United States

012, The Interface Study of Photoresist/Underlayer Using Hybrid R-ray Reflectivity and X-ray Standing Wave Approach
Atul Tiwari1, Roberto Fallica3, Marcelo D. Ackermann1, and Igor A. Makhotkin1
1Industrial Focus Group XUV Optics, MESA+ Institute for Nanotechnology, University of Twente,
Drienerlolaan 5, 7522 NB Enschede, The Netherlands
2IMEC, Kapeldreef 75, 3001 Leuven, Belgium

013, Paradigm Shift: Conical Frustum Arrays for Electron-Beam Goniometry
A. C. Madison1, K. A. Cochrane2, J. S. Villarrubia1,3, D. A. Westly1, R. G. Dixon1, C. R. Copeland1, J. D. Gerling2, A. D. Brodie2, J. A. Liddle1, L. P. Muray2, and S. M. Stavis1
1National Institute of Standards and Technology, Gaithersburg, Maryland 20899
2KLA Corporation, Milpitas, California 95035

014, Automation of Precession-Assisted Nanobeam Diffraction and 4D-STEM Measurements for Multimodal Characterization of Semiconductor Devices
Daniel Němeček1 and Robert Stroud2
1TESCAN GROUP, Libušina třída 21, 62300 Brno, Czech Republic
2TESCAN GROUP, 765 Commonwealth Dr #101, Warrendale, PA 15086, USA

015, Self Focusing SIMS to Enable Boron Quantification in Small Si and SiGe Structures
Alexis Franquet1, Valentina Spampinato1,2, and Paul A.W. van der Heide1
1IMEC, Kapeldreef 75, 3001 Leuven, Belgium
2Università degli Studi di Catania, Dipartimento di Scienze Chimiche, Viale A. Doria 6, 95125 Catania, Italy
016, Etching Monitoring of Advanced Forksheet Devices Using AKONIS SIMS Tool
A-S. Robbes¹, O. Dulac¹, K. Soulard¹, M. Adier¹, S. Choi¹, D. Jacobson², A. Merkulov³, R. Tilmann³, P.A.W. van der Heide³, and A. Franquet³
¹CAMECA, 29 quai des grésillons 92622 Gennevilliers Cedex
²CAMECA Instruments Inc., 5500 Nobel Drive, Madison, WI, USA
³IMEC, Kapeldreef 75, 3001 Leuven, Belgium

017, In-situ and Ex-situ Diagnostics for Ion Measurement and Control for RF-driven Plasma Tools
A. Verma¹, T. Gilmore¹, and D. Simpson²
¹Impedans Ltd, Chase House, City Junction Business Park, Northern Cross, Dublin, D17 AK63, Ireland
²Centre for Light Matter Interactions, School of Mathematics and Physics, Queen’s University Belfast, UK

018, Improving Self-Focusing SIMS On Hybrid SIMS Instruments – Instrumental Aspects and Method Development
T. Grehl¹, S. Kayser¹, J. Zakel¹, D. Rading¹, A. Pirkl¹, H. Arlinghaus¹, V. Spampinato²,³, and A. Franquet²
¹IONTOF GmbH, 48149 Muenster, Germany
²MCA, IMEC, Kapeldreef 75, 3001 Leuven, Belgium
³Università degli Studi di Catania, Dipartimento di Scienze Chimiche, Viale A. Doria 6, 95125 Catania, Italy

019, Towards a Better Understanding of GaN Based HEMT Electrical Response Thanks to XPS, nano-Auger and STEM-EDX Multi-technique Approach
K. Gaffar¹, S. Béchu¹, G. Patriarche², and M. Bouttemy¹
¹Institut Lavoisier de Versailles, UVSQ, Université Paris-Saclay, CNRS, UMR 8180, 45 avenue des Etats-Unis, 78035 Versailles CEDEX, France
²C2N, Université Paris-Saclay, CNRS, Palaiseau, France

020, EBIC Mapping of Threshold Voltage Distribution During Device Turn-on in SiC MOSFETs
Greg M. Johnson¹, Andreas Rummel², and Heiko Stegmann³
¹Carl Zeiss Microscopy, Dublin, CA
²Kliendiek Nanotechnik, Reutlingen, Germany
³Carl Zeiss Microscopy GmbH, Munich, Germany

021, Coming of Age of Computational SEM
Benjamin D. Bunday, Shari Klotzkin, Douglas Patriarche, and Yvette Ball
AMAG nanometro, Schenectady, NY, 12303, USA

022, New Development of X-ray Assisted Device Alteration (XADA) for Circuit Debugging: A Solution for Backside Power Delivery (BPD)
Sylvia Lewis, Benjamin Stripe, Frances Su, Michael Lun, Quoc Nguyen, Mark Cordier, Stuart Coleman, S.H. Lau, and Wenbing Yun
Sigray, Inc., 1590 Solano Way, Suite A, Concord CA 94520

