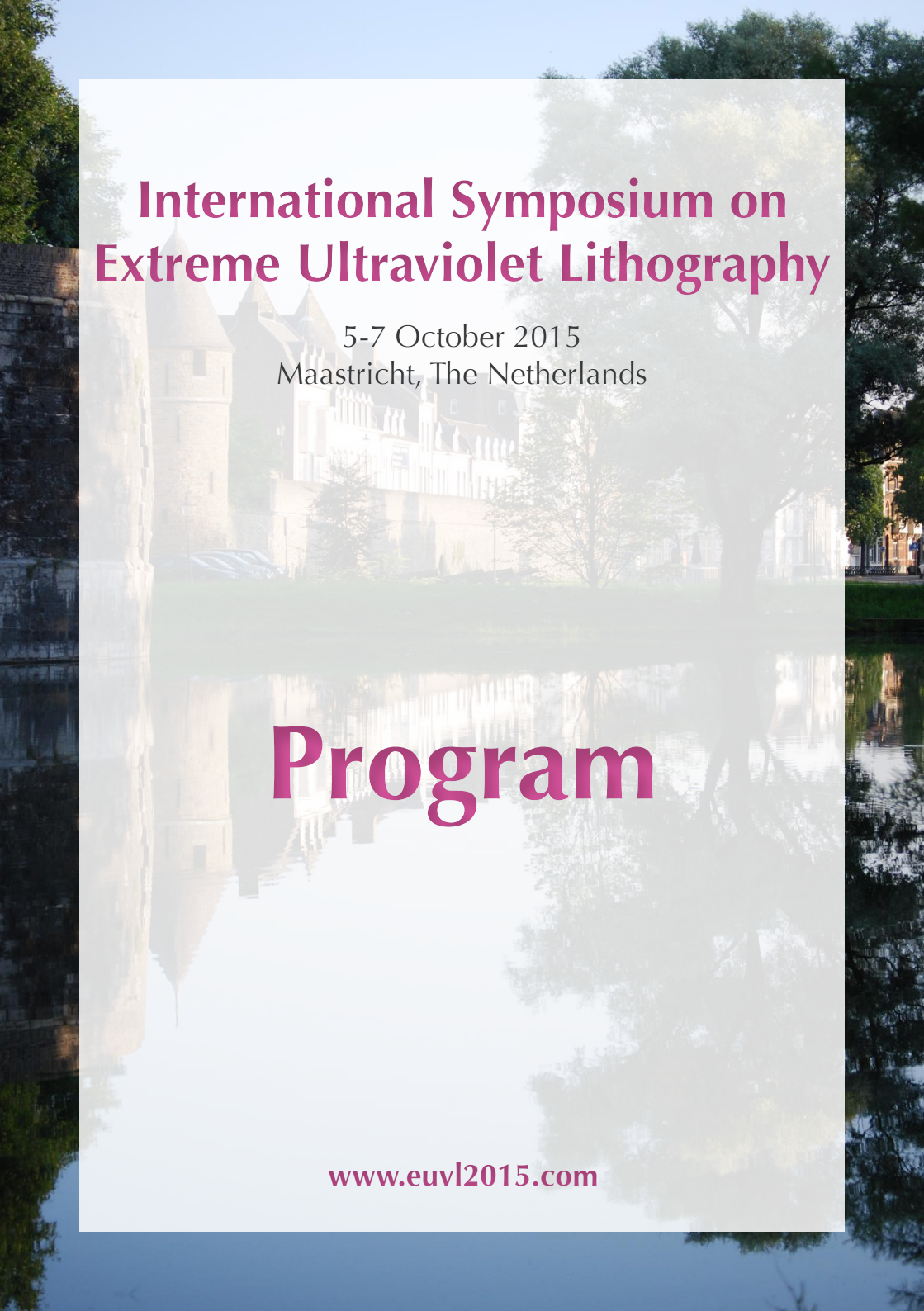

International Symposium on Extreme Ultraviolet Lithography

5-7 October 2015
Maastricht, The Netherlands

Program

www.euvl2015.com

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Welcome Address

Welcome to the **2015 International Symposium of Extreme Ultra Violet Lithography** in Maastricht (NL). Located close to the borders between The Netherlands, Belgium and Germany, this city is in the center of gravity of all EUVL R&D activities in Europe.

This conference builds on last year's Symposium (Washington, USA), where Esin Terzioglu of Qualcomm defined a checkpoint for EUVL readiness around this time for introduction of EUVL in 7nm logic node critical layers. Keynote speakers, as well as several invited speakers who are experienced users of the ASML NXE:3300B, have been selected to provide a close view on where EUVL is today with respect to 7nm, not only in terms of the scanner, but also the resist and mask infrastructure.

EUV source power has continued to increase after last year's EUVL Symposium and a lot of attention is paid to the reliability of these sources, which is a key requirement from the economic point of view. The status, progress and roadmap of the EUV sources will also be shared at this Symposium.

Several recent developments are well represented in the conference program, such as EUV pellicle and metal containing resists. Status will also be given of key pieces of infrastructure, such as EUV AIMs, actinic mask inspection and clean EUV mask blank fabrication.

Finally, 7nm can certainly not be the end-point for EUV technology. Extendibility beyond 7nm is absolutely necessary and that will be covered as the second major focus item of this Symposium.

Like last year, the EUVL Symposium is combined with IEUVI Technical Working Group meetings (on Sunday) and an OSA Source workshop (on Thu and Fri). Participation to all these activities is encouraged and this is reflected in the registration fee.

Having received over 120 abstracts from all main EUVL stakeholders, this Symposium will give you the most up-to-date view on where EUVL is today, and where it will go in the future.

I wish you a very fruitful Symposium that combines state-of-the-art technical sessions and also has plenty of time for networking.

Welcome to Maastricht!

Kurt Ronse
2015 EUVL Symposium Chair

Eric Hendrickx
2015 EUVL Program Chair

Session 1: EUV Insertion in Manufacturing 1

Chairs: Rudy Peeters, ASML & Matt Colburn, IBM

08.00 **Welcome**
Kurt Ronse & Eric Hendrickx, imec

08.25 **Keynote Lecture**
Cost-effective shrink with Holistic lithography, extended by EUV
Martin van den Brink, ASML

09.00 **Invited Lecture**
Progress on enabling EUV lithography for high volume manufacturing
Jack J.H. Chen, TSMC

09.30 **Invited Lecture**
EUVL readiness for 7nm
Mark Phillips, Intel Corporation

10.00 Coffee Break

Session 2: EUV Insertion in Manufacturing 2

Chairs: Sang Lee, Intel & Jack J.H. Chen, TSMC

10.30 **Invited Lecture**
Inserting EUV lithography at 7nm
Matthew Colburn, IBM

11.00 **NXE:3300 insertion for N7: Status and challenges**
Vicky Philipsen, imec

11.20 **Edge placement error analysis for N7 logic patterning options**
Eelco van Setten, ASML

11.40 **Experimental verification of phase induced mask 3D effects in EUV imaging**
Friso Wittebrood, ASML

12.00 **Implementation of model-based assist features in EUV**
Fan Jiang, Mentor Graphics Corp.

12.20 Lunch

Session 3: EUV Light Source

Chairs: Eric Panning, Intel & Shinji Okazaki, Gigaphoton

13.20 **EUV sources: Progress towards industrialization**
Alberto Pirati, ASML

13.40 **In-situ EUV collector cleaning by hydrogen plasma**
Daniel Elg, University of Illinois

14.00 **Update of one hundred watt HVM LPP-EUV source performance**
Hakaru Mizoguchi, Gigaphoton inc.

14.20 **Low-loss and high-gain CO_2 amplifiers to generate extreme ultraviolet, EUV powers of 250W and > 500W**
Koji Yasui, Mitsubishi Electric Corp.

14.40 **SASE, RAFEL, oscillator, or a self-seeded free-electron laser source for EUV lithography**
Erik Hosler, Globalfoundries

15.00 **Challenges and opportunities for an industrial EUV free electron laser**
Alex Murokh, RadiaBeam Technologies, LLC.

15.20 Coffee Break

Program - Monday October 5, 2015

Session 4: Mask Inspection and Review 1

Chairs: Emily Gallagher, imec & Hidehiro Watanabe, EIDEC

15.50 **Invited Lecture**
EUV mask infrastructure readiness for HVM; Do we overlook something important?
Naoya Hayashi, Dai Nippon Printing Co., Ldt.

16.20 **Status and recent achievements of the AIMS EUV system for actinic review of EUV masks**
Sascha Perlitz, Carl Zeiss SMT

16.40 **EUVL patterned mask inspection for 11 nm half-pitch, (hp) generation with defect detection capability enhancement by a learning system**
Ryoichi Hirano, EIDEC

17.00 **Defect review capability on actinic blank inspection tool**
Hiroki Miyai, Lasertec

17.20 **Assessment of AIMS™ EUV and SHARP actinic wavelength mask defect review tools for the evaluation of blank defect printability**
Erik Hosler, Globalfoundries

17.40 **High-radiance LDP source for mask inspection**
Yusuke Teramoto, Ushio Inc.

18.00 **Poster Session**

21.00 End of Day 1

Program - Tuesday October 6, 2015

Session 5: EUV Resist 1

Chairs: Mieke Goethals, imec & Suigen Kyoh, Toshiba

08.00 **Keynote Lecture**
30 years have passed from the first experiment
Hiroo Kinoshita, University of Hyogo

08.35 **The road towards single digit nanometer resolution patterning in mass production: State-of-the-art EUV resists platforms compared**
Elizabeth Buitrago, Paul Scherrer Institute

08.55 **Novel EUV resist development for 13 nm half pitch**
Satoshi Dei, JSR Micro N.V.

09.15 **Study on defect control of resist process for production ready EUV lithography**
Junghyung Lee, SK Hynix

09.35 **Sub-50 nm metrology on EUV chemically amplified resist: A systematic assessment**
Diederik Maas, TNO

09.55 **A defectivity study on dry development rinse process, DDRP**
Harold Stokes, imec

10.15 **Coffee Break**

Session 6: Mask Inspection and Review 2

Chairs: Bryan Kasprowicz, Photronics & Naoya Hayashi, DNP

10.45 **Recent progress of EUV blanks development**
Takahiro Onoue, Hoya Corporation

11.05 **ABI tool performance confirmed by NXE3300 printing results**
Rik Jonckheere, imec

11.25 **Actinic mask imaging: Taking a SHARP look at next generation photomasks**
Markus Benk, LBNL

11.45 **Enhanced defect sensitivity by Zernike phase contrast for Actinic blank inspection**
Yow-Gwo Wang, UC Berkeley

12.05 **Defectivity study on extreme ultraviolet mask**
Kazunori Seki, Toppan Photomasks, Inc.

12.25 **A novel method in EUV mask repair**
Chun-Hao Tseng, TSMC

12.45 **Lunch**

Program - Tuesday October 6, 2015

Session 7: EUV Resist 2

Chairs: Danilo De Simone, imec & Andrew Grenville, Inpria

13.45 **The Multivariate Poisson Propagation Model and resist stochastics**
Patrick Naulleau, LBNL

14.05 **Advances in EUV nanoparticle photoresist development**
Eric Panning, Intel Corporation

14.25 **Combined experimental and theoretical investigation of EUVL radiation chemistry fundamentals**
Frank Ogletee, Lawrence Berkeley National Lab

14.45 **Improving EUV resist performance through material designs**
Douglas Guerrero, Brewer Science, Inc.

15.05 **Novel ultra-high sensitive non-CAR materials using EUV exposure**
Toru Fujimori, EIDEC

15.25 **Suppression of stochastic effects in chemically amplified resist processes for extreme ultraviolet lithography**
Takahiro Kozawa, Osaka University

15.45 Coffee Break

Session 8: EUV Resist 3

Chairs: Huixiong Dai, AMAT & Koen Van Ingen Schenau, ASML

16.15 **Metal oxide photoresists: Unlocking the full potential of EUV patterning**
Michael Kocsis, Inpria

16.35 **Challenge for 10nm resolution by applying dry development rinse process, DDRP and materials, DDRM**
Wataru Shibayama, Nissan Chemical

16.55 **Novel materials based on negative-tone imaging for EUVL**
Hideaki Tsubaki, Fujifilm Corporation

17.15 **Identifying EUV resist materials for sub-10 nm nodes**
Tero S. Kulmala, Paul Scherrer Institute

17.35 End of Day 2

18.00 Dinner at Château Neercanne

Program - Wednesday October 7, 2015

Session 9: EUV Lithography Extendibility

Chairs: Vicky Philipsen, imec & Erik Hosler, GF

08.00 **Keynote Lecture**
EUV optics – The enabler of high resolution imaging
Winfried Kaiser, Carl Zeiss SMT GmbH

08.35 **Anamorphic high NA optics enabling EUV lithography with sub 8 nm resolution**
Tilmann Heil, Carl Zeiss SMT GmbH

08.55 **EUV high-NA scanner and mask for sub 8 nm resolution**
Jan Van Schoot, ASML

09.15 **Current status and outlook of etched multilayer mask for EUV extension**
Takashi Kamo, Toshiba Corp.

09.35 **Impact of conductive layer for etched multilayer EUV mask on the sensitivity of patterned mask inspection**
Susumu Iida, EIDEC

09.55 **Modeling EUV mask using alternative materials for mask 3D effect compensation**
Kim Vu Luong, imec

10.15 Coffee Break

Session 10: Pellicle, Mask Cleaning and Thermal Expansion

Chairs: Rik Jonckheere, imec & Abbas Rastegar, AMAT

10.45 **IEUVI presentation**
Paolo Gargini, Stanford University

11.05 **An EUV pellicle solution for defectivity control**
Paul Janssen, ASML

11.25 **Properties and performance of EUVL pellicle membranes**
Emily Gallagher, imec

11.45 **Thermal limitation of silicon EUV pellicle and possible improvements for mass production of EUV lithography**
Sungwon Kwon, Samsung Electronics

12.05 **Plasma-assisted cleaning to enhance EUV mask cleanliness and durability**
Ching-Wei Shen, TSMC

12.25 **Considerations on thermal expansion specification for EUV mask substrates**
Carlos Duran, Corning Inc.

12.45 Closing Remarks

13.00 **Lunch Boxes - Networking**

EUV Insertion in Manufacturing

P-IM-01 **EUV process establishment for NXE3300 and beyond**
Yuhei Kuwahara, Tokyo Electron Limited

P-IM-02 **LWR improvement on EUV track system**
Masahiko Harumoto, SCREEN

P-IM-03 **Metal contained material integration on coater/developer system**
Hiroshi Mizunoura, Tokyo Electron Limited

P-IM-04 **Benchmarking study of contact hole imaging**
Warren Montgomery, SUNY Polytechnic (CNSE)

P-IM-05 **Studies directed towards decrease contact hole printability**
Warren Montgomery, SUNY Polytechnic (CNSE)

P-IM-06 **Resist readiness for N7 patterning in EUV**
Mieke Goethals, imec

EUV Lithography Extendibility

P-LI-01 **EUVL micro-field exposure tools with 0.5 NA**
Louis Marchetti, Ametek / Zygo

P-LI-02 **Non-conventional shadow effect caused by anamorphic numerical aperture system at extreme-ultraviolet lithography**
In-Seon Kim, Hanyang University

P-LI-03 **Fabrication of transmission grating of EUV interference lithography for 1X nm hp EUV resist evaluation**
Takeo Watanabe, University of Hyogo

P-LI-04 **B-based multilayer coatings for next generation lithography at λ = 6.X nm**
Philipp Naujok, Fraunhofer IOF

P-LI-05 **Development of a high numerical aperture EUV lithography tool: The Berkeley MET5 Platform**
Patrick Naulleau, LBNL

P-LI-06 **Anamorphic high NA source optimization for high quality patterning below 10 nm node**
Kiho Ko, Hanyang University

P-LI-07 **High reflectance La/B based multilayer mirrors for 6.x nm wavelength**
Dmitry Kuznetsov, XUV optics group, University of Twente

EUV Resist

P-RE-01 **Improving pattern fidelity in helium ion beam lithography**
Wouter Mulckhuyse, TNO

P-RE-02 **Characterization of high resolution electron beam resists under extreme ultraviolet irradiation**
Sascha Brose, RWTH Aachen University

P-RE-03 **Development of the xanthendiol derivatives applied to the negativetone molecular resists for EB/EUVL**
Takumi Toida, Mitsubishi Gas Chemical Company, Inc.

P-RE-04 **Novel DDR process and materials meet NTD process**
Shuhei Shigaki, Nissan Chemical Industries, Ltd.

P-RE-05 **Study on resist performance of chemically amplified molecular resist based on Noria derivative and calixarene derivative for EUV lithography**
Hiroki Yamamoto, ISIR, Osaka University

P-RE-06 **Absorption coefficient and Dill's parameters of CAR and organo-metallic Sn-based resist**
Roberto Fallica, Laboratory for Micro and Nano technology

P-RE-07 **Development of metal resist and underlayer**
Shinya Minegishi, EIDEC

P-RE-08 **A study of EUV resist sensitivity by using metal materials**
Atsushi Sekiguchi, Litho Tech Japan

P-RE-09 **Investigation of luminescent materials for EUV metrology applications**
Oskar Hofmann, RWTH Aachen

P-RE-10 **Fundamental understanding of EUV radiation induced chemistry on a molecular level**
Frank Ogletree, Lawrence Berkeley National Laboratory

P-RE-11 **Calculation of inelastic mean free path of secondary electrons in EUV resists with EELS measurements**
Suchit Bhattarai, University of California, Berkeley

P-RE-12 **Modeling the interaction of EUV radiation with photoresist materials**
Frank Ogletree, Lawrence Berkeley National Laboratory

P-RE-13 **Understanding EUV resist exposures - Measurements of PAG reaction cross sections to low energy electrons**
Greg Denbeaux, SUNY Polytechnic Institute

Poster List

EUV Source for Metrology and Inspection

P-MI-01 **Laser driven table-top coherent EUV Source for high resolution diffractive microscopy**
Michal Odstrcil, University Southampton

P-MI-02 **Light sources for high volume metrology & inspection applications**
Bob Rollinger, ETH Zurich

P-MI-03 **Compact discharge based EUV Source for metrology and inspection**
Jochen Vieker, Fraunhofer Institute for Laser Technology

P-MI-04 **Metrology tools for the characterization of light sources in the spectral region around 6.x nm**
Klaus Bergmann, Fraunhofer Institute for Laser Technology

P-MI-05 **Coherent diffractive imaging for actinic inspection with EUV light produced by a laboratory-scale gas-discharge plasma source**
Jan Bußmann, Experimental Physics of Extreme Ultraviolet EUV

P-MI-06 **EUV scattering metrology with high-brightness discharge plasma source**
Aleksey Maryasov, RWTH EUV

P-MI-07 **High stability droplet generator for EUV actinic inspection applications**
Mikhail Krivokorytov, EUV Labs

EUV Source for Patterning

P-PA-01 **The target formation for LPP EUV light source with laser pulses of femtosecond and picosecond duration**
Mikhail Krivokorytov, EUV Labs

P-PA-02 **Picosecond, kW thin disc laser technology for LPP and FEL EUV sources**
Akira Endo, Waseda University

P-PA-03 **LPP light source development for HVM**
Igor Fomenkov, Cymer LLC

P-PA-04 **Lensless interference patterns for several types of EUV sources**
Hyun-su Kim, RWTH Aachen University

P-PA-05 **Key components technology update of 100W EUV light source for HVM**
Tamotsu Abe, GIGAPHOTON INC.

P-PA-06 **A wide band transmission mode spectrometer for diagnosis of EUV sources**
Muharrem Bayraktar, University of Twente

Poster List

Mask Inspection and Review

P-MR-01 **3D reticle backside inspection**
Peter van der Walle, TNO

P-MR-02 **Quantitative phase contrast imaging of phase defect using a lensless microscope**
Tetsuo Harada, University of Hyogo

P-MR-03 **Actinic characterization of EUV photomasks by EUV scatterometry**
Christian Laubis, PTB

P-MR-04 **RapidNano: An affordable particle detection platform for EUV mask blanks**
Jacques van der Donck, TNO

P-MR-05 **Actinic EUV mask inspection using scanning coherent diffraction imaging methods**
Patrick Helfenstein, Paul Scherrer Institute

P-MR-06 **Parallel AFM Status: Demonstration of 3D metrology and inspection with 1000 times increase in speed**
Hamed Sadeghian, TNO

P-MR-07 **Scattering analyses of defects in EUV multilayers**
Lukas Bahrenberg, RWTH Aachen

P-MR-08 **Overlay improvement via large dynamic range scanning probe microscope**
Stefan Kuiper, TNO

P-MR-09 **Challenges in constructing EUV metrology tools to qualify the EUV masks for HVM implementation**
Rupert Perera, EUV Tech

P-MR-10 **Improving scan speed and resolution of AFM for elucidating resist dissolution dynamics**
Frank Ogletree, Lawrence Berkeley National Lab

Poster List

Mask, Pellicle, Mask Cleaning and Thermal Expansion

P-MP-01 **Temperature distribution of multi-stack EUV pellicle with various structures and materials**
Jong-Hoon Lee, Hanyang University

P-MP-02 **Feasibility study of through pellicle inspection for patterned extreme ultraviolet mask**
Guk-Jin Kim, Hanyang University

P-MP-03 **Thermo-mechanical distortion of extreme-ultraviolet pellicle**
Sung-Gyu Lee, Hanyang University

P-MP-04 **A conductive under layer for an etched multilayer type black border: Influence of the mask structure on mask pattern images captured by EB optics**
Tsuyoshi Amano, EIDEC

P-MP-05 **Feasibility study on inserting graphene layers into EUV pellicle structure**
Jung Hwan Kim, Hanyang University

P-MP-06 **Optical testing of EUV pellicle materials**
Ivan Pollentier, imec

P-MP-07 **Extending final clean of EUVL reticles to 100X cleaning cycles**
Jens Kruemberg, Suss MicroTec

P-MP-08 **Understanding the effects of transmittance and stand-off distance of EUV pellicle**
Seung Min Lee, Hanyang University

P-MP-09 **Thermomechanical behavior of the EUVL pellicle during the exposure**
Eun-Sang Park, Hanyang University

P-MP-10 **Multilayer mask roughness: Correlation between scatterometry and image-plane speckle**
Patrick Naulleau, LBNL

P-MP-11 **Ultrahigh efficiency contact-hole printing with phase shift mask**
Patrick Naulleau, LBNL

P-MP-12 **Using the SHARP EUV microscope's aerial images to study line edge roughness**
Antoine Wojdyla, LBNL

P-MP-13 **SHARP imaging at high mask-side NA**
Markus Benk, LBNL

Poster List

Outgas and Contamination Monitoring

P-OC-01 **A traffic light for clean vacuum: The Mass-Filtered Ion Gauge (MFIG)**
Michel van Putten, TNO

P-OC-02 **EBL2: EUV exposure and surface analysis system**
Edwin te Sligte, TNO

P-OC-03 **Image distortion by very small defect with larger density**
Ji Hye-Rim, Hanyang University

P-OC-04 **Patterning dependency on high NA Anamorphic directionality through contamination study**
Hyun-Ju Lee, Hanyang University

P-OC-05 **Recent progress in resist outgas testing for the new platform at EIDEC**
Eishi Shiobara, EIDEC

P-OC-06 **Comparison of EUV resist outgassing between organic and inorganic materials**
Yukiko Kikuchi, EIDEC

P-OC-07 **Chemometrics study of EUV resist materials for witness sample based outgas testing**
Yu-Jen Fan, SEMATECH

P-OC-08 **Spectroscopic EUV reflectometry for characterization of thin films and layered structures**
Larissa Juschkin, RWTH Aachen University

P-OC-09 **Structural spectroscopy by extreme ultraviolet reflectometry**
Stefan Herbert, RWTH Aachen University

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