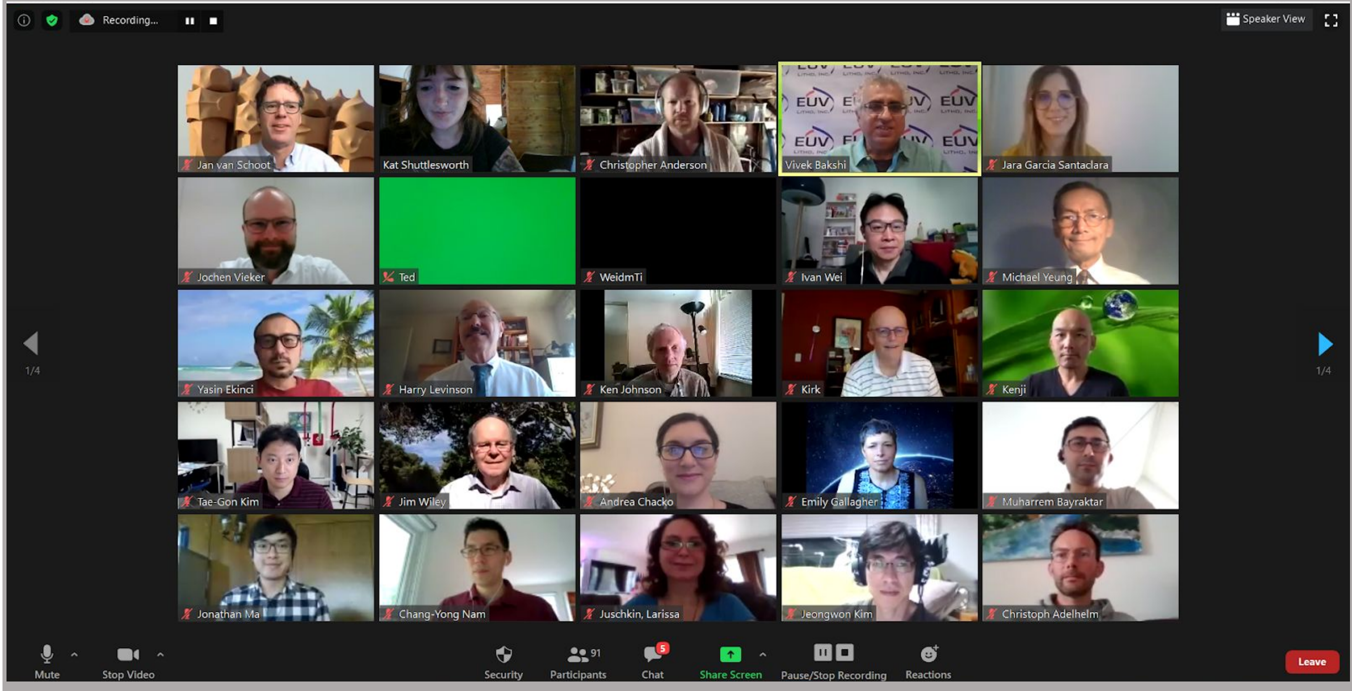
2020 EUVL Workshop

June 7-11, 2020

Held Online

Workshop Proceedings

2020 EUVL Workshop



2020 EUVL Workshop Sponsors

Organized by

Vivek Bakshi (EUV Litho, Inc.), Chair

Patrick Naulleau (CXRO), Co-Chair

Workshop Agenda Outline

2020 EUVL Workshop

Held Online as a Live Event

June 7-11, 2020

All Event times are in US Central Time Zone

Sunday, June 7, 2020
EUVL Short Course
5:30 PM US Central Time (7:30 AM, **Monday June 8**, Korea and Japan)

Monday, June 8, 2020
Session 1: CXRO Program Showcase
9:00 AM US Central Time (4:00 PM, Monday June 8, Netherlands)

Tuesday, June 9, 2020
Session 2: Keynote Presentations
8:30 AM US Central Time (3:30 PM, Tuesday June 9, Netherlands)

