2022 EUVL WORKSHOP & SUPPLIER SHOWCASE
JUNE 4TH - 9TH, 2022

Workshop Proceedings

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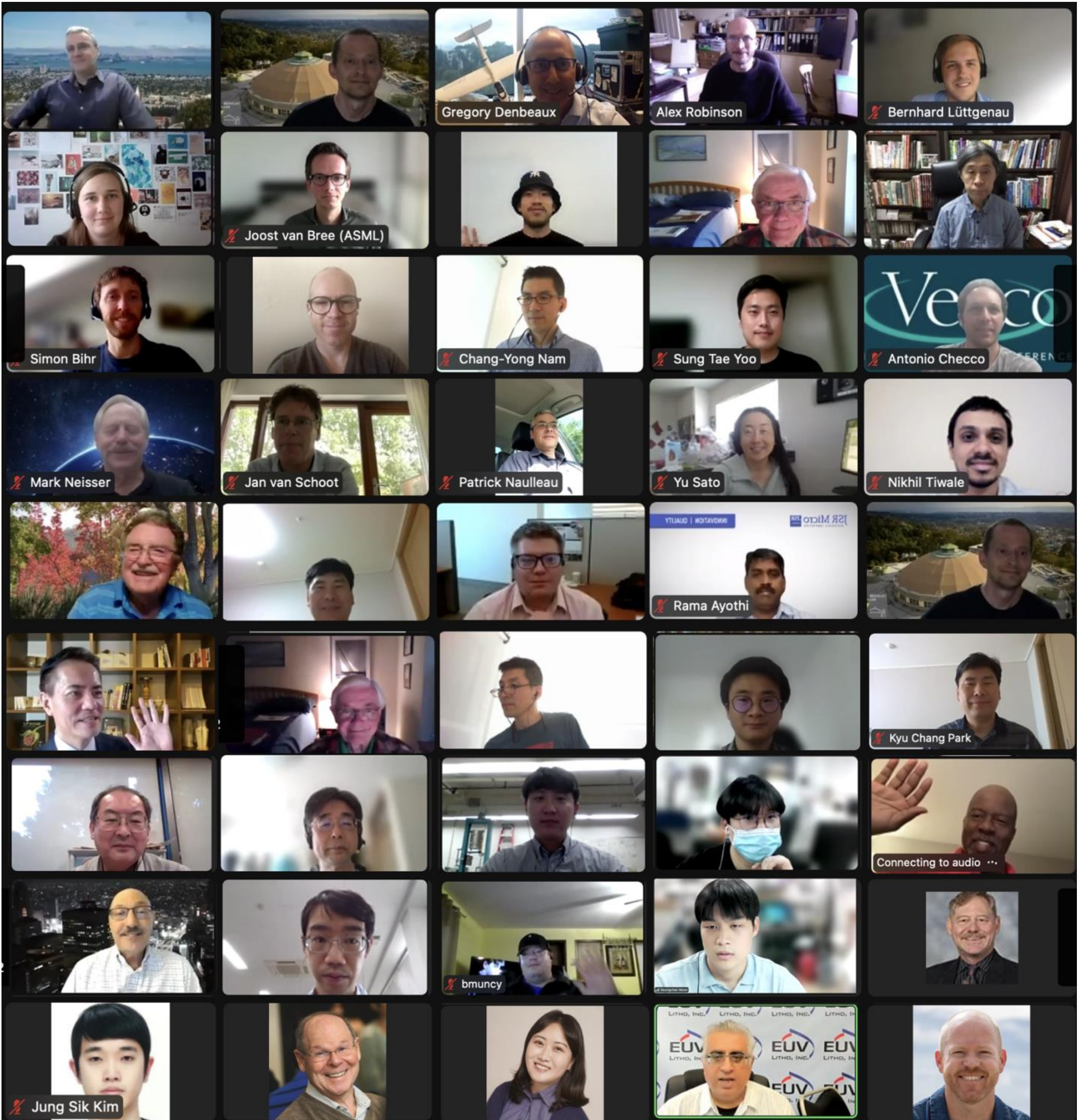
Organized By:

