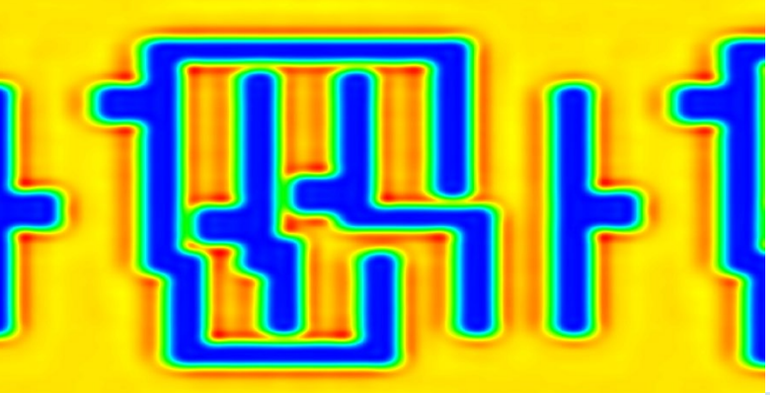

AGENDA

The workshop brings together experts from various fields of lithography simulation.

It provides an excellent opportunity to exchange ideas and discuss results and developments in:

- Computational EUV lithography: 3D mask, high NA and stochastic effects, resolution enhancement techniques, novel resist materials and phenomena
- Computational metrology and imaging for lithography: Deep learning and related techniques, mask characterization, hybrid optical models, SEM modeling, big data and novel methods for process characterization
- Modeling challenges and solutions for lithography applications beyond CMOS: 3D lithography and gray tone techniques for micro- and nanooptics, Si-photonics, bio-sensing, MEMS, ...

DIRECTIONS AND CONTACT

ADDRESS

Behringers Freizeit- und Tagungshotel
Behringersmühle 23, 91327 Gößweinstein, Germany

phone +49 9242 740030
www.tagungshotel-behringers.de

If you arrive by car:

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phone: +49 9131 / 761 258
lithography@iisb.fraunhofer.de
www.drlitho.com

REGISTRATION

www.litho-workshop.com

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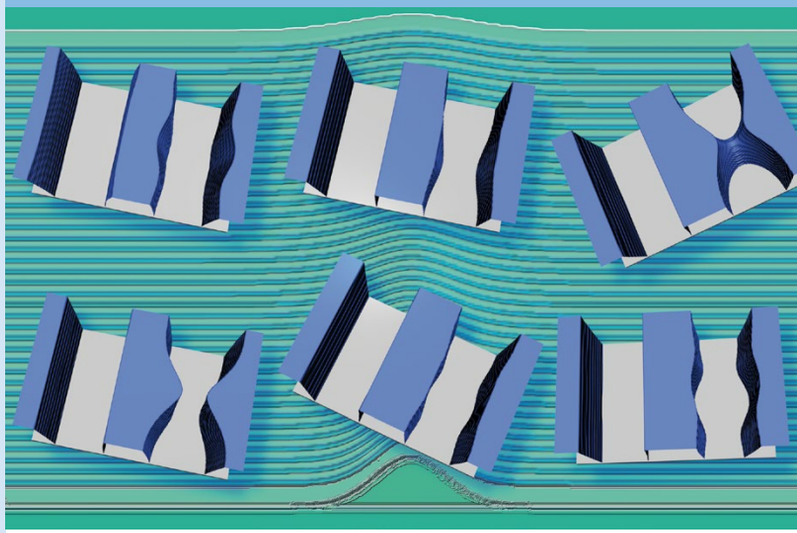
FRAUNHOFER INSTITUTE FOR
INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY

17th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 26 – 28, 2019, Behringersmühle, Germany



Lithography Simulation

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PROGRAM

Thursday, September 26

18:00 *Welcome reception*

20:00 – 20:15 **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

20:15 – 21:00 **A Rising Tide Lifts All Boats: Machine Learning in the Context of Photomask Production,** C. Utzny (AMTC)

Friday, September 27

09:00 – 09:25 **Developing Methods for Studying Ultrafast EUV Resist Kinetics for Improved Resist Modeling,** R. Fallica[1], I. Pollentier[1], P. Vanelderen[1], B. Peterson[2], P. van der Heide[1], J. Petersen[1] ([1]imec, [2]KMLabs)

09:25 – 09:50 **Pattern Formation Mechanisms of Metal Oxide Nanocluster EUV Resists,** T. Kozawa (Osaka University)

09:50 – 10:15 **Calibration Strategy of Physical Stochastic EUV Resist Models,** D. Ponomarenco, T. Mülders, U. Welling, J. Tang, H.-J. Stock (Synopsis)

10:15 – 10:45 Coffee break

10:45 – 11:10 **High NA EUV Lithography Simulation Using New Calibrated Mo/Si Multilayer Model,** M. Wu, I. Makhotkin, V, Philipsen (imec)

11:10 – 11:35 **Pathfinding the Perfect EUV Mask: The Role of the Multilayer,** H. Mesilhy[1], P. Evanschitzky[1], G. Bottiglieri[2], E. van Setten[2], T. Fliervoet[2], A. Erdmann[1] ([1]Fraunhofer IISB, [2]ASML)

11:35 – 12:00 **Extreme-Ultraviolet Refractive Optics,** O. Kornilov, L. Drescher, T. Witting, M. Vrakking, B. Schütte (Max-Born-Institut Berlin)

12:00 – 13:30 Lunch

13:30 – 13:55 **Computational Metrology: Challenges and Opportunities,** A. Fay[1], A. Forier[1], A. Girodon[1], J.-B. Henry[1], L. Perraud[1], P. Quéméré[1], S. Bérard-Bergery[1], C. Valade[2] ([1]Leti, [2]STMicroelectonics)

13:55 – 14:20 **EUVPtycho – Ptychography Reconstruction Using Distributed GPUs,** U. Locans, A. Dejkameh, Y. Ekinci, I. Mochi, R. Nebling (PSI)

