2023 EUVL Workshop & Supplier Showcase

June 3rd - 7th, 2023

Held In-Person at imec

imec EUV Litho, Inc. EUV-IUCC

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Workshop Proceedings

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Vivek Bakshi (EUV Litho, Inc), Chair

Kurt Ronse (imec), Co-Chair

Group Photo

EUV Litho, Inc.

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Workshop Proceedings
2023 EUVL Workshop & Supplier Showcase
June 3rd – 7th, 2023
imec, Leuven, Belgium

2023 EUVL Workshop
Day One: Monday, June 5th, 2023

2:00 PM – 2:10 PM Welcome and Announcements

2:10 PM Session One: imec EUVL Program Showcase
Chair: Kurt Ronse (imec)

Metrology for Scaling Towards 2030 (P74)
Philippe Leray
imec

Modeling Stochastic Effects in EUV Lithography with a Rigorous Physical Simulator (P75)
Roel Gronheid
KLA+

High Repeatability and Low Shrinkage Solution Using CD-SEM For EUV Resist (P73)
Masaki Sugie, Toshimasa Kameda, Shunsuke Mizutani
Hitachi HT

EUV Stochastic Metrology with High Resolution and High Throughput E-Beam System (P72)
Abdalmohsen Elmalk
ASML-HMI

Patterning Control Solutions for EUV Challenges and Readiness Towards High NA EUV Transition (P71)
Ran Alkoken
AMAT

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DAY ONE ADJOURNED
2023 EUVL Workshop
Day Two: Tuesday, June 6th, 2023

9:00 AM – 9:30 AM Welcome and Announcements

9:30 AM Session Two: Keynote Presentations
Chair: Kurt Ronse (imec)

The High-NA EUV Exposure Tool: Nearing Completion and Next Steps (P1)
Jan van Schoot
ASML

Mask3D effects in EUV Lithography and Their Impact on Resolution Enhancements (P2)
Andreas Erdman
FhG IISB

BREAK 10:30 AM – 10:50 AM

10:50 AM Session Three: EUV Resist Patterning - 1
Co-Chairs: Alex Robinson (IM) and Sonia Castellanos (Inpria)

Gaining Insights Into EUV Radiation Chemistry (P33)
Patrick Naulleau
CXRO

EUV Lithography Patterning Targeting Low Dose and High Resolution Using Multi-Trigger Resist (P35)
C. Popescu[a], G. O'Callaghan[a], A. McClelland[a], C. Storey[a], J. Roth[b], E. Jackson[b], A.P.G. Robinson[a,c]
[a]*Irresistible Materials*
[b]*Nano-C*
[c]*School of Chemical Engineering, University of Birmingham*

EUV Lithography Patterning Towards Device Nano-Scaling (P39)
Danilo De Simone
imec

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High-NA Era: Interfaces Are the New Litho and Etch (P40)
Philippe Bezard
imec

Metal Oxide Resist Formulation and Process Chemistry for High-NA EUV Lithography (P41)
Sonia Castellanos
Inpria

Dry Resist Patterning Progress and Readiness Towards High-NA EUV Lithography (P42)
Anuja De Silva
LAM

Challenges For Stochastic EUV Lithography Simulation (P43)
Ulrich Welling, Lawrence S. Melvin III, Hans-Jürgen Stock
Synopsys GmbH

AM Session Adjourned

2:00 PM Session Three: Resist and Patterning – 2
Co-Chairs: Takeo Watanabe (University of Hyogo) and Seiji Nagahara (TEL)

Fundamental Research of EUV Resist Evaluation at NewSUBARU (P45)
Takeo Watanabe, Atsunori Nakamoto, Tetsuo Harada, Shinji Yamakawa
University of Hyogo

Advanced Resist Patterning Processes for High-NA EUV Lithography (P44)
Seiji Nagahara
TEL

LWR Offset: Identifying Root Causes by Simulation (P31)
Luc van Kessel, Bernardo Oyarzun, Joost van Bree, Ruben Maas
ASML