Vivek Bakshi (EUV Litho, Inc), Chair

Patrick Naulleau (CXRO, Lawrence Berkeley National Laboratory), Co-Chair



Gregory Denbeaux
Alex Robinson
Bernhard Lüttgenau
Joost van Bree (ASML)
Simon Bihr
Chang-Yong Nam
Sung Tae Yoo
Antonio Checco
Mark Neisser
Jan van Schoot
Patrick Naulleau
Yu Sato
Nikhil Tiwale
Rama Ayothi
Kyu Chang Park
Connecting to audio
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Jung Sik Kim

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Workshop Proceedings

2022 EUVL Workshop & Supplier Showcase
June 6th – 9th, 2022
Held Online

2022 EUVL Workshop
Day One: Monday, June 6th, 2022
Full Video

6:30 PM – 6:40 PM Welcome and Announcements

6:40 PM Session One: CXRO Program Showcase
Chair: Patrick Naulleau (CXRO)

Codesign of Ultra-Low-Voltage, Beyond CMOS Microelectronics (P13) Presentation Recording
R. Ramesh, LBNL & UC Berkeley, Principal Investigator; co-PIs: L.W. Martin, S. Salahuddin, LBNL & UC Berkeley; S. Griffin, Z. Yao, D. Vasudevan, P. Shafer, J. Shalf, L. Ramakrishnan, LBNL
LBNL, 1 Cyclotron Rd, Berkeley, CA 94720

Accelerated Materials Discovery with Theory and Computation: Microelectronics and Quantum (P17) Presentation Recording
Sinéad M. Griffin
LBNL, 1 Cyclotron Rd, Berkeley, CA 94720

Patterning Potential Landscapes on an Atomically Thin Canvas (P18) Presentation Recording
Archana Raja
LBNL, 1 Cyclotron Rd, Berkeley, CA 94720

Spin textures, Skyrmions for Novel and Energy-efficient Microelectronics (P16) Presentation Recording
Mi-Young Im
LBNL, 1 Cyclotron Rd, Berkeley, CA 94720

Nanopatterning with Hierarchical Materials (P12) Presentation Recording
Ricardo Ruiz
Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

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Predictive Stochastic Analysis of Massive Filter-based Electrochemical Reaction Networks (P11) Presentation Recording

Samuel M. Blau
Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

Uncovering Local Interactions and Morphology in Soft Materials with Chemically Sensitive X-rays (P15) Presentation Recording

Gregory Su
Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

Probing Morphology and Chemistry in Complex Soft Materials with in situ Resonant Soft X-ray Scattering (P14) Presentation Recording

Cheng Wang
Advanced Light Source, Lawrence Berkeley National Lab

DAY ONE ADJOURNED

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2022 EUVL Workshop
Day Two: Tuesday, June 7th, 2022
Full Video 1 Full Video 2

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

9:10 AM Session Two: Keynote Presentations – 1
Chair: Patrick Naulleau (CXRO)

Journal of Micro/Nanopatterning, Materials, and Metrology (JM3)
Presentation Recording (Video One)
Harry Levinson
JM^3

Ecosystem Readiness Towards High NA in IMEC (Keynote) (P2)
Presentation Recording (Video One)
Kurt Ronse
IMEC, Leuven, Belgium

High-NA EUV: Getting Closer to Industry Introduction (Keynote) (P3)
Presentation Recording (Video One)
Jan van Schoot
ASML Netherlands B.V. (The Netherlands); De Run 6501, 5504 DR Veldhoven, The Netherlands

BREAK 10:15 AM – 10:35 AM

10:35 AM Session Three: Mask – 1
Co-Chairs: Iacopo Mochi (PSI) and Katrina Rook (Veeco)