Session 3: EUV Mask, EUV Sources and "Speed Presentations"
6:00 PM US Central Time (8:00 AM, **Wednesday June 10**, Korea and Japan)

Wednesday, June 10, 2020
Session 4: EUV Optics, EUV Sources and "Speed Presentations"
9:00 AM US Central Time (4:00 PM, Wednesday June 10, Netherlands)

Session 5: EUV Resist
6:30 PM US Central Time (8:30 AM, **Thursday June 11**, Korea and Japan)

Thursday, June 11, 2020
Session 6: EUV Patterning and EUV Resist
8:30 AM US Central Time (4:00 PM, Thursday June 11, Netherlands)

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Monday, June 8, 2020

Session 1: CXRO Program Showcase (9:00 AM US Central Time)

Session Video Recording: Session 1 (Part 1) (Part 2)

Introductory Remarks and CXRO Overview (P71)
Patrick Naulleau
CXRO, LBL

A SHARP look at EUV masks from a different angle (P72)
Markus Benk, Weilun Chao, Ryan Miyakawa, Kenneth Goldberg, Patrick Naulleau *CXRO, LBL*

Approaches for EUV mask phase imaging (P73)
Ryan Miyakawa
CXRO, LBL

Probing multilayer, absorber, and 3D phase effects in EUV masks (P74)
Stuart Sherwin
CXRO, LBL

Critical Dimension GISAXS: Application using soft, tender and hard x-rays (P76)
Guillaume Freychet
CXRO, LBL

Break (20 Minutes)

Depth Profiling with Standing Wave X-ray Spectroscopy (P75)
Slavomir Nemsak
ALS, LBL

Advanced Characterization for nanoscale photoresist structure and spectroscopy (P77)
Miquel Salmeron
MSD, LBL

EUV fundamental processes—from understanding to engineering (P78)
Jonathan H. Ma, Han Wang, David Prendergast, Oleg Kostko, Andrew Neureuther, and Patrick Naulleau
CXRO, LBL

Contrast enhancement for soft materials with resonant soft x-ray scattering (P79)
Cheng Wang
ALS, LBL

Latent X-ray and AFM metrology of EUV photo resists (P80)
Luke Long, Isvar Cordova, Paul Ashby, Andrew Neureuther, and Patrick Naulleau
CXRO, LBL

Tuesday, June 9, 2020

Session 2: Keynote Presentations (9:00 AM)

Session Video Recording: Session 2

EUV Lithography And The Materials That Propel It Forward (P2)
Emily Gallagher, Eric Hendrickx, Ryoung han Kim, Philippe Leray, Vicky Philipsen, Ivan Pollentier Danilo DeSimone, Paulina Rincon, Kurt Ronse, Marina Timmermans,
IMEC

EUV Lithography and its Enablement of Future Generations of Semiconductor Devices (P3)
Nak Seong
ASML

Break

Lithographic Performance of the first Entirely Dry Process for EUV Lithography (P1)
Mohammed Alvi[1], Dictus Dries[1], Richard Gottscho[1], Kevin Gu[1], Benjamin Kam[1], Siva Kanakasabapathy[1], Da Li[1], Jeffrey Marks[1], Katie Nardi[1], Thad Nicholson[1], Yang Pan[1], Daniel Peters[1], Al Schoepp[1], Nader Shamma[1], Easwar Srinivasan[1], Samantha Tan[1], Clint Thomas[1], Boris Volosskiy[1], **Tim Weidman**[1*], Rich Wise[1], William Wu[1], Jun Xue[1], Jengyi Yu[1], Christophe Fouqu[2], Rolf Custers[2], Jara Garcia Santaclara[2], Michael Kubis[2], Gijsbert Rispens[2], Lidia van Lent-Protasova[2], Mircea Dusa[3], Patrick Jaenen[3], and Abhinav Pathak[3]
[1]LAM Research, [2]ASML, [3]IMEC

EUV Lithography: 0.33NA in HVM and preparation for future nodes (P5)
Steven Carson
Intel