Organic-Inorganic Hybrid EUV Photoresists Derived From Atomic Layer Deposition (P32)
Chang-Yong Nam[1], Jiyoung Kim[2]
[1]*Center for Functional Nanomaterials, Brookhaven National Laboratory*

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[2]Department of Materials Science and Engineering, University of Texas at Dallas

Disruptive EUV Material Characterization in imec's AttoLab (P36)
Kevin Dorney
imec

Development of Computational Spectroscopies to Unravel Atomistic Mechanism in EUVL (P37)
Michiel van Setten
imec

DSA-Assisted EUV Patterning (P38)
Hyo Seon Suh, Lander Verstraete, Julie Van Bel, Purnota Hannan Timi, Remi Vallat, Philippe Bezard, Jelle Vandereyken, Matteo Beggiato, A.m.ir-Hossein Ta.m.addon, Christophe Beral, Waikin Li, Mihir Gupta, Roberto Fallica

BREAK 3:45 PM – 4:05 PM

4:05 PM Session Four: EUV Sources
Co-Chairs: David Reisman (Energetiq) and Yusuke Teramoto (Ushio)

Plasma Dynamics and Future of LPP-EUV Source for Semiconductor Manufacturing (P53)
Hakaru Mizoguchi, [3]Kentaro Tomita, [4]Yiming Pan, [5]Atsushi Sunahara, [2]Kouichiro Kouge, [6]Katsunobu Nishihara, [1]Daisuke Nakamura, [1]Yukihiro Yamagata, and [1]Masaharu Shiratani
Gigaphoton

1. *Quantum and Photonics Technology Research Center, Graduate School of Information and Electrical Engineering, Kyushu University*
2. *Gigaphoton Inc.*
3. *Division of Quantum Science and Engineering, Graduate School of Engineering, Hokkaido University*
4. *Interdisciplinary Graduate School of Engineering Sciences, Kyushu University*
5. *Center for Materials Under eXtreme Environment (CMUXE), School of Nuclear Engineering, Purdue University*
6. *Institute of Laser Engineering, Osaka University*

High-Brightness EUV Source For Inspection and Exposure Applications (P55)
Yusuke Teramoto[1], Kazuya Aoki[2], Akihisa Nagano[2], Noritaka Ashizawa[2], Takahiro Shirai[2], Shunichi Morimoto[2], Hidenori Watanabe[2], Yoshihiko Sato[2]
[1] *Ushio Germany GmbH*
[2] *Ushio Inc.*

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Source Driven By A Solid-State Pulsed-Power System (P52)

David Reisman[1], Daniel Arcaro[1], Wolfram Neff[1], Michael Roderick[1], Bob Grzybinski[1], Scott Moore[1], Chris Lee[1], and Fred Niell[2]

[1] *Energetiq Technology, Inc.*

[2] *Nielltronix Inc.*

BREAK 4:50 PM – 5:10 PM

5:10 PM Session Five: Poster Session and Reception Session
Co-Chairs: Vivek Bakshi (EUV Litho, Inc.) and Kurt Ronse (imec)

Investigating the Impact of Multi-Emission Layers on the Emissivity of EUV Pellicles (P20)

Young Woo Kang, Seong Ju Wi, Ha Neul Kim, Won Jin Kim, Jungyeon Kim and Jinho Ahn

Hanyang University, EUV-IUCC (Industry University Collaboration Center)

EUV Lighting Technique By the Irradiation of C-Beam. and Its Characteristics (P54)

Bishwa Chandra Adhikari, Kyu Chang Park

Department of Information Display, Kyung Hee University

Deposition, Etching and Cleaning for EUVL Optics with UHV Processing Equipment (P79)

Marcel Demmler

Scia Systems

Performance of a DPP EUV Source Drive By a Solid-State Pulsed-Power System (P80)

David Reisman

Energetiq

Advanced Lab-Scale Spectro-Microscopies for Characterization and Enhancement of EUV Materials (P46)

Kevin M. Dorney[1,*], Nicola N. Kissoon[2], Fabian Holzmeier[1], Esben W. Larsen[1], Dhirendra P. Singh[1], Claudia Fleischmann[1,2], Stefan De Gendt[1,3], Paul A.W. van der Heide[1], John S. Petersen[1]