Progressing Insights on Low-n Masks for EUV Lithography (Invited) (P35)
Presentation Recording (Video One)
M.-Claire van Lare, Tasja van Rhee, Mykyta Voronov, Toine van den Boogaard, Jo Finders
ASML Netherlands B.V. (Netherlands)

EUV Lensless Imaging with Synthetic Pupil Illumination (Invited) (P32)
Presentation Recording (Video One)
Iacopo Mochi, Hyun-su Kim, Tao Shen, Yasin Ekinci
Paul Scherrer Institute, Forschungsstrasse 111, 5232 Villigen PSI Switzerland

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Novel Diamond-Like-Carbon Capping Layer for EUV Masks (Invited) (P31)
Presentation Recording (Video One)
Antonio Checco
Veeco Instruments, Advanced Deposition and Etch; 1 Terminal Drive, Plainview, NY 11803

AM Session Adjourned

6:30 PM – 6:40 PM Welcome and Announcements

6:40 PM Session Four: Keynote – 2
Chairs: Vivek Bakshi (EUV Litho, Inc.)

An Introduction to Quantum Computing and Leading Technologies (Keynote) (P1) Presentation Recording (Video Two)
Paul Welander
SLAC National Accelerator Laboratory; 2575 Sand Hill Rd, Menlo Park, CA 94025

Extending EUV Lithography with High-NA (Keynote) (P4)
Presentation Recording (Video Two)
Steven Carson
Intel, Santa Clara, California

BREAK 7:40 PM – 8:00 PM

8:00 PM Session Five: EUV Mask & Modeling – 2
Chair: Meng Lee (Veeco)

Optimization of the Diffraction Phase Effect for EUV Phase Shift Mask (Invited) (P34) Presentation Recording (Video Two)
Dongmin Jeong[a,c], Yunsoo Kim[a,c], Minsun Cho[b,c], Jinho Ahn[a,b,c]
[a]*Division of Materials Science and Engineering*
[b]*Division of Nanoscale Semiconductor Engineering,*
[c]*EUV-IUCC (Industry University Collaboration Center)*
Hanyang University, Seoul, 04763, Republic of Korea

Understanding Line-Edge Roughness in Extreme Ultraviolet Lithography and Fin-Field-Effect-Transistor: Computational Study (P36)
Presentation Recording (Video Two)
Sang-Kon Kim
The Faculty of Liberal Arts, Hongik University, Seoul 04066, Korea

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An Actinic Review System Consisting Only of Diffractive Optical Elements (Invited) (P33) Presentation Recording (Video Two)

Dong Gun Lee and Byung Gook Kim
ESOL (EUV Solution), Inc.; 45 Dongtansandan 10-gil, Hwaseong-si, Gyeonggi-do, Republic of Korea

DAY TWO ADJOURNED

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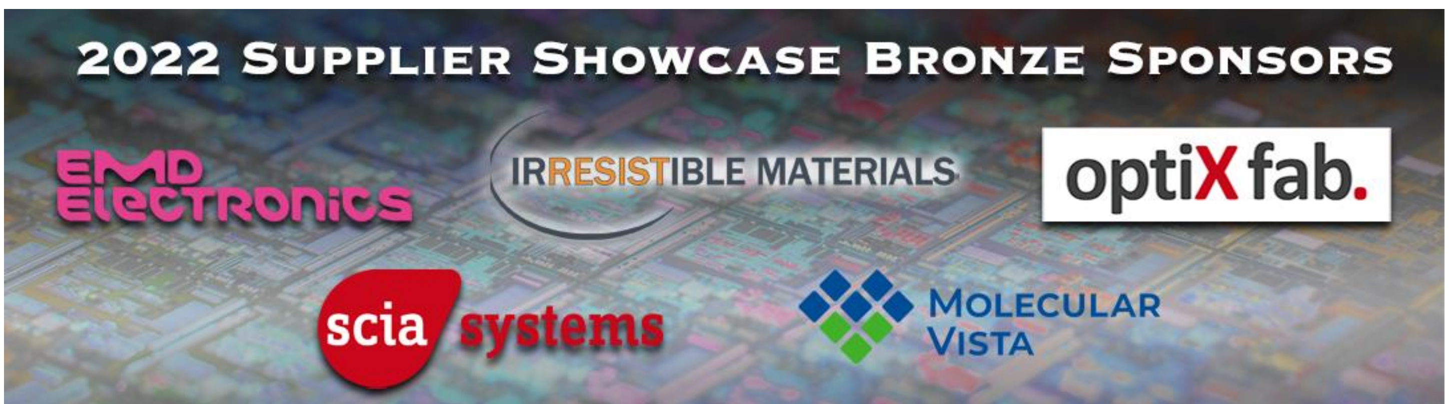