Break

Deep Learning for Science (P4)
Prabhat
Lawrence Berkeley National Lab (LBL)

Session 3: EUV Mask, EUV Sources and "Speed Presentations" (6:00 PM)

Session Video Recording: Session 3

Effect of Annealing on Interfacial Quality of Ion Beam Sputtered Mo/Si Multilayers for EUV Mask Blanks (Invited) (P18)

T. Henry[1], N. Srinivasan[1], K. Rook[1], P. Turner[1], K. Yamamoto[2], V. Ip[1], M. H. Lee[1]
[1]Veeco Instruments, Advanced Deposition and Etch
[2]Veeco Japan
[1]Terminal Drive, Plainview, NY 11803, USA

Current Progress in a-PSM Mask Development (Tentative Title) (Invited) (P11)

Vibhu Jindal
AMAT

Compact modeling to predict and correct stochastic hotspots in EUVL (Invited) (P17)

Zachary Levinson*[a], Yudhishthir Kandel[b], Ryan Chen[c], Yunqiang Zhang[d], Qiliang Yan[c], Makoto Miyagi[a], Xiaohai Li[c], Kevin Lucas[a]
[a]Synopsys Inc., 1301 S MoPac Expy Bld 4 # 200, Austin, TX 78746;
[b]Synopsys Inc., 1101 Slater Road, Brighton Hall Suite 300, Durham, NC 27703;
[c]Synopsys Inc., 2025 NE Cornelius Pass Rd, Hillsboro, OR 97214;
[d]Synopsys Inc., 690 E Middlefield Rd., Mountain View, CA 94043

Pathfinding the Novel Absorber Materials for High-NA EUV lithography (Invited) (P13)

Jinho Ahn
EUV-IUCC, Hanyang University

Actinic Tools using Coherent EUV Source for High Volume Manufacturing (Invited) (P12)

Dong Gun Lee
E-Sol

Reflectance Measurement of EUV Mask under OoB-Irradiation, and Hydrogen and Water Vapor Environments under the High Power EUV Irradiation (Invited) (P16)

Takeo Watanabe
University of Hyogo

Break

Speed Presentation Session

Multi-stack Ni absorber EUV mask for high numerical aperture extreme ultraviolet lithography (Poster) (P14)

Yoon Jong Han[1,3], Dongmin Jeong[2,3], and Jinho Ahn[1,2,3]
[1] Division of Nanoscale Semiconductor Engineering
[2] Division of Materials Science and Engineering
[3] EUV-IUCC (Industry University Collaboration Center)
Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

EUV pellicle defect review using EUV ptychography microscope (Poster) (P15)

Byungmin Yoo[1,3], Dong Gon Woo[3], Young Woong Kim[2,3], Young Ju Jang[1,3], Seong Ju Wi[2,3] and Jinho Ahn[1,2,3]
[1] Division of Nanoscale Semiconductor Engineering
[2] Division of Materials Science and Engineering
[3] EUV-IUCC (Industry University Collaboration Center)
Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

Probing Multilayer, Absorber, and 3D Phase Effects in EUV Masks (Poster) (P85)

Stuart Sherwin
LBL (CXRO)

END Speed Presentation Session

Break

High-power EUV Light Source Based on Steady-state Microbunching Mechanism (P65)

Xiujie Deng
Tsinghua University, Beijing, China (On behalf of the SSMB Task Force)

Update of >300W High Power LPP-EUV Source Challenge for Semiconductor HVM (Invited) (P63)

Hakaru Mizoguchi, Hiroaki Nakarai, Tamotsu Abe, Hiroshi Tanaka, Yukio Watanabe, Tsukasa Hori, Yutaka Shiraishi, Tatsuya Yanagida, Georg Soumagne, Tsuyoshi Yamada and Takashi Saitou
Gigaphoton Inc. Hiratsuka facility, 3-25-1 Shinomiya Hiratsuka Kanagawa, 254-8567, JAPAN

Wednesday, June 10, 2020

Session 4: EUV Optics, EUV Sources and "Speed Presentations" (9:00 AM)