023, Effective Pupil Apodization in Digital Holographic Microscopy
T. Cromwijk¹,², M. Noordam¹,², S. Witte¹,², J. F. de Boer², A. den Boef³
¹Department of Physics and Astronomy, and LaserLaB, Vrije Universiteit, The Netherlands
²Advanced Research Center for Nanolithography (ARCNL), The Netherlands
³ASML Netherlands B.V., The Netherlands

024, Polarization Sensitive Digital Holographic Microscopy
M. L. Noordam¹,², T. Cromwijk¹,², J. F. de Boer², and A. J. den Boef¹,²,³
¹Advanced Research Center for Nanolithography (ARCNL), Science Park 106, 1098 XG Amsterdam, The Netherlands
025, Combining In-Line Atomic Force Microscopy and Scatterometry for Metrology of 3D Holographic Patterns in Roll-to-Roll Nanoscale Manufacturing
Barbara Groh, Kwon Sang Lee, Shashank Venkatesan, Luis Arturo Aguirre, Sofia Frey, Liam G. Connolly, Michael Baldea, Chih-Hao Chang, and Michael Cullinan
1Walker Department of Mechanical Engineering, University of Texas at Austin
2McKetta Department of Chemical Engineering, University of Texas at Austin
3Microsystems and Nanotechnology Division, Physical Measurement Laboratory, National Institute of Standards and Technology

026, Dark Uncertainty in Hybrid Metrology for Semiconductor Manufacturing
Ronald G. Dixson, Adam L. Pintar, R. Joseph Kline, Thomas A. Germer, John S. Villarrubia, and Samuel M. Stavis
National Institute of Standards and Technology, Gaithersburg, Maryland 20899

027, GaN/InGaN µLEDs Study by Cathodoluminescence and Photo-Sensitive Kelvin Probe Force Microscopy
Palmerina González-Izquierdo, Névine Rochat, Davide Zoccarato, Fabian Rol, Julia Simon, Patrick Le Maître, Marion Volpert, Matthew Charles, Matthieu Lafossas, Simona Torrengo, Narciso Gambacorti, and Łukasz Borowik
Univ. Grenoble Alpes, CEA, Leti, F-38000 Grenoble, France

028, 3D Corner Residue Monitoring for CFET Gate Patterning Using CD-SEM
Wei Sun, Emmanuel Dupuy, Il Gyo Koo, BT Chan, Gian Lorusso, Janusz Bogdanowicz, Anne-Laurie Charley, Jef Geypen, Patrick Carolan, Kei Sakai, Zhenghan Li, and Miki Isawa
1Hitachi High-Tech Corp., 552-53, Shinkocho, Hitachinaka-shi, Ibaraki, Japan
2IMEC, Kapeldreef 75, 3001 Leuven, Belgium

029, Fluorescence-Guided Sub-micron Optical Photothermal Infrared Spectroscopy (O-PTIR) for the Localization and Identification of Defects and Contaminants
Eoghan Dillon and Michael K. F. Lo
Photothermal Spectroscopy Corp. 325 Chapala Street, Santa Barbara, CA, 93101

030, Instrument Development for Spectroscopic Ellipsometry and Diffractometry in the EUV
1Physical Measurement Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, 20899, USA
2Materials Measurement Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, 20899, USA

031, Defect Localization in metallization on Advanced Packages Using Magnetic Imaging
T. Venkatesan, Nesco Lettsome, Jeet Patel, Solomon Saul, Fred Cawthorne, Fred Wellstood, Steve Garrahan, and Henri Lezec
1Neocera Magma LLC, 10000 Virginia Manor Road, Beltsville MD 20705
2CORT, Department of Physics and Astronomy, University of Oklahoma, Norma OK 73019
3NIST Gaithersburg, 100 Bureau Dr., Gaithersburg, MD 20899

032, DUV-Vis-NIR OCD Metrology for BCD Semiconductor Manufacturing Yield Enhancements
Jeffrey W. Roberts, John C. Lam, Nikolaos Pallikarakis, Kostas Florios, Marco Colli, Matteo
Nathan Nakamura, Joseph W. Fowler, Zachary H. Levine, Paul Szypryt, and Daniel S. Swetz
1 National Institute of Standards and Technology, Boulder, Colorado 80305, USA
2 Department of Physics, University of Colorado, Boulder, Colorado 80309, USA
3 National Institute of Standards and Technology, Gaithersburg, Maryland 20899, USA

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Shawn Sallis, Tian Lian, Jin Zhang, Ying Gao, and Osman Sorkhabi
Lam Research Corporation, 4400 Cushing Parkway, Fremont, California 94538

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