2022 Supplier Showcase
Day Three: Wednesday, June 8th, 2022
Full Video 1 Full Video 2

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

9:10 AM Session 1: Keynote – 1, Non-Profits, Supplier Showcase – 1

Session 1A
Chair: Vivek Bakshi (EUV Litho, Inc.)

Confessions of an EUV Skeptic (Keynote) (SS1) Presentation Recording
Ralph Dammel
EMD Electronics; 3050 Spruce St., St. Louis, Missouri 63103

Synchrotron-Radiation Based EUV Metrology at PTB (Invited) (SS6) Presentation Recording (Video One)
Michael Kolbe, Christian Laubis, Richard Ciesielski, Victor Soltwisch, Frank Scholze
Physikalisch-Technische Bundesanstalt (PTB); Abbestraße 2-12, 10587 Berlin, Germany

TNO EUV Materials Research for EUV Infrastructure (Invited) (SS7) Presentation Recording (Video One)
H.H.P.Th. Bekman, C-C. Wu, J. Stortelder, N. Koster
TNO; Stieltjesweg 1, 2628 CK Delft, The Netherlands

Systems for Development and Accelerated Testing of EUVL Components (Invited) (SS8) Presentation Recording (Video One)
Jochen Vieker and Klaus Bergmann
Fraunhofer Institute for Laser Technology – ILT

BREAK 10:10 AM – 10:30 AM

10:30 AM Session 1B
Co-Chairs: Torsten Fiegal (optiXfab) and Vivek Bakshi (EUV Litho, Inc.)

25 Years of EUV Multilayer Optics at Fraunhofer IOF and OXF (SS14)
Presentation Recording (Video One)
Torsten Feigl, Marco Perske, Hagen Pauer, Tobias Fiedler, Philipp Naujok, Klara Stallhofer, Tina Seifert, Ernesto Roa Romero, Annika Schmitt
optiX fab GmbH; Otto-Schott-Str. 41, 07745 Jena, Germany

Vacuum Processing Equipment for EUVL – From Small Substrates to Huge Optics (Invited) (SS11) **Presentation Recording (Video One)**
Matthias Nestler
scia Systems; Clemens-Winkler-Straße 6c, 09116 Chemnitz, Germany

Rigaku EUV Optics and Detector Technology (SS15)
Presentation Recording (Video One)
Peter Oberta
Rigaku; Novodvorská 994, Praha 4, 142 21, Czech Republic

AM SESSION ADJOURNED

6:30 PM – 6:40 PM Welcome and Announcements

6:40 PM Session Two: Keynote – 2, Non-Profits, Supplier Showcase – 2

Session 2A
Chair: Meng Lee (Veeco)

EUV Manufacturing for the Next Decade (Keynote) (SS2)
Presentation Recording (Video Two)
Michael Lercel
ASML, Veldhoven, Netherlands

Generation of Wrinkles and its Effect on the Performance of EUV Pellicles (SS3)
Presentation Recording (Video Two)
Dong Gi Lee, Young Woong Kim, Seung Chan Moon, and Jinho Ahn
EUV-IUCC (Industry University Collaboration Center), Hanyang University; Seoul, 04763, Republic of Korea

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Ultra-Sensitive Indium Based EUV Resist for High-NA Extreme-Ultraviolet Lithography Applications (Invited) (SS4) Presentation Recording (Video Two)