14:20 – 14:50 Coffee break

14:50 – 15:15 **Deep Learning with Broad Applications in Lithography,** M. Pisarenco, S. Middlebrooks, M. Kooiman, C. Batistakis, T. Huisman (ASML)

15:15 – 15:40 **Mask Defect Assessment from SEM Images Aided by Deep Learning Methods,** P. Evanschitzky (Fraunhofer IISB)

16:00 Special event and dinner

Saturday, September 28

09:00 – 09:25 **First Principle Based Physical Modeling of Photoresists,** G. Khaira, Y. Granik, A. Drutsa, G. Fenger, A. Kostas (Mentor Graphics)

09:25 – 09:50 **Simulation Study for Organometallic Resists for EUV Lithography,** Z. Belete[1, 2], A. Erdmann[1, 2], P. De Bisschop[3], U. Welling[4] ([1]Fraunhofer IISB, [2]FAU Erlangen-Nürnberg, [3]imec, [4]Synopsys)

09:50 – 10:15 **Mask Simulation Impact on Wafer Pattern Stochastic Patterning Predictions,** D. Dunn[1], S. Sieg[1], L. Melvin[2], K. Hooker[2], M. Ramadan[3], M. Green[3] ([1]IBM, [2]Synopsys, [3]Photronics)

10:15 – 10:45 Coffee break

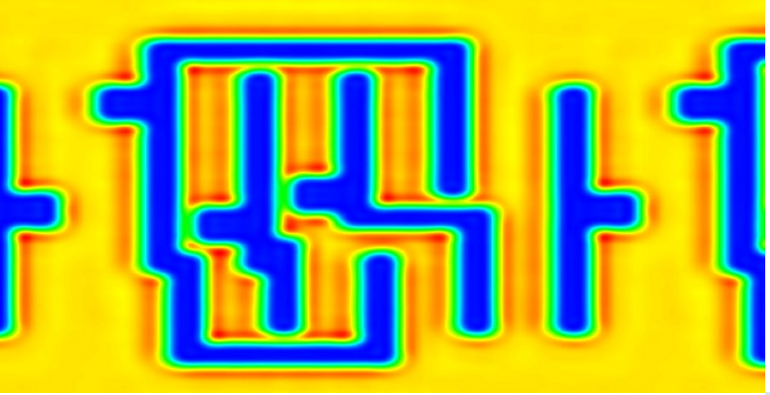
10:45 – 11:10 **Investigating the Lithographic Effects of Particles on High NA EUV Mask Pellicle,** L. Devaraj[1], G. Bottiglieri[1], A. Erdmann[2], F. Wählisch[1], M. Kupers[1], E. van Setten[1], T. Fliervoet[1] ([1]ASML, [2]Fraunhofer IISB)

11:10 – 11:35 **Critical Pattern Behavior at Nanometer Scale Vicinity of Etched Black Border,** T. Kovalevich[1], J. Bekaert[1], V. Wiaux[1], M.-C. Tien[2], N. Davydova[3] ([1]imec, [2]Brion, [3]ASML)

11:35 – 12:00 **Introducing Etch Kernels for Efficient Pattern Sampling and Etch Bias Prediction,** F. Weisbuch, A. Lutich, J. Schatz (Globalfoundries)

12:10 – 12:20 **Final discussion and concluding remarks**

12:30 Lunch



AGENDA

The workshop brings together experts from various fields of lithography simulation.

It provides an excellent opportunity to exchange ideas and discuss results and developments in:

- Computational EUV lithography: 3D mask, high NA and stochastic effects, resolution enhancement techniques, mask metrology
- Emerging computational techniques for lithography and imaging: Machine learning, deep learning, multi-objective optimization
- Modeling challenges and solutions for lithography applications beyond CMOS: Si-photonics, flat-panel displays, bio-sensing, MEMS, ...

DIRECTIONS AND CONTACT

ADDRESS

HOTEL SCHLOSSBERG
Haidhof 5, 91322 Gräfenberg, Germany

phone +49 9197 62 84 0
www.hotel-schlossberg.com

Arrival by car:
- Ask your navigation system

Public transport:
You have the following choices,
- take the train line R21 from Nuremberg station Nordost to Gräfenberg; hourly connection,
- take train or bus to Forchheim (Oberfranken) and Bus 223 to Gräfenberg; connection every 90 minutes.

Inform us about your approximate arrival time in Gräfenberg. We will organize shuttle service from the hotel.

If you require further information, please contact:
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Integrated Systems and Device Technology IISB
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REGISTRATION

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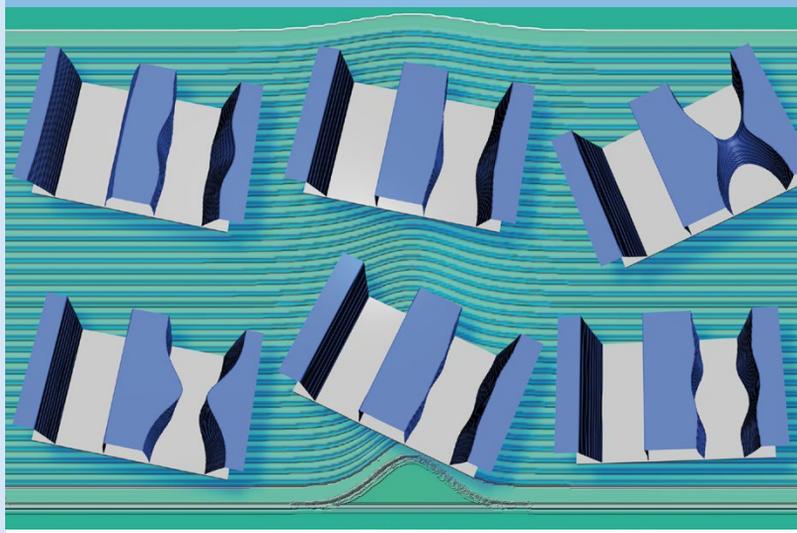
INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY

16th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 13 – 15, 2018, Gräfenberg, Germany



