20th Fraunhofer IISB Lithography Simulation Workshop

May 22 – 24, 2025, Gößweinstein, Germany

Lithography Simulation

Program

(status as of May 19, 2025)

Thursday, May 22

12:00: Welcome and lunch

- 14:00 – 14:15: **Welcome and introduction**, Andreas Erdmann (Fraunhofer IISB, Germany)
- 14:15 – 14:40: **AIMS® EUV: A holistic approach to EUV mask qualification**, Matthias Roesch, Maximilian Albert, Grizelda Kersteen, Andreas Verch, Klaus Gwosch, Renzo Capelli (Zeiss SMT, Germany)
- 14:40 – 15:05: **DNN based approaches for EUV mask inspection**, Paolo Ansuinelli, Suman Saha, Luis Felipe Barba Flores, Benjamín Béjar Haro, Yasin Ekinci, Iacopo Mochi (PSI, Switzerland)
- 15:05 – 15:30: **Exploring the crucial role of mask3D-induced imaging mechanisms in high- and hyper-NA EUV lithography: a study of the near- and far-field of the diffracted light**, Andreas Erdmann[1], Gerardo Bottiglieri[2], Peter Evanschitzky[1], Christian Schwemmer[1], Tim Brunner[2], Eelco van Setten[2], M.-Claire van Lare[2], Mark van de Kerkhof[2] ([1]Fraunhofer IISB, [2]ASML)

15:30 – 16:00: Coffee break

- 16:00 – 16:25: **Kinetic modeling of radical inhibition in tomographic volumetric 3D printing**, Quinten Thijssen, Antonio Jaén Ortega, Roniérik Pioli Vieira, Sandra Van Vlierberghe (Ghent University, Belgium)
- 16:25 – 16:50: **Recent computational advances in tomographic volumetric additive manufacturing**, Felix Wechsler, Viola Sgarminato, Christophe Moser (EPFL, Lausanne, Switzerland)
- 16:50 – 17:15: **Accelerating the characterization of nanostructures through novel forward simulations and neural network approaches**, Vinh-Binh Truong[1], Analia Fernandez Herrero[1], Philipp Hönicke[2], Victor Soltwisch[2] ([1]PTB, Germany, [2]HZB, Germany)

17:30: Poster session

- **Is it time to adopt the bright field mask in EUV?,** Shih-Hsiang Liu (ASML, Netherlands)
- **Mask optimization for BEUV lithography,** Ziqi Li[1,3], Lisong Dong[1], Xu Ma[2], Iacopo Mochi[3], Yasin Ekinci[3], and Yayi Wei[1] ([1]Chinese Academy of Sciences, China, [2]Beijing Institute of Technology, China, [3]PSI, Switzerland)
- **A Convolution-variation-separated rigorous formulation for mask3D and Hopkins imaging**, Song Zhang, David H. Wei (Quantica Computing LLC, USA)
- **Investigating anamorphic reduction options for Hyper-NA EUV**, Lin Han[1], Gerardo Bottiglieri[1], John McNamara[1], Michael Patra[2], Jan van Schoot[1] ([1]ASML, Netherlands, [2]Carl Zeiss SMT GmbH)
- **Full GPU implementation of RCWA with optimized eigenvalue problem for efficient simulation of curvilinear mask structures,** Peter Evanschitzky (Fraunhofer IISB, Germany)
- **Analytical waveguide model for EUV masks: insights and comparison with RCWA,** Varun Jadhav, Andreas Erdmann (Fraunhofer IISB, Germany)
- **Precompensation of spatiotemporal proximity effects in a multi-spot two-photon polymerisation process: digital modelling and experimental validation,** Joël Rovera (IMT Atlantique, France)
- **Modeling and simulation of mechanical effects in two-photon lithography,** Alap Mundayoor, Andreas Erdmann, and Valeriia Sedova (Fraunhofer IISB, Germany)

- **Modeling of two-photon lithography including oxygen diffusion using a generalized compact model,** Yuan Yu, Valeriia Sedova; Christian Schwemmer; Andreas Erdmann (Fraunhofer IISB, Germany)
- **Agnostic Compensation of periodic errors in position sensing,** Christian Schwemmer, Martin Jäntsch (Fraunhofer IISB, Germany)
- **Boosting light extraction from Si vacancy color centers in SiC,** Mostafa Kotkat, Christian Schwemmer, M.Scharin-Mehlmann, P.Berwian, A.Erdmann (Fraunhofer IISB, Germany)

18:30: Dinner

- 20:00 – 20:20: **20 years Fraunhofer Simulation Workshop**
- 20:20 – 21:10 pm: **Not so artificial intelligence: leveraging physics informed computation to understand stochastics and enable novel metrologies (keynote),** Patrick Naulleau (EUV Tech Inc. and Berkeley Lab, USA)