Manvendra Chauhan[1], Sumit Choudhary[1], Satinder K. Sharma[*1], Kenneth. E. Gonsalves[2*]
[1]School of Computing & Electrical Engineering (SCEE),
[2]School of Basic Sciences (SBS) Indian Institute of Technology (IIT), Mandi, MANDI-175005, (Himachal Pradesh), India

Preparing For the Next Generation of EUV Lithography at the Center for X-ray Optics (Invited) (SS5) Presentation Recording (Video Two)

Ryan Miyakawa
CXRO, Lawrence Berkeley National Laboratory; 54 Cyclotron Rd, Berkeley, CA 94720

BREAK 7:55 PM – 8:15 PM

Session 2B
Chair: Vivek Bakshi (EUV Litho, Inc.)

Veeco Ion Beam Deposition Technology for EUV Photomask (Invited) (SS12) Presentation Recording (Video Two)

Meng Lee
Veeco, 1 Terminal Drive, Plainview, New York 11803, USA

From EUV to SXR: Next-Gen Metrology and Inspection Sources (SS13) Presentation Recording (Video Two)

Bill Solari
Energetiq Technology, Wilmington, MA, USA

Chemical Identification of Sub-20 nm Defects and Monolayer Residues with Nano IR PiFM (Invited) (SS10) Presentation Recording (Video Two)

Derek Nowak[1], Brian Grenon[2], Tom Albrecht[1], Sung Park[1]
1. Molecular Vista, San Jose, CA
2. Grenon Consulting Inc., Forest Grove, OR

2022 Supplier Showcase Adjourned

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2022 EUVL Workshop
Day Four: Thursday, June 9th, 2022
Full Video 1 Video 2

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

9:10 AM – Session 6: Source – 1
Co-Chairs: Oscar Versolato (ARCNL) and Vivek Bakshi (EUV Litho, Inc.)

Characterization of 1- and 2-um Solid-State-Laser-Driven Plasma Sources of EUV Light (Invited) (P45) Presentation Recording (Video One)

Oscar Versolato
ARCNL; Science Park 106, 1098 XG Amsterdam, The Netherlands

Ultra-high Photon Flux High-Harmonic Generation (P46) Presentation Recording (Video One)

Maxim Tschernajew[1], Steffen Hädrich[1], Robert Klas[2,3], Martin Gebhardt[2,3], Roland Horsten[4], Sven Weerdenburg[4], Sergey Pyatchenkov[4], Wim Coene[4,5], Sven Breitkopf[1], Oliver Herrfurth[1], Jan Rothhardt[2,3], Tino Eidam[1] and Jens Limpert[1,2,3,6]
1. Active Fiber Systems GmbH, Ernst-Ruska-Ring 17, 07745 Jena, Germany
2. Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Albert-Einstein-Str. 15, 07745 Jena, Germany
3. Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany
4.Optics Research Group, Delft University of Technology, 2628 CH, Delft, The Netherlands
5. ASML Netherlands B.V., P.O. Box 324, 5500 AH Veldhoven, The Netherlands
6. Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany

Modeling the EQ-10 Discharge Produced Plasma (DPP) EUV Source (Invited) (P43) Presentation Recording (Video One)

David Reisman
Energetiq Technology, Inc., Wilmington, MA 01887, USA

BREAK 9:55 AM – 10:15 AM

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10:15am – Session Seven: Resist and Patterning – 1
Co-Chairs: Alex Robinson (IM) and Greg Denbeaux (University of Albany)

ZEISS EUV Optics – Past, Present and Future (Invited) (P53)
Presentation Recording (Video One)
Simon Bihr, Paul Graeupner, Dirk Jürgens, Jens Timo Neumann
Carl Zeiss SMT GmbH; Rudolf-Eber-Str. 2, 73447 Oberkochen, Germany