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PROGRAM

Thursday, September 13

12:30 *Welcome, lunch*

14:00 – 14:15 **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

14:15 – 15:00 **Logic technology scaling paradigm change – its impact on patterning and computational lithography,** R.H. Kim et al. (imec)

15:00 – 15:30 Coffee break

15:30 – 15:55 **High NA EUV lithography: The next step in EUV imaging,** E. van Setten[1], J. McNamara[1], J. van Schoot[1], G. Bottiglieri[1], K. Troost[1], T. Fliervoet[1], S. Hsu[2], J. Zimmermann[3], J.T. Neumann[3], M. Roesch[3], P. Graeupner[3] ([1]ASML Netherlands B.V., [2]ASML Brion, [3]Carl Zeiss SMT)

15:55 – 16:20 **EUV optics with flexible illumination for enhanced resolution,** J. Liddle et al. (Carl Zeiss SMT)

16:20 – 16:45 **3D mask effects in high NA EUV imaging,** A. Erdmann[1], P. Evanschitzky[1], G. Bottiglieri[2], E. van Setten[2], T. Fliervoet[2] (Fraunhofer IISB, ASML)

16:45 – 17:15 Coffee break

17:15 – 17:40 **Lithography simulation and OPC for photonic IC,** N. Uenal[1], U. Hofmann[1], J. Bolk[2] ([1]GenISys, [2]TU Eindhoven)

17:40 – 18:05 **3D shapes patterning with single optical lithography step: Application to the imagers case,** S. Bérard-Bergery[1], J. Hazart[1], P. Quéméré[1], P. Chevalier[2] et al. ([1]CEA LETI, [2]STMicroelectronics)

18:05 – 18:30 **Projection, ablation and printing through multimode fibres,** E. Kakkava, B. Rahmani, G. Konstantinou, D. Psaltis, C. Moser (EPFL Lausanne)

19:00 Conference reception

Friday, September 14

09:00 – 09:25 **Is the future of semiconductor metrology with short wavelengths?,** S. Danylyuk, L. Bahrenberg, P. Loosen (RWTH Aachen)

09:25 – 09:50 **Image recovery in lenless imaging of EUV reticles with broad band illumination employing state mixtures,** S. Fernandez, R. Rajeev, P. Helfenstein, I. Mochi, D. Kazazis, and Y. Ekinci (PSI)

9:50 – 10:15 **Spectrally resolved lensless imaging with table-top extreme-ultraviolet sources;** M. Jansen, A. de Beurs, X. Liu, K. Eikema, S. Witte (ARCNL)

10:15 – 10:45 Coffee break

10:45 – 11:10 **Simulating scattering of lamellar optical gratings with irregularities,** M. Heusinger[1], M. Banasch[2], D. Michaelis[3], T. Flügel-Paul[3], Uwe D. Zeitner[1,3] ([1]FSU Jena, IAP; [2]Vistec Electron Beam GmbH, [3]Fraunhofer IOF)

11:10 – 11:35 **Study of simulated EUV mask absorber thickness and sidewall variation impact on wafer pattern fidelity,** L.S. Melvin III[1], E. Gallagher[2], A. Frommhold[2], Y. Shusuke[3] et al. ([1]Synopsys, [2]imec, [3]NuFlare)

11:35 – 12:00 **Stochasticity in EUV lithography,** T. Kozawa[1], J.J. Santillan[2], T. Itani[2] ([1]Osaka Univ., [2]EIDEC)

12:00 – 13:30 Lunch

13:30 – 13:55 **A generalized framework for reconstructing low-resolution lithography images using Fourier ptychography and U-net convolutional network,** P. Govalkar[1], C. Syben[1], A. Erdmann[1,2], A. Maier[1] ([1]FAU Erlangen-Nuremberg, [2]Fraunhofer IISB)

13:55 – 14:20 **Ptychography with multiple wavelength illumination,** X. Wei, H.P. Urbach (TU Delft)

14:20 – 14:45 **Analysis of resist deformation and shrinkage during lithographic processing,** S. D'Silva[1], T. Mülders[2], H.J. Stock[2], A. Erdmann[1] ([1]Fraunhofer IISB, [2]Synopsys)

14:45 – 15:15 Coffee break

15:15 – 15:40 **New EUV mask absorbers,** V. Luong, V. Philipsen, E. Hendrickx (imec)

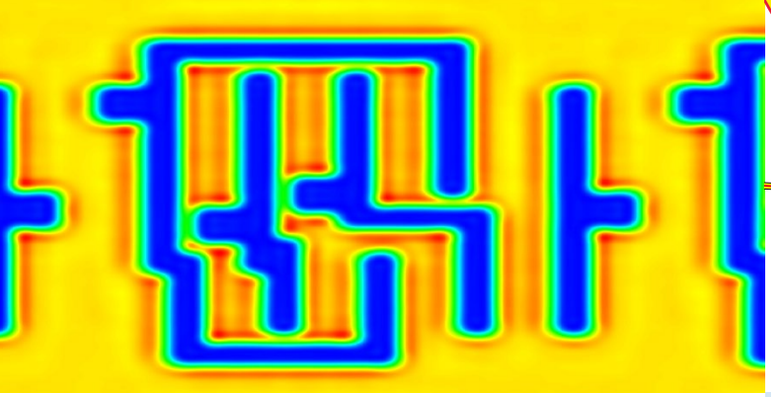
15:40 – 16:05 **Rigorous EUV SRAF optimization,** F. Lenahan[1], P. Evanschitzky[1], V. Philipsen[2], A. Erdmann[1] ([1]Fraunhofer IISB, [2]imec)

16:05 – 16:30 **Patterning analysis for 5nm and beyond employing virtual fabrication,** B. Vincent et al. (Coventor – A Lam Research Company)

17:00 Special event and dinner

Saturday, September 15

09:00 – 14:00 Litho hike ~ 10 km: Participation optional; risk, food and drink are on your own.
Don't forget walking shoes!



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- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

scatterometry mask defect inspection
interference lithography
high-NA EUV
new mask stacks
direct laser writing lithography
gray-tone lithography
3-D lithography GSAX
non-IC applications
EUV pellicle EUV DSA phase retrieval
ptychography stochastic effects
STED-inspired lithography
metrology for DSA

DIRECTIONS AND CONTACT

Address:

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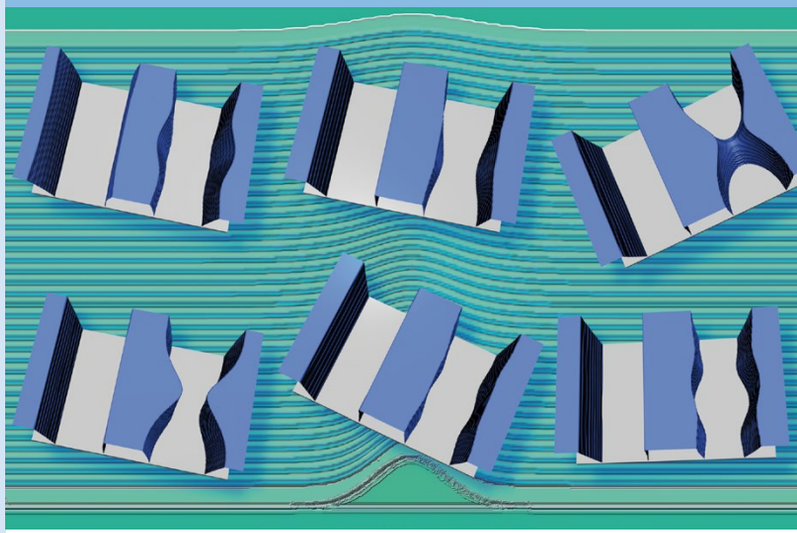
15th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 21 – 23, 2017, Behringersmühle, Germany



Lithography Simulation

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PROGRAM

Thursday, September 21

06:00 p.m. Welcome reception

08:00 – 08:15 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:15 – 09:00 p.m. **Computational microscopes for gigapixel 3D imaging and inspection,** R. Horstmeyer (Charite, Humboldt University Berlin)

Friday, September 22

09:00 – 09:25 a.m. **Latest developments in EUV optics,** J. Liddle, J. Zimmermann, J.T. Neumann, M. Roesch, R. Gehrke, P. Gräupner (Zeiss SMT)

09:25 – 09:50 a.m. **Exploration of nearfield scattering in an EUV lithography mask stack with a high numerical aperture systems,** Y. Kandel, L. S. Melvin III (Synopsys)

09:50 – 10:15 a.m. **Attenuated PSM for EUV: Will they fly?,** A. Erdmann[1], P. Evanschitzky[1], T. Fühner[1], V. Philipsen[2], E. Hendricx[2], M. Bauer[3] ([1]Fraunhofer IISB, [2]imec, [3]Zeiss SMS)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **SLM-based three-dimensional micro-printing,** F. E.H. Waller, J. Hering, C. Jörg, G. von Freymann (TU Kaiserslautern)

11:10 – 11:35 a.m. **3D direct laser writing of camera lenses on CMOS substrates,** S. Ristok, S. Thiele, T. Gissibl, A. Herkommer, H. Gießen (University of Stuttgart)

11:35 – 12:00 a.m. **Exploring 3D resist effects in e-beam and laser direct writing,** FC. Kaspar[1], T. Onanuga[2] ([1]IMS Chips, [2]Fraunhofer IISB)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **Impact of NXE3400 source on process window for 7 nm node,** Jae Uk Lee and Ryan Ryoung han Kim (imec)

01:55 – 02:20 p.m. **Application of SRAFs and source optimization for mitigation of mask3D effects in high-NA EUV lithography,** J. Lubkoll, E. van Setten, J. Finders, L. de Winter (ASML)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Simulation of metal resist used for extreme ultraviolet lithography,** T. Kozawa[1], J.J. Santillan[2], T. Itani[2] ([1]The Institute of Scientific and Industrial Research, Osaka University, [2]Evolving Nano-process Infrastructure Development Center, Inc. - EIDEC)

03:15 – 03:40 p.m. **Comparison of modeling options for NTD resist shrinkage,** S. D´Silva[1], T. Mulders[2], H.J. Stock[2], A. Erdmann[1] ([1]Fraunhofer IISB, [2]Synopsys)

04:00 p.m. Special event and dinner

Saturday, September 23

09:00 – 09:25 a.m. **A heuristic derivation of fundamental laws of optical lithography,** D. Peng (TSMC)

09:25 – 09:50 a.m. **Application of hyperbolic meta-material for waveguide engineering,** Ying Tang (TU Delft)

09:50 – 10:15 a.m. **Characterization of Talbot lithography based on self-imaging,** T. Sato, A. Yamada, T. Suto, R. Inanami, K. Matsuki, S. Ito (Toshiba)

10:15 – 10:45 a.m. Coffee break

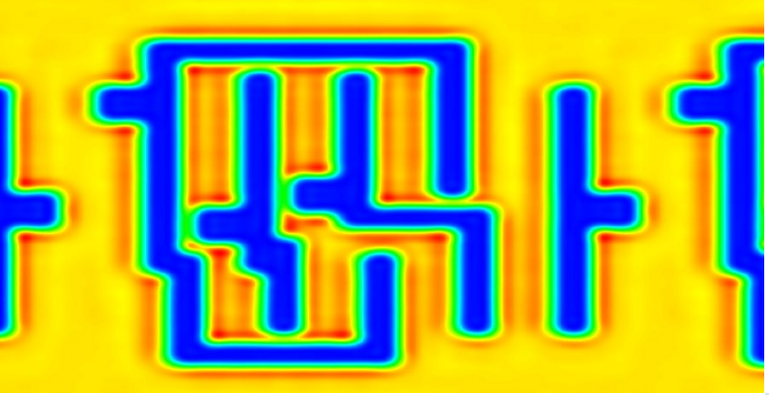
10:45 – 11:10 a.m. **Single exposure EUV block downscaling for metal pitches below 32nm,** J.H. Franke[1], P. Colsters[2], J. Bekaert[1], E. Hendrickx[1], F. Wittebrood[2], A. Pathak[1], G. Schiffelers[2] ([1]imec, [2]ASML)

11:10 – 11:35 a.m. **Actinic mask inspection with RESCAN - recent progress,** P. Helfenstein[1], I. Mochi[1], R. Rajeev[1], Y. Ekinci[1], S. Yoshitake[2] ([1]PSI, [2]NuFlare)

11:35 – 12:10 a.m. **High NA anamorphic EUV lithography: Scanner design and imaging performance from a different angle,** E. van Setten[1], G. Bottiglieri[1], L. de Winter[1], J. McNamara[1], P. Rusu[1], J. Lubkoll[1], G. Rispens[1], J. van Schoot[1], J.T. Neumann[2], M. Roesch[2], B. Kneer[2] ([1]ASML, [2]Zeiss SMT)

12:10 – 12:30 p.m. **Final discussion and concluding remarks**

12:30 p.m. Lunch



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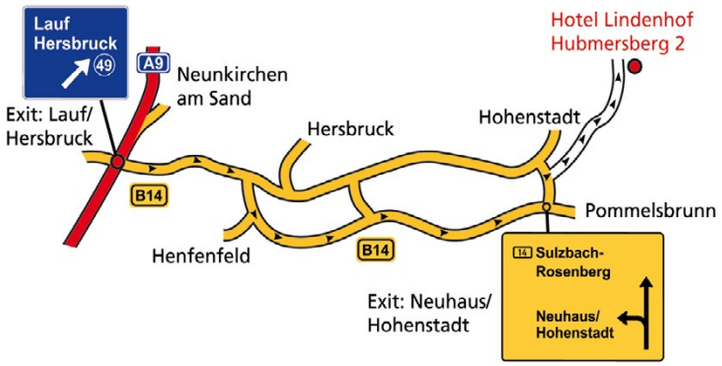
- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Computational resolution enhancements for lithography, microscopy and other imaging applications
- Modeling of material-driven resolution enhancements: directed self-assembly (DSA), multi-color lithography
- Computational challenges of EUV lithography: high NA, new mask stacks, stochastic effects
- Lithography applications beyond CMOS: Silicon-photonics, MEMS, flat panel displays, bio-sensing, …



DIRECTIONS AND CONTACT

Address:

Hotel Lindenhof
Hubmersberg 2, 91224 Pommelsbrunn, Germany

phone +49 9154 / 270 | fax +49 9154 / 273 70
www.tagungsoase.de

If you arrive by car:

Follow highway A9 (Munich–Nuremberg–Berlin), take the exit to Hersbruck / Sulzbach-Rosenberg, pass Hersbruck, follow the B14 and take the exit Neuhaus-Hohenstadt. After 500 m, turn right to Hubmersberg.

If you arrive by airplane or by train, or if you require further information, please contact:

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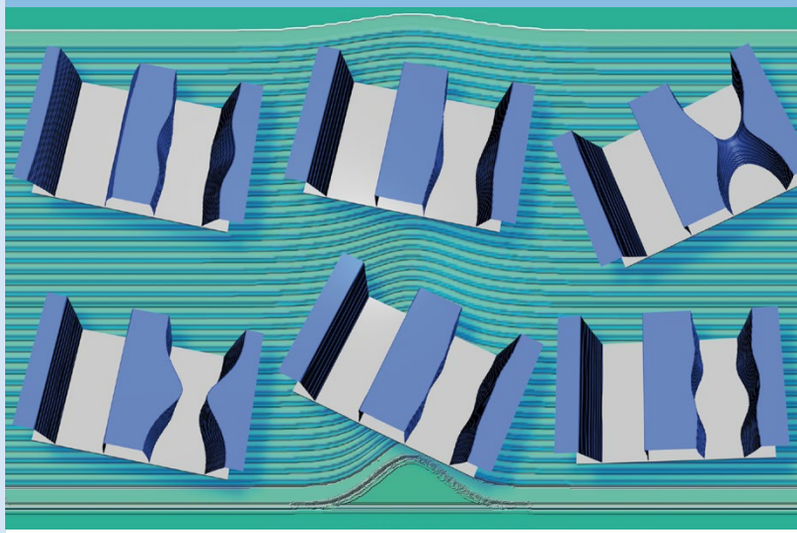
14th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 22 – 24, 2016, Hersbruck, Germany



Lithography Simulation

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PROGRAM

Thursday, September 22

06:00 p.m. *Welcome reception*

08:00 – 08:30 p.m. **Welcome and introduction,**
A. Erdmann (Fraunhofer IISB)

08:30 – 09:00 p.m. **Imaging at the 5 nm node,**
J. Finders (ASML)

Friday, September 23

09:00 – 09:25 a.m. **EUV mask modeling and material improvements for reducing M3D effects,**
V. Philipsen[1], V. Long[1], E. Hendrickx[1], A. Erdmann[2], P. Evanschitzky[2], D. Xu[2], C. Laubis[3], F. Scholze[3]
([1]imec, [2]Fraunhofer IISB, [3]PTB)

09:25 – 09:50 a.m. **Lensless imaging of EUV waveguides: Mode profiles and polarization dependence,**
S. Zayko, M. Sivis, T. Salditt, S. Schäfer, C. Ropers
(University of Göttingen)

09:50 – 10:15 a.m. **Challenges in EUV modeling for OPC simulations due to exposure field dependent effects,**
K. Adam, M. Lam, G. Fenger (Mentor Graphics)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Challenges in sub-10 nm fabrication using EUV lithography,**
T. Kozawa[1], J.J. Santillan[2], T. Itani[2]
([1]Osaka Univ., [2]EIDEC)

11:10 – 11:35 a.m. **Bright field vs. dark field imaging in EUV at N7 pitches and beyond,**
J.-H. Franke[1], J. Bekaert[1], E. Gallagher[1], E. Hendrickx[1], P. Colsters[2], F. Wittebrood[2], G. Schiffelers[2], M. Dusa[2], J. van Dijk[2] ([1]imec, [2]ASML)

11:35 – 12:00 a.m. **Optical systems with freeform surfaces – challenges in simulation and realization,**
H. Gross, A. Brömel, J. Stock (FSU Jena)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **Scanning coherent diffraction microscopy for EUV photomask metrology,**
P. Helfenstein, I. Mohacsi, Y. Ekinici
(Paul Scherrer Institute)

01:55 – 02:20 p.m. **Variations of ptychographic phase retrieval algorithms,**
S. Konijnenberg[1], W. Coene[1,2], S. Pereira[1], P. Urbach[1]
([1]TU Delft, [2]ASML)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Comparison of the Cahn-Hillard equation and direct minimization of the free energy functional for the simulation of directed self-assembly,**
B. Meliorisz, T. Mülders, H.-J. Stock, W. Gao (Synopsys)

03:15 – 03:40 p.m. **Automated source/mask/directed self-assembly optimization using a self-adaptive hierarchical modeling approach,**
T. Fühner (Fraunhofer IISB)

04:00 p.m. Special event and dinner

Saturday, September 24

09:00 – 09:25 a.m. **Shaping wavefronts with spatial light modulators,**
A. Jesacher (Innsbruck Medical University, SAOT)

09:25 – 09:50 a.m. **Flexible pattern generation with laser illumination for mask aligner lithography,**
T. Weichelt[1], U.D. Zeitner[1,2], Yannick Bourgin[1]
([1]FSU Jena, [2]Fraunhofer IOF)

09:50 – 10:15 a.m. **A physical model for laser direct write lithography,**
T. Onanuga (Fraunhofer IISB, SAOT)

10:15 – 10:45 a.m. Coffee break

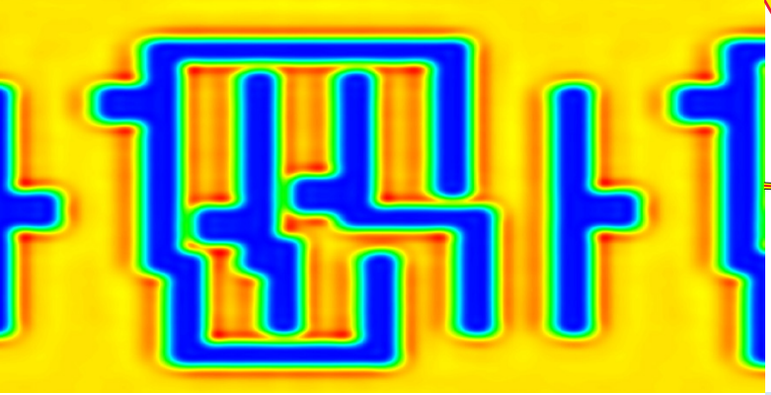
10:45 – 11:10 a.m. **Topology optimization projection methods for micro/nano lithography,**
B. Lazarov, M. Zhou, O. Sigmund
(Technical University of Denmark)

11:10 – 11:35 a.m. **A semi-analytical method for fast electromagnetic modeling in the EUV range,**
M. Pisarenco, R. Quintanilha, M.G. M. M. van Kraaij, W.M. J. Coene (ASML)

11:35 – 12:00 a.m. **Efficient simulation of EUV pellicles,**
P. Evanschitzky (Fraunhofer IISB)

12:00 – 12:20 p.m. **Final discussion and concluding remarks**

12:30 p.m. Lunch



AGENDA

The workshop brings together experts from various fields of lithography simulation.

It provides an excellent opportunity to exchange ideas and discuss results and developments in:

- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers and semiconductor manufacturing)

This year's workshop will focus on:

- Computational chemistry for material-driven resolution enhancements: directed self-assembly, multiple patterning and novel imaging materials
- Computational challenges of EUV lithography
- Computational optics for the creation and detection of micro- and nanopatterns: similarities and differences between resolution enhancements in lithography and microscopy

DIRECTIONS AND CONTACT

Address:

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www.tagungshotel-behringers.de

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FRAUNHOFER INSTITUTE FOR
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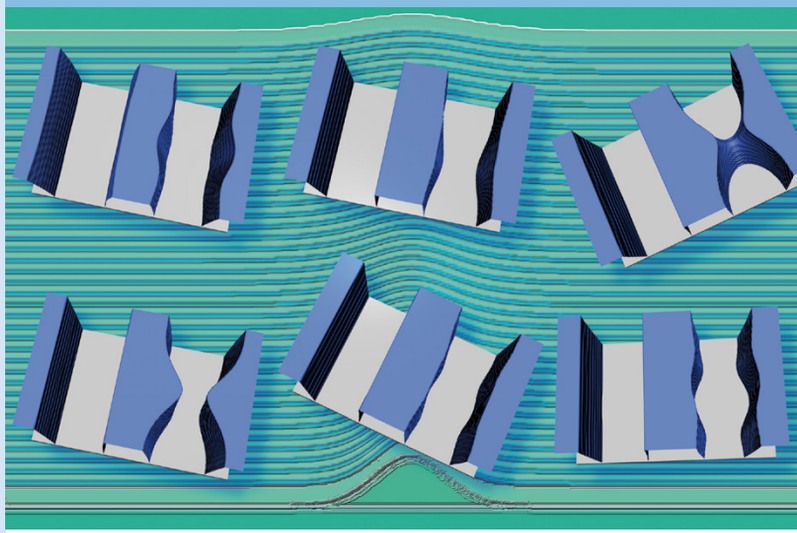
13th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 10 – 12, 2015, Behringersmühle, Germany



Lithography Simulation

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PROGRAM

Thursday, September 10

06:00 p.m. Welcome reception

08:00 – 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:30 – 09:00 p.m. **Predictive modeling of equilibrium and non-equilibrium block polymer directed assembly for sub-lithographic patterning,** J. de Pablo[1], P. Nealey[1], M. Müller[2] ([1]University of Chicago, [2]University of Göttingen)

Friday, September 11

09:00 – 09:25 a.m. **High-NA EUV lithography optics: The key to shrinking beyond 8 nm,** M. Rösch, J.T. Neumann, B. Kneer, P. Gräupner (Zeiss SMT)

09:25 – 09:50 a.m. **Mask topography-induced phase aberrations in EUVL: Impact, fundamental understanding, mitigation,** T. Last, L. de Winter, J. Finders (ASML)

09:50 – 10:15 a.m. **EUV challenges in N7 printability: Experiment vs. simulation,** V. Philipsen[1], V. Luong[1], I. Mochi[1], L. Van Look[1], E. Hendrickx[1], F. Wittebrood[2], G. Schiffelers[2], M. Dusa[2], T. Fliervoet[2] ([1]imec, [2]ASML)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Actinic characterization of EUV photomasks by EUV scatterometry,** F. Scholze[1], V. Soltwisch[1], A. Ullrich[2], V. Philipsen[3], S. Burger[4] ([1]PTB, [2]AMTC, [3]imec, [4]JCMwave)

11:10 – 11:35 a.m. **Understanding and modeling illumination systems in projection lithography,** D. Smith, D. Flagello, J. Sakamoto (Nikon Research Corporation of America)

11:35 – 12:00 a.m. **Using SEM contours to calibrate OPC models: Advantages and challenges,** F. Weisbuch, K. Jantzen (Globalfoundries)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **193i lithography for contact doubling with grapho-epitaxy DSA: A simulation study,** A. Fouquet[1], L. Perraud[1], S. Bérard-Bergery[1], A. Gharbi[1], P. Pimenta-Barros[1], R. Tiron[1], J. Hazart[1], V. Farys[2] ([1]CEA-LETI, [2]ST Microelectronics)

01:55 – 02:20 p.m. **A Hamiltonian model application for full chip directed self-assembly (DSA) simulation,** G. Fenger, A. Torres, Y. Ma, Y. Granik, P. Krasnova, J. Mitra (Mentor Graphics)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Reduced models for DSA simulations,** U. Welling[1], W. Li[1], J.C. Orozco[1], P. Michalak[2], T. Fühner[2], A. Erdmann[2], M. Müller[1] ([1]University of Göttingen, [2]FhG IISB)

03:15 – 03:40 p.m. **Toward an integrated lithography/DSA modeling platform,** T. Fühner[1], P. Michalak[1], U. Welling[2], W. Li[2], J.C. Orozco[2], M. Müller[2], A. Erdmann[1] ([1]FhG IISB, [2]University of Göttingen)

04:00 p.m. Special event and dinner

Saturday, September 12

09:00 – 09:25 a.m. **Shot noise effects in extreme ultraviolet lithography,** T. Kozawa[1], J.J. Santillan[2], T. Itani[2] ([1]Osaka University, [2]EIDEC)

09:25 – 09:50 a.m. **Radially polarized light for detection and nanolocalization of dielectric particles on a planar substrate,** S. Roy, K. Ushakova, Q. van den Berg, S.F. Pereira, H.P. Urbach (TU Delft)

09:50 – 10:15 a.m. **Detection of sub-lambda asymmetries using phase only structured illumination,** S. Peterhänsel, M.L. Gödecke, K. Frenner, W. Osten (University of Stuttgart)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Angular dependent scattering of extreme ultraviolet phase and amplitude multilayer defects in an actinic defect inspection,** L. Bahrenberg[1], S. Herbert[1], S. Danylyuk[1], J. Tempeler[1], A. Maryasov[1], R. Lebert[2], P. Loosen[1], L. Juschkin[1] ([1]RWTH Aachen, [2]RI Research Instruments GmbH)

11:10 – 11:35 a.m. **EUV multilayer defect parameter retrieval for patterned masks,** D. Xu (FhG IISB)

11:35 – 12:00 a.m. **Methods to determine the optimal shift of pattern shifting for mitigation of mask defects in EUV lithography,** S. Li, X. Wang, X. Liu, H. Zhang, F. Dai, C. Yang (SIOM)

12:00 – 12:20 p.m. **Final discussion and concluding remarks**

12:30 p.m. Lunch

AGENDA

The workshop brings together experts from various fields of lithography simulation.

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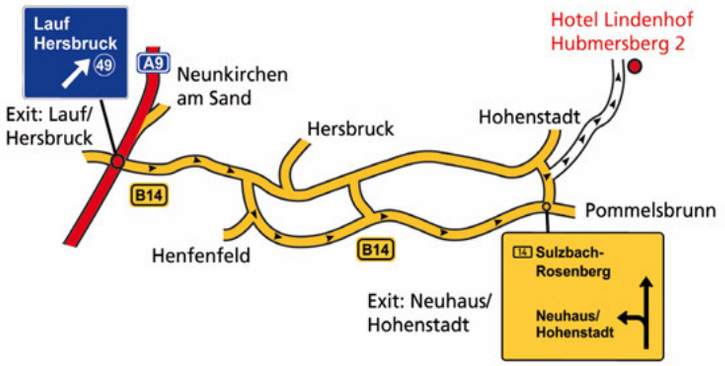
- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Material-driven versus wavelength-driven scaling: latest results from double patterning, directed self-assembly and EUV
- Combination of simulation and metrology: methods to retrieve modeling parameters from metrology, simulation-aided metrology
- Lithography applications beyond CMOS: 3-D nanoprinting, fabrication of photonic components, MEMS and more



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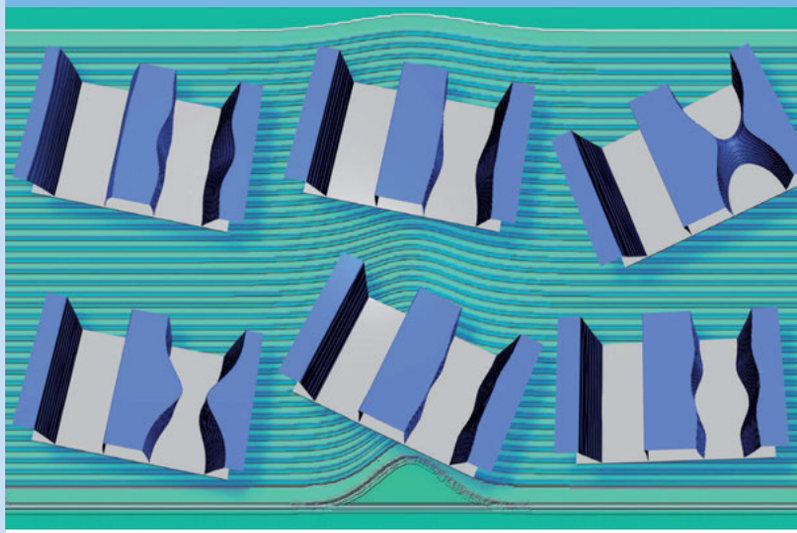
12th FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 11–13, 2014, Hersbruck, Germany



Lithography Simulation

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PROGRAM

Thursday, September 11

06:00 p.m. *Welcome reception*

08:00 – 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:30 – 09:00 p.m. **High NA – the extension path of EUV lithography,** J.T. Neumann (Zeiss SMT)

Friday, September 12

09:00 – 09:25 a.m. **Evaluation of EUV shadowing models across slit position,** M. Lam, C. Clifford, G. Fenger (Mentor Graphics)

09:25 – 09:50 a.m. **Capabilities of next generation EUV illumination system 3400,** A. Keckeisen (Zeiss SMT)

09:50 – 10:15 a.m. **Mask-induced phase effects in EUV and DUV,** A. Erdmann[1], P. Evanschitzky[1], J.T. Neumann[2], P. Gräupner[2] ([1]Fraunhofer IISB, [2]Zeiss SMT)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Periodic phase masks for high resolution proximity lithography,** L. Stürzebecher, F. Fuchs, T. Harzendorf, U. D. Zeitner (Fraunhofer IOF)

11:10 – 11:35 a.m. **Process window optimization for mask aligner proximity lithography,** U. Vogler[1], A. Bramati[1], R. Völkel[1], D. Nguyen[1], J. Brugger[1], A. Voigt[2], G. Grützner[2], A. Erdmann[3], N. Ünal[4], U. Hofmann[4] ([1]Süss Microoptics, [2]Microresist Technology, [3]Fraunhofer IISB, [4]GenISys GmbH)

11:35 – 12:00 a.m. **Displacement Talbot lithography using phase-shift masks,** H. Solak, F. Clube, C. Dais, L. Wang (Eulitha)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **OPW limiting mechanisms of M1 printability performance for random-logic applications with 193i,** J. Mailfert, P. De Bisschop, K. De Meyer (IMEC)

01:55 – 02:20 p.m. **Application of basis functions to robust and efficient lithography optimization,** X. Wu[1], S. Liu[2], W. Lv[1], E. Y. Lam[1] ([1]Hongkong University, [2]Huazhong University)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Theoretical study on stochastic effects in chemically amplified resist process for extreme ultraviolet lithography,** T. Takahiro Kozawa[1], J.J. Santillan[2], T. Itani[2] ([1]Osaka University, [2]EIDEC)

03:15 – 03:40 p.m. **Stochastic modeling via SEM emulator and PSD analysis,** A. Vaglio Pret, C. Fang, M.D. Smith, J.J. Biafore, S. Robertson (KLA-Tencor)

04:00 p.m. Special event and dinner

Saturday, September 13

09:00 – 09:25 a.m. **Defocus based phase imaging for quantifying electromagnetic edge effects in photomasks,** A. Shanker[1], M. Sczyrba[2], B. Connolly[3], A. Neureuther[1], L. Waller[1] ([1]UC Berkeley, [2]AMTC, [3]Toppan)

09:25 – 09:50 a.m. **Mask defect parameter retrieval based on high-NA optical projection images,** D. Xu (Fraunhofer IISB)

09:50 – 10:15 a.m. **Method to retrieve aberration of an optics from measured vectorial aerial images,** Y. Li, L. Dong, K. Liu, X. Guo (Beijing Institute of Technology)

10:15 – 10:40 a.m. **Demonstration of aberration retrieval by using extended Nijboer-Zernike theory,** Y. Shao, A. Polo, S.F. Pereira, H.P. Urbach (TU Delft)

10:40 – 11:10 a.m. Coffee break

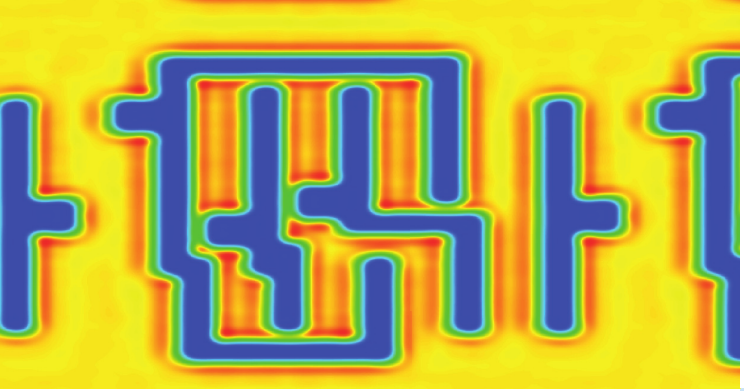
11:10 – 11:35 a.m. **Defect removal of block-copolymers on patterned surfaces,** W. Li[1], U. Welling[1], J. Orozco[1], M. Müller[1], P. Michalak[2], T. Fühner[2], A. Erdmann[2] ([1]Univ. of Göttingen, [2]Fraunhofer IISB)

11:35 – 12:00 a.m. **Validation of reduced models for DSA by coarse grained simulations,** P. Michalak[1], T. Fühner[1], A. Erdmann[1], W. Li[2], J. Orozco[2], U. Welling[2], M. Müller[2] ([1]Fraunhofer IISB, [2]Univ. of Göttingen)

12:00 – 12:25 p.m. **Multi-color lithography asessment by simulation,** J.S. Petersen[1], J.T. Fourkas[2], C.A. Mack[3], D.A. Markle[1] ([1]Periodic Structures, [2]Univ. of Maryland, [3]lithoguro.com)

12:25 – 12:45 p.m. **Final discussion and concluding remarks**

12:45 – 01:45 p.m. Lunch



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