[1]*imec vzw*

[2]*Quantum Solid State Physics, KU Leuven*

[3] *Chemistry Department, KU Leuven*

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EUV Reflectometry and Ptychography for the Characterization of Thin Films, Stacks, Photoresists, and In-Depth Imaging of Nano-sized Structures (P47)

K.M. Dorney[1], N.N. Kissoon[2], E. W. Larsen[1], F. Holzmeier[1], I.A. Makhotkin[3], V. Philipsen[1], J.S. Petersen[1], S. De Gendt[1,2], V.V. Krasnov[*,1,2], P. van der Heide[1], C. Fleischmann[1,2]
[1] *imec*
[2] *KU Leuven*
[3]*Industrial Focus Group XUV Optics, MESA+ Institute for Nanotechnology, University of Twente*

Mean Free Path of Electrons in EUV Photoresists in the Range 20-450 eV (P48)

Roberto Fallica
imec

CHiPPS EFRC at ALS: EUV Photoresist Funda.m.entals and Soft X-ray Metrology (P49)

Cheng Wang
Lawrence Berkeley National Lab

Reflective Optics at Thales SESO: Opportunities for EUV Lithography (P83)

Dr. Luca Peverini
Thales SESO SAS

Near-field Infrared Nanoscopic Study of EUV- and e-beam-exposed Hydrogen Silsesquioxane Photoresist (P50)

Jiho Kim[1], Jin-Kyun Lee[3], Boknam Chae[1], Jinho Ahn[4], Sangsul Lee[1 2]
[1]*Pohang Accelerator Laboratory, POSTECH*
[2]*Department of Semiconductor Engineering, POSTECH*
[3]*Department of Polymer Science and Engineering, Inha University*
[4]*Division of Materials Sceince and Engineering, Hanyang University*

Intrafield overlay and reproducibility on thin resist towards High NA (P91)

Christiane Jehoula, Jan Hermansa , Anne-Laure Charleya, Rishab Baganib, Gabriel Zaccab, Maurits van der Schaarb
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DAY TWO ADJOURNED

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2023 EUVL Workshop
Day Three: Wednesday, June 7th, 2023

9:00 AM – 9:10 AM Welcome and Announcements

9:10 AM Session Six: EUV Masks
Co-Chairs: Jinho Ahn (Hanyang University) and Katrina Rook (Veeco)

Metal Silicide EUV Pellicle and the Effect of Wrinkles On Mask3D Effects (P13)
Dong Gi Lee,[a,c] Seungchan Moon,[b,c] Jinhyuk Choi, [b,c] Seung Ju Wi [a,c] and Jinho Ahn,[a,b,c,*]
[a]*Division of Materials Science and Engineering, Hanyang University*
[b]*Division of Nanoscale Semiconductor Engineering, Hanyang University*
[c]*EUV-IUCC (Industry University Collaboration Center), Hanyang University*

Masks For Optimized Imaging with High-NA EUV Lithography (P11)
M.-Claire van Lare, Eelco van Setten, Jo Finders
ASML Netherlands B.V.

Developing Cost-Effective Actinic Solutions for EUV Lithography (P12)
Dong Gun Lee and Byung Gook Kim
ESOL (EUV Solution), Inc.

High-K Based Near n≈1 EUV Mask for M3D Effects and Focus Control in High-NA Lithography (P14)
Dongmin Jeong, Yunsoo Kim, Seung Ho Lee, and Jinho Ahn
Hanyang University, EUV-IUCC (Industry University Collaboration Center)

CNT Pellicles: Recent Optimization and Exposure Results (P15)
J. Bekaert, E. Gallagher, M. Y. Timmermans, I. Pollentier, R. Jonckheere, R. Aubert, E. Hendrickx

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Mask Challenges Towards High-NA EUV Lithography (P16)
Andreas Frommold
imec

Metrology and Inspection for High-NA EUV Lithography (P17)
Roel Gronheid
KLA+

Probing the Layer and Interlayer Quality of Mo/Si and Ru/Si Multilayers for EUV Mask Blanks (P19)
Katrina Rook
Veeco