Photoresist Roughness Understanding & LWR Floor (P55)
Presentation Recording (Video One)
Joost van Bree[1], Ruben Maas[1], Paulina Rincon Delgadillo[2]
[1]ASML, Veldhoven, The Netherlands
[2]IMEC, Leuven, Belgium

Performance Advances of Multi-Trigger Resist for EUV Lithography (Invited) (P56) Presentation Recording (Video One)
C. Popescu[a], G. O'Callaghan[a], A. McClelland[a], J. Roth[b], E. Jackson[b], A.P.G. Robinson[a]
[a]Irresistible Materials, Birmingham Research Park, Birmingham, UK
[b]Nano-C, 33 Southwest Park, Westwood, MA, USA.

Industrial Photoresist Qualification with a Compact EUV Exposure Tool (P62)
Presentation Recording (Video One)
Bernhard Lüttgenau[a,b], Sascha Brosea[b], Serhiy Danylyukc, Jochen Stollenwerk[ab,c], Carlo Holly[a,b]
[a]RWTH Aachen University, Chair for Technology of Optical Systems, Aachen, 52074, Germany
[b]JARA – Fundamentals of Future Information Technology, Jülich, 52428, Germany
[c]Fraunhofer Institute for Laser Technology, Aachen, 52074, German

Atomic Layer Deposition Derived Organic-Inorganic Hybrid EUV Resists (Invited) (P61) Presentation Recording (Video One)
Chang-Yong Nam[1], Jiyoung Kim[2]
[1]Center for Functional Nanomaterials, Brookhaven National Laboratory, Upton, NY 11973
[2]Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX 75080

EUV Resist Challenges and Chemical Stochastics (Invited) (P59)
Presentation Recording (Video One)
Greg Denbeaux
University of Albany

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Latent Image Characterization in Photoresists by EUV Spectrometry (P66) Presentation Recording (Video One)

Sophia Schröder[1,2], Sven Glabisch[1,2], Bernhard Lüttgenau[1,2], Sascha Brose[1,2], Jochen Stollenwerk[1,2,3], and Carlo Holly[1,2]
[1]RWTH Aachen University TOS - Chair for Technology of Optical Systems, Steinbachstr. 15, 52074 Aachen, Germany;
[2]JARA - Fundamentals of Future Information Technology, Research Centre Jülich, 52425 Jülich, Germany;
[3]Fraunhofer ILT - Institute for Laser Technology, Steinbachstr. 15, 52074 Aachen, Germany

AM Session Adjourned

6:30 PM – 6:40 PM Announcements and Welcome

6:40 PM – Session Eight: Source - 2
Chair: Vivek Bakshi (EUV Litho, Inc.)

High Power LPP-EUV Source for Semiconductor HVM; Lithography and Other Application (Invited) (P42) Presentation Recording (Video Two)

Hakaru Mizoguchi, Senior Fellow of Gigaphoton Inc.
Gigaphoton, 400 Yokokura-shinden Oyama-shi Tochigi, 323-8558, JAPAN

Update of Tsinghua SSMB EUV Light Source Development (P47) Presentation Recording (Video Two)

Xiujie Deng
Tsinghua University, Beijing, China

Modeling of EUV Spectrum of Unresolved Transition Arrays of High-Z Ions Using Theoretical and Data Driven Approach (P48) Presentation Recording (Video Two)

Akira Sasaki
National Institutes for Quantum Science and Technology; 8-1 Umemidai, Kizugawa-shi, Kyoto, 619-0215 Japan

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6:40 PM – Session Nine: Speed Presentations
Chair: Vivek Bakshi (EUV Litho, Inc.)

High-sensitivity Hybrid EUV Resist Synthesis via Vapor-phase Infiltration (P64) Presentation Recording (Video Two) **2nd Place Winner**

Nikhil Tiwale[1], Ashwanth Subramanian[2], Kim Kisslinger[1], Ming Lu[1], Aaron Stein[1], Jiyoung Kim[3], and Chang-Yong Nam[1,2]
[1]Center for Functional Nanomaterials (CFN), Brookhaven National Laboratory (BNL), Upton, NY 11973, USA
[2]Department of Materials Science & Chemical Engineering, Stony Brook University, Stony Brook, NY 11794, USA
[3]Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, TX 75080

Low-Energy Electron Exposure and Dry Etching Characteristics of Hybrid Thin Films Prepared by Molecular Atomic Layer Deposition for EUV Lithography (P63) Presentation Recording (Video Two)

Won-Il Lee[1], Ashwanth Subramanian[1], Nikhil Tiwale[2], Dan Le[3], Su Min Hwang[3], Jiyoung Kim[3], Chang-Yong Nam[1, 2]
[1]Department of Materials Science and Chemical Engineering, Stony Brook University, Stony Brook, New York 11794, USA
[2]Center for Functional Nanomaterials, Brookhaven National Laboratory, Upton, New York 11973, USA
[3]Department of Materials Science and Engineering, The University of Texas at Dallas, Richardson, TX 75080, USA

Effect of Wrinkles on Pellicle Reflectivity and Local Critical Dimension (P37) Presentation Recording (Video Two) **1st Place Winner**

Seung Chan Moon, Dong Gi Lee, Young Woong Kim, Jin Hyuk Choi and Jinho Ahn
Hanyang University, Seoul, 04763, Republic of Korea; EUV-IUCC (Industry University Collaboration Center)

Enhanced EUV Lighting with Optimized C-beam Irradiation (P49) Presentation Recording (Video Two)

Sung Tae Yoo, and Kyu Chang Park*
Department of Information Display, Kyung Hee University; Dongdaemun-gu, Seoul, 02447, Korea

BREAK 7:45 PM – 8:05 PM

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8:05 PM Session Ten: Resist and Patterning – 2
Session Co-Chairs: Takeo Watanabe (University of Hyogo) and Seiji Nagahara (TEL)

Research Activities Including the Hydrogen Brittle Evaluation in EUVL at NewSUBARU (Invited) (P58) Presentation Recording (Video Two)
Takeo Watanabe, Tetsuo Harada, and Shinji Yamakawa
Center for EUVL, LASTI, University of Hyogo, 3-1-2 Kouto, Kamigori, Akou-gun, Hyogo 678-1205, Japan

Advanced EUV Resist Patterning with Metal Oxide Resist (MOR) (Invited) (P60) Presentation Recording (Video Two)
Seiji Nagahara
Tokyo Electron Limited, Tokyo, Japan

Improvement of Patterning Performance in EUV Lithography (Invited) (P51) Presentation Recording (Video Two)
Jung Sik Kim
SK Hynix, 2091, Gyeongchung-daero, Bubal-eup, Icheon-si, Gyeonggi-do, Korea

Multitrigger (MTR): Making a "Negative" Positive (Invited) (SS9) Presentation Recording (Video Two)
Warren Montgomery[1,2],
[1]*Irresistible Materials Ltd., Langdon House, Swansea Waterfront, Swansea SA1 8QY, United Kingdom*
[2]*MWM Strategic Development Solutions, PO Box 873669, Vancouver, WA 98687*

Berkeley MET5 Enters Mature Phase of Research (Invited) (P52) Presentation Recording (Video Two)
Chris Anderson
Lawrence Berkeley National Laboratory, Center for X-Ray Optics, 54 Cyclotron Rd, Berkeley, CA 94720

AFM of EUV Photoresist for Material Limit Characterization (P54) Presentation Recording (Video Two)
Luke Long[1,2], Andrew Neureuther[1,2], and Patrick Naulleau[2]
1. University of California at Berkeley
2. Center for X-ray Optics, Lawrence Berkeley National Lab

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Experimental Characterization of EUV Resist Materials: Photoelectron Spectroscopy (P57) Presentation Recording (Video Two)

Oleg Kostko, Terry R. McAfee, Patrick Naulleau
Center for X-Ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

9:50 PM – 10:00 PM Announcements

2022 EUVL Workshop & Supplier Showcase Adjourned

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