Session Video Recording: Session 4 (Part 1) (Part 2)

What's new in EUV Lithography Optics at ZEISS? (Invited) (P21)
Michael Busshardt
Carl Zeiss

EUV Lithography Design Concepts using Diffraction Optics (Invited) (P22)
Ken Johnson
KJ Innovation

EUV-induced carbon growth at contaminant pressures between 10E-10 mbar and 10E-6 mbar: Experiment and model (P23)
Charles Tarrio
NIST

Speed Presentation Session

Effect of beam-stop on the EUV Ptychography reconstruction (Poster) (P19)
Atoosa Dejkameh
PSI

Latent X-ray and AFM Metrology of EUV Photo Resists (Poster) (P84)
Luke Long
CXRO, LBL

Understanding EUV Electron Driven Processes—a Progress Update (Poster) (P86)
Jonathan Ma
CXRO, LBL

Intriguing Etch Resistance Evolution in Hybrid Resists Synthesized by Vapor Phase Infiltration (Poster) (P87)
Nikhil Tiwale
BNL

END Speed Presentation Session

Break

Tin plasma driven by a 2-µm-wavelength laser (Invited) (P61)
Oscar Versolato
ARCNL

Physics of Energetiq Source (Tentative Title) (Invited) (P62)

Wolfram Neff, Steve Horne
Energetiq

Simulations of Laser-Driven EUV Sources – the Impact of Laser Wavelength (Invited) (P64)

Steve Langer
LLNL

Efficient high-power laser drivers for Next-generation High Power EUV sources (P66)

Brendan Reagan
LLNL

Session 5: EUV Resist (6:30 PM)

Session Video Recording: Session 5

EUV Resists: What's the Road to High NA? (Invited) (P48)
Anna Lio
Intel

Predicting Chemical Dynamics upon EUV Exposure to Optimize Lithography (Invited) (P83)
David Prendergast
LBL (Molecular Foundry)

Combining EUV Monolayer Resists with Area Selective Depositions (Invited) (P44)
Rudy J Wojtecki
IBM

Prescreening of Resists for EUVL from N7 down to N3 by EBL AND HIM (Invited) (P45)
Kenneth Gonsalves
IIT Mandi

Vapor-Phase Infiltration Synthesis of Organic-Inorganic Hybrid Nanocomposite Resists Towards EUVL (Invited) (P51)
Chang-Yong Nam
BNL

Break

High Fluorinated Molecular Resists working under Electron-beam and Extreme UV Irradiation (Invited) (P47)
Jin-Kyun Lee
Inha University

Determination of effective attenuation length of slow secondary electrons in polymer films (P50)
Oleg Kostco
CXRO

Flood Exposure Assisted Chemical Gradient Enhancement Technology (FACET) and Stochastic Aware Resist Formulation and Process Optimizer (SARF-Pro) for EUV Lithography (Invited) (P49)
Seiji Nagahara
TEL

Fundamental Research of EUV Resist to Resolve the Issues in EUV Lithography (Invited) (P43)
Takeo Watanabe, *Hyogo University*

Thursday, June 11, 2020

Session 6: EUV Patterning and EUV Resist (8:30 AM)

Session Video Recording: Session 6

High-NA EUV Lithography Exposure Tool: Advantages and Program Progress (Invited) (P42)
Jan van Schoot
ASML

Challenges for the Ultimate Resolution in Photolithography (Invited) (P33)
Ekinci Yasin
PSI

Irradiation systems for accelerated testing of EUVL components (P32)
Jochen Vieker
Fraunhofer

MET5 Update (P31)
Chris Anderson
CXRO

Break

Progress towards High-NA EUV photoresists (Invited) (P41)
Jara Garcia Santa Clara
ASML

High Opacity Multi-Trigger Resist (Invited) (P46)
Alex Robinson
Irresistible Materials

Announcements
Vivek Bakshi
EUV Litho, Inc.

Workshop Adjourned

EUV
LITHO, INC.