BREAK 11:10 AM – 11:30 AM

11:30 AM Session Seven: EUV Supplier Showcase
Co-Chairs: Meng Lee (Veeco) and Ibrahim Burki (Hoya)

Industrialization of EUVL and Future Roadmap (P62)
Raymond Maas
ASML

Accelerating the Journey to Future Technology Nodes with Veeco's Advanced Technologies in Deposition and Etch (P70)
Meng Lee
Veeco

High-NA EUV Mask Blank Development with Smart Factory (I4.0) Advanced Analytics and AI Process Control (P61)
Ibrahim Burki, Zaw Win Phyo
Hoya

An Overview of EUVL Activities at Berkeley Lab (P64)
Patrick Naulleau
CXRO-LBL

AM SESSION ADJOURNED

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2:00 PM Session Eight: EUV Supplier Showcase
Co-Chairs: Jochen Vieker (Fraunhofer) and Patrick Naulleau (EUV Tech)

Irradiation System for Testing of EUVL Components – Status of Incorporation (P67)
Jochen Vieker
Fraunhofer Institute for Laser Technology - ILT

Design Approaches for High-Flux High-Harmonic Generation Sources Using Advanced Nonlinear Laser Technologies (P63)
Robert Riedel
Class 5 Photonics GmbH

Providing Powerful and Stabile Extreme Ultraviolet (EUV) Light to Support the EUV Lithography Metrology Ecosystem (P66)
Henry Chou
Energetiq Technology

Extreme Cleanliness by Dry UHV Processing (P76)
Marcel Demmler
scia Systems GmbH

Synchrotron-Radiation Based EUV Metrology at PTB (P69)
Michael Kolbe, Christian Laubis, Richard Ciesielski, Victor Soltwisch, Andreas Fischer, Frank Scholze
Physikalisch-Technische Bundesanstalt (PTB)

Nanoscale Chemical Analysis of EUV Resists (P68)
Derek Nowak, Tom Albrecht, Sung Park
Molecular Vista

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An Introduction to EUV Tech (P81)
Patrick Naulleau
EUV Tech

Extreme-Ultraviolet Metrology at the Synchrotron Ultraviolet Radiation Facility (P82)
Edward Hagley, C. Tarrio, R. F. Berg, R. E. Vest, and S. Grantham.
National Institute of Standards and Technology (NIST)

BREAK 3:45 PM – 4:05 PM
4:05 PM Session Nine: Optics and Metrology
Co-Chairs: Gian Lorusso (imec) and Iacopo Mochi (PSI)

High-NA EUV Optics: Preparing the Next Major Lithography Step (P21)
Alexandre Lopes, Paul Graeupner, Peter Kuerz
Carl Zeiss SMT GmbH

Transparent Conductive Backside Coatings for EUV Mask Tuning (P23)
Klara Stallhofer[1], Philipp Naujok[1], Torsten Feigl[1], Chen Klein[2], Alastair Cunningham[2], Valerio Pruneri[2]
[1]optiX fab Gmb
[2]ICFO-Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology

Grazing Incidence Wafer Metrology with REGINE (P18)
Iacopo Mochi, Tao Shen, Paolo Ansuinelli, Yasin Ekinci
Paul Scherrer Institute

Trends in E-Beam Metrology and Inspection (P22)
Gian Francesco Lorusso
imec

Optical Materials Constants in the EUV and Their Impact on Scatterometry Measurements (P24)
Richard Ciesielski
Physikalisch-Technische Bundesanstalt (PTB)

EUV Spectrometry as a Versatile Characterization Technique for Thin Film Layer Systems (P25)

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Sascha Brose[1,2], Sophia Schröder[1,2], Sven Glabisch[1,2], Jochen Stollenwerk[1,2,3], and Carlo Holly[1,2,3]
[1]*RWTH Aachen University TOS - Chair for Technology of Optical Systems*
[2]*JARA - Fundamentals of Future Information Technology, Research Centre Jülich*
[3]*Fraunhofer ILT - Institute for Laser Technology*

5:50 PM – 6:00 PM Announcements

2023 EUVL Workshop & Supplier Showcase Adjourned

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