

2017 International Workshop on EUV Lithography

June 12-15, 2017

CXRO, LBNL ▪ Berkeley, CA

Workshop Agenda

2017 International Workshop on EUV Lithography
(2017 EUVL Workshop)

June 12-15, 2017, The Center for X-ray Optics (CXRO), Lawrence
Berkeley National Laboratory, Berkeley, CA, USA



Organized by:



Co-Chairs

**Vivek Bakshi (EUV Litho, Inc.)
Patrick Naulleau (CXRO)**

2017 International Workshop on EUV Lithography

CXRO, LBNL, Berkeley, CA, USA

June 12-15, 2017

Workshop Agenda Outline

Monday, June 12, 2017

EUVL Short Course: 8:30 AM to 5 PM

Building name: Building 66

Room Number: 66-316

Coffee served during AM and PM breaks. Walk from Building 66 to Café for lunch.

Tuesday, June 13, 2017

Lab Tour: 3 PM to 5:00 PM (Tentative. Details to be announced)

Building name: CXRO (4th Floor lobby) (Tentative meeting location)

Meet in the lobby at 3 PM (Tour Guide: Patrick Naulleau)

Registration, Speaker prep and Reception: 5:00 PM - 6:30 PM

Building name: Building 54 (Also known as Bay View Cafeteria – name not shown on the building)

Room Number: Main hall

Wednesday, June 14, 2017

Building name: Building 66

Room Number: Auditorium (317). Building entrance is from the second floor. Stairs are directly to the left after entering the building.

Continental Breakfast and Registration: 7:00 AM – 8:00 AM

Workshop Presentations: 8:00 AM – 4:20 PM

Lunch: 12:20 PM – 1:20 PM

Continental Breakfast, morning registration and coffee during breaks will be served outside the auditorium. Seating also available next door in room # 316.

Group will walk together for Lunch to patio of Building 67. We also have inside room (67-3111, Chemla room) reserved for those who will prefer to eat inside.

Poster Session and Reception: 5:00 to 6:30 PM

Building name: Building 54 (Bay View Cafeteria - Name not shown on the building)
(Shuttle will be provided to take attendees from the auditorium to the poster session location.)

Thursday, June 15, 2017

Building name: Building 66 (317)

Continental Breakfast: 7:00 AM – 8:00 AM

Workshop Presentations: 8:00 AM – 4:40 PM

Lunch: 12:00 PM – 1:00 PM

Steering Committee Meeting (Closed working lunch meeting) 12:00 to 1:00 PM

Building name: Building 66
Room Number: 66-316 (Located next door to the main auditorium #317)

Depart for Dinner: 4:50 PM

Dinner Cruise Location: Berkeley Mariana, Empress Hornblower Upper Deck
Shuttle will be available for pickup for off-site dinner and drop-off after dinner

Workshop Adjourned: 9:00 PM

Shuttle Bus Services and Parking Information to be available at the website
www.euvlitho.com

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(2017 EUVL Workshop)

*CXRO, LBNL, Berkeley, CA, USA
June 12-15, 2017*

Workshop Agenda

Monday, June 12, 2017

Short Courses

EUV Lithography
by Vivek Bakshi (EUV Litho, Inc.), Patrick Naulleau (LBNL) and Jinho Ahn (Hanyang University)

8:30 AM -5:00 PM (Building 66 – Room 316)

Tuesday, June 13, 2017

Facility Tour, Registration and Reception

3:00 PM- 5:00 PM	Tour (Building # 2, Fourth floor) – Tour details to be announced in the updated agenda
5:00 PM- 6:30 PM	Registration, reception & Speaker Prep (Building 54, Bay View Cafeteria)

Wednesday, June 14, 2017

8:00 AM Welcome and Introduction

Introductions (Intro-1)
Vivek Bakshi
EUV Litho, Inc., Austin, TX, USA

Session 1: Keynote – 1

Session Chair:

EUVL: Current Status & Remaining Challenges (P1) (Keynote Presentation)
Obert R Wood II
GLOBALFOUNDRIES, 400 Stone Break Road Extension, Malta, New York 12020, U.S.A.

EUV Lithography for HVM (P3) (Keynote Presentation)
Britt Turkot
Intel Corporation

Break (20 minutes)

Session 2: EUV Masks and Mask Metrology

Session Co-chairs:

EUV Mask Economics: Impact of Mask Costs on Patterning Strategy (P33) (Invited Paper)
Bryan S. Kasprovicz¹ and Michael Lercel²
¹*Photronics, Inc.*
²*ASML, Inc.*

Reduction of Large Killer Defects in EUV Mask Blanks (P39) (Invited Paper)
Adrian Devasahayam, Alan V. Hayes, Boris Druz, Sandeep Kohli, Rustam Yevtukhov,
Veeco Instruments Inc (United States)

NewSUBARU EUVL R&D Activities and EUV Mask Defect Inspection (P34) (Invited Paper)
Takeo Watanabe and Tetsuo Harada
Center for EUVL, Laboratory of Advanced Science and Technology for Industry, University of Hyogo

Anamorphic Imaging: Emulating Future Nodes of EUV Lithography on the SHARP Microscope (P38)

Markus Benk, Weilun Chao, Ryan Miyakawa, Kenneth Goldberg, Patrick Naulleau
Lawrence Berkeley National Laboratory, Center for X-ray Optics, 1 Cyclotron Road,
Berkeley, California, United States, 94720

Improved Inspection Ability of Coherent Scattering Microscopy by Applying Ptychography (P31)

Young Woong Kim¹, Dong Gon Woo¹, Seung Hyuk Shin², Hoon Jo², Whoi-Yul Kim² and
Jinho Ahn¹

¹Division of Materials Science and Engineering

²Department of Electronics and Computer Engineering

Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 04763, Republic of Korea

RESCAN - A Standalone Tool for EUV Mask Defect Inspection (P32)

Patrick Helfenstein^a, Iacopo Mochi^a, Rajeev Rajendran^a, Istvan Mohacsi^a, Yoshitake
Shusuke^b, Yasin Ekinci^a

^aPaul Scherrer Institute, Villigen PSI, Villigen, CH-5232, Switzerland

^bNuFlare Technology, Inc., 8-1 Shinsugita-cho, Yokohama 235-8522, Japan

Rigorous 3D Electromagnetic Simulation of Ultrahigh Efficiency EUV Contact-hole Printing with Chromeless Phase-shift Mask (P37)

Stuart Sherwin^a, Thomas V. Pistor, Andrew Neureuther^a, and Patrick Naulleau^b

^aUniversity of California, Berkeley, Department of Electrical Engineering and Computer
Sciences, Berkeley, California, United States, 94720

^bLawrence Berkeley National Laboratory, Center for X-ray Optics, 1 Cyclotron Road,
Berkeley, California, United States, 94720

Lunch 12:20 AM – 1:20 PM

Session 3: EUV Sources- I

Session Co-chairs:

kW-class Picosecond Thin-disk Pre-pulse Laser PERLA for Efficient EUV Generation (P11) (Invited Paper)

Akira Endo¹, Martin Smrž¹, Jiří Mužík^{1,2}, Ondřej Novák¹, Michal Chyla¹,
Tomáš Mocek¹

¹ HiLASE Centre, Institute of Physics AS CR, Za Radnicí 828, 252 41 Dolní Břežany, Czech
Republic

² Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in
Prague, Břehová 7, 115 19 Praha 1, Czech Republic

Scalability of CO₂ Amplifiers to Generate Stable > 500W Extreme Ultraviolet (EUV) Beams (P12) (Invited Paper)

Koji Yasui¹, Naoyuki Nakamura², Jun-ichi Nishimae²,
Masashi Naruse³, Kazuo Sugihara³, and Masato Matsubara³

¹*Mitsubishi Electric Corporation, Head quarter, Factory Automation Systems Group, Tokyo, Japan*

²*Mitsubishi Electric Corporation, Advanced technology R&D center, Hyogo, Japan*

³*Mitsubishi Electric Corporation, Nagoya works, Nagoya, Japan*

Simulating EUV Production – an Overview of the Underpinnings (P13) (Invited Paper)

Howard Scott and Steve Langer

Lawrence Livermore National Laboratory, USA

Short-pulsed Nd:YAG Laser Interaction with Tin Micro-droplets (P14) (Invited Paper)

Oscar O. Versolato

Advanced Research Center for Nanolithography (ARCNL), Science Park 110, 1098 XG Amsterdam, The Netherlands

Break 2:20 PM (20 Minutes)

Session 4: EUV Sources - II

Session Chair:

Next Generation Source Power Requirements: What will we need at the 3 nm node and beyond? (P15) (Invited Paper)

Erik R. Hosler

GLOBALFOUNDRIES, 400 Stone Break Road Extension, Malta, NY 12020

A Compact Linac-Driven EUV Light Source utilizing a Short-Period Microwave-Driven Undulator (P16)

Filippos Toufexis^{*}, Cecile Limborg-Deprey, Valery A. Dolgashev, Sami G. Tantawi

SLAC National Accelerator Laboratory, 2575 Sand Hill Rd, Menlo Park, California 94025

^{*} *Also at the Department of Electrical Engineering, Stanford University*

Concept for 1kW EUV Source for Lithography Based on FEL Emission in Compact Storage Ring (P17) (Invited Paper)

Michael Feser

Lyncean Technologies Inc.

Challenges to Realize the EUV-FEL High Power Light Source - Present Status on the EUV-FEL R&D Activities (P18) (Invited Paper)

Hiroshi Kawata

High Energy Accelerator Research Organization (KEK), Tsukuba, Ibaraki 305-0801, Japan

Session 5: Poster Session 5:00 6:30 PM

Large Collector Mirror Reflectometer for the High Power EUV Light Source Achievement (P25)

Takeo Watanabe and Tetsuo Harada

Center for EUVL, Laboratory of Advanced Science and Technology for Industry, University of Hyogo

Measuring Aberrations with Mask Roughness (P35)

Aamod Shanker

Dept. of Electrical Engineering and Computer Sciences, University of California, Berkeley, CA

Impact of Tool Design on Defect Detection Sensitivity for EUV Actinic Blank Inspection (P36)

Yow-Gwo Wang,^{a,b,*} Andrew R. Neureuther,^{a,b} Patrick P. Naulleau^b

^a*University of California, Berkeley, Department of Electrical Engineering and Computer Sciences, Berkeley, California, United States, 94720*

^b*Lawrence Berkeley National Laboratory, Center for X-ray Optics, 1 Cyclotron Road, Berkeley, California, United States, 94720*

Variable Separation Method for Three-dimensional EUVL Mask Diffraction Simulation (P40)

Xiangzhao Wang^{*}, Heng Zhang, Sikun Li

Laboratory of Information Optics and Opto-electronic Technology, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, Shanghai, China, 201800

Estimation of Lithographically-relevant Secondary Electron Blur (P51)

Roberto Fallica and Yasin Ekinci

Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

EUV Lithography Research and Development Activities at University of Hyogo (P52)

Takeo Watanabe and Tetsuo Harada

Center for EUVL, Laboratory of Advanced Science and Technology for Industry, University of Hyogo

Additional Poster Papers to be Announced Soon

End Day 1

Thursday, June 15, 2017

Welcome and Announcements (Intro-2)

Vivek Bakshi
EUV Litho, Inc.

Session 6: Keynote-2

Session Chair:

Tabletop Coherent EUV Sources and Applications: Full Field Sub-Wavelength Imaging at 13.5nm and Materials Metrology (P4) (Keynote Presentation)

Margaret Murnane
JILA, University of Colorado at Boulder and KMLabs Inc.

High Power HVM LPP-EUV Source with Long Collector Mirror Lifetime (P2) (Keynote Presentation)

Hakaru Mizoguchi
Gigaphoton Inc., Hiratsuka Kanagawa, 254-8567, JAPAN

EUV Lithography: Progress in LPP Source Power Scaling and Availability (P5) (Keynote Presentation)

Igor Fomenkov
Cymer LLC, An ASML Company, San Diego, CA 92127, USA

Break (20 Minutes)

Session 7: Optics and Contamination

Session Co-Chairs:

EUV Optics Life-time Research: Past, Present and Future (P21) (Invited Review paper)

Norbert Koster, Edwin te Sligte, Arnold Storm, Herman Bekman, Jacques van der Donck, Diederik Maas, Jochem Janssen, Rogier Verberk
TNO, Stieltjesweg 1, 2628 CK Delft, The Netherlands

The Future of EUV Lithography: Enabling Moore's Law in the Next Decade (P22) (Invited Paper)

Jan van Schoot, Kars Troost, Alberto Pirati, Rob van Ballegoij, Peter Krabbendam, Judon Stoeldraijer, Erik Loopstra, Jos Benschop, Jo Finders, Hans Meiling, Eelco van Setten, Bernhard Kneer*, Bernd Thuering*, Winfried Kaiser*, Tilmann Heil*, Sascha Migura*
ASML Netherlands B.V., De Run 6501, 5504 DR Veldhoven, The Netherlands
*Carl Zeiss SMT GmbH, Rudolf-Eber-Straße 2, 73447 Oberkochen

Latest Developments in EUV Optics (P23) (Invited Paper)

Jack Liddle, Joerg Zimmermann, Jens Timo Neumann, Matthias Roesch, Ralf Gehrke, Bernhard Kneer, *Eelco van Setten, *Jan van Schoot
Carl Zeiss SMT GmbH, Rudolf-Eber-Straße 2, 73447 Oberkochen
*ASML Netherlands B.V., De Run 6501, 5504 DR Veldhoven, The Netherlands

EUV/SXR Optics and Metrology Development at RITE (P24) (Invited Paper)

Ladislav Pina
Rigaku Innovative Technologies Europe (RITE), Prague, Czech Republic

Lunch 12:00 PM (60 Minutes)

Steering Committee working lunch meeting (Closed meeting)

Session 8: Resist and Patterning -1

Session Co-Chairs:

EUVL Developments at Imec (P47) (Invited Paper)

Greg McIntyre
IMEC

Reactivity of Metal Oxalate EUV Resists as a Function of the Central Metal (P41) (Invited Paper)

Steven Grzeskowiak,^a Amrit Narasimhan,^a Michael Murphy,^a Lee Napolitano,^b Daniel A. Freedman,^b Robert L. Brainard,^a and Greg Denbeaux^a
^a State University of New York Polytechnic Institute - CNSE, 257 Fuller Rd. Albany, NY 12203
^b State University of New York at New Paltz, 1 Hawk Drive New Paltz, NY 12561

Novel EUV resist development for sub-7 nm node (P43) (Invited Paper)

Yoshi Hishiro
JSR Micro INC, 1280 N. Mathilda Ave, Sunnyvale, CA 94089, USA

Metal Oxide Photoresists: Breaking Paradigms in EUV Lithography (P50) (Invited Paper)

Jason Stowers
Inpria

Fundamental Aspect of Photosensitized Chemically Amplified Resist: How to overcome RLS trade-off (P46) (Tentative Title) (Invited Paper)

Seiichi Tagawa^{1,2}
¹Graduate School of Engineering, Osaka University, Ibaraki, Osaka 567-0047, Japan,
²Institute of Scientific and Industrial Research, Osaka University, Ibaraki, Osaka 567-0047, Japan

Break 2:50 PM (20 Minutes)

Session 9: Resist and Patterning -2

Session Co-chairs:

Towards Real-Time Analysis of Morphologies using Scattering (P42) (Invited Paper)

Alex Hexemer

Lawrence Berkeley National Laboratory, Berkeley, California, United States, 94720

Extreme ultraviolet Induced Chemical Reactions in Photoresists and Model Systems (P44) (Invited Paper)

S. Castellanos^a, Y. Zhang^a, J. Haitjema^a, L. Wu^a, O. Luigier^a, D. Kazazis^b, M. Vockenhuber^b, T. R. Fallica^b, Y. Ekinici^b, A.M. Brouwer^a.

^a *Advanced Research Center for Nanolithography, Science Park 110, 1098XG Amsterdam, The Netherlands*

^b *Paul Scherrer Institute, 5232 Villigen PSI, Switzerland*

Fundamentals of X-Ray Excitation and Relaxation in EUV Resists (*Tentative Title*) (P45) (Invited Paper)

D. Frank Ogletree

Molecular Foundry, Materials Sciences Division, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley CA 94720 USA

Fundamental Aspects of Low Energy Electron Driven Chemistry (P48) (Invited Paper)

Dan Slaughter

Chemical Sciences Division, LBNL

EUVL Workshop Summary (P70)

Vivek Bakshi

EUVLitho, Inc.

Depart for Dinner

6:00 -9:00 PM Dinner Cruise