Friday, May 23

- 9:00 – 9:25: **An eigendecomposition-free RCWA implementation for high-performance parallel computing**, Frank van der Ceelen, Yifeng Shao, Wim Coene (TU Delft, Netherlands)
- 9:25 – 9:50: **Rigorous electromagnetic simulation for EUV lithography and CNN reproducing electromagnetic simulations**, Hiroyoshi Tanabe, Masayuki Shimoda and Atsushi Takahashi (Institute of Science Tokyo, Japan)
- 9:50 – 10:15: **Physics-informed deep learning for 3D modeling of light diffraction**, Vlad Medvedev, Andreas Erdmann, Andreas Rosskopf (Fraunhofer IISB, Germany)

10:15 – 10:45: Coffee break

- 10:45 – 11:10: **Multiphoton absorption polymerization: fundamentals, kinetics, and potential alternatives**, John T. Fourkas, John S. Petersen, Nicholas Fisher, Nikos Liaros, Mac Cohen, Sandra Gutierrez-Razo, Anders Dollard, and Julio Argueta (Univ. of Maryland, USA)
- 11:10 – 11:35: **Physics-based deep learning network for inverse lithography in two-photon polymerization**, Valeriia Sedova[1], Thomas Le Deun[2], Joël Rovera[2], Jonas Wiedenmann[3], Kevin Heggarty[2], Andreas Erdmann[1] ([1]Fraunhofer IISB, Germany, [2]IMT Atlantique, France, [3]Heidelberg Instruments Mikrotechnik GmbH, Germany)
- 11:35 – 12:00: **A machine learning approach to structure precompensation in 3D µ-printing,** Sven Enns, Nicholas Lang, Julian Hering-Stratemeier, Georg von Freymann (RPTU Kaiserslautern, Fraunhofer ITWM, Germany)

12:00: Lunch

- 13:30 – 13:55: **EUV diffraction orders and absorber dielectric index: comparison of analytical and simulation approach,** Martin Burkhardt, Rajiv Sejpal (IBM Research, USA)
- 13:55 – 14:20: **Mask absorber impact on local MEEF for pitch 32 nm hexagonal contact hole printing with low-n EUV masks**, Andreas Frommhold, Vicky Philipsen (imec, Belgium)
- 14:20 – 14:45: **High NA stitching: model and OPC assessment by using low-n mask**, Dongbo Xu[1], Qinglin Zeng[1], Xuefeng Zeng[1], Werner Gillijns[2], Shibing Wang[1], Germain Fenger[1] ([1]Siemens EDA, Belgium, [2]imec, Belgium)
- 14:45 – 15:10: **Efficient aerial image simulations of rotated 1D patterns in anamorphic systems for lens aberration reconstruction from in-resist measurements**, Bas van Meerten, Dennis Stoel, Hilbert van Loo, Laurens de Winter (ASML, Netherlands)

15:30 pm: Special event and dinner

Saturday, May 24

- 9:00 – 9:25: **Modeling and characterization of EUV resists**, Takahiro Kozawa (SANKEN, Osaka University, Japan)
- 9:25 – 9:50: **Multi-trigger resists: Modeling and simulation results**, Thiago J. dos Santos[1], Andreas Erdmann[1], Alex P. G. Robinson[2,3], Alexandra McClelland[2], Carmen Popescu[2], Bernardo Oyarzún[4], Joost van Bree[4], and Mark van de Kerkhof[4] ([1]Fraunhofer IISB, Germany, [2]Irresistible Materials, UK, [3]University of Birmingham, UK, [4]ASML, Netherlands)
- 9:50 – 10:15: **Tuning resist profile and pattern variability with depth of focus and absorption**, Christoph Hauenstein[1], Bernardo Oyarzun Rivera[1], Luc van Kessel[1], Joost van Bree[1], Ruben Maas[1], Vincent Renaud[2], Tatiana Kovalevich[2], Bhavishya Chowrira[2] ([1]ASML, Netherlands, [2]IMEC, Belgium)

10:15 – 10:45: Coffee break

- 10:45 – 11:10: **Inverse mask design for displacement Talbot lithography,** Zhixin Wang, Stefan Rietmann, Li Wang, Harun H. Solak (Eulitha, Switzerland)
- 11:10 – 11:35: **From physics-based optimization to augmented deep learning optimization in grayscale photolithography mask**, Merlin Moreau, Jean-Baptiste Henry, Stéphane Bonnet (Univ. Grenoble Alpes, CEA, Leti, France)
- 11:35 – 12:00: **Modeling spectral behavior of grayscale lithography for broadband imaging and display**, Aamod Shanker[1,2], Arka Majumdar[1], Diogo Aguiam[2] ([1]University of Washington, USA , [2]Iberian Nanotechnology Laboratory, Portugal)
- 12:00 – 12:10: **Concluding remarks**

12:30: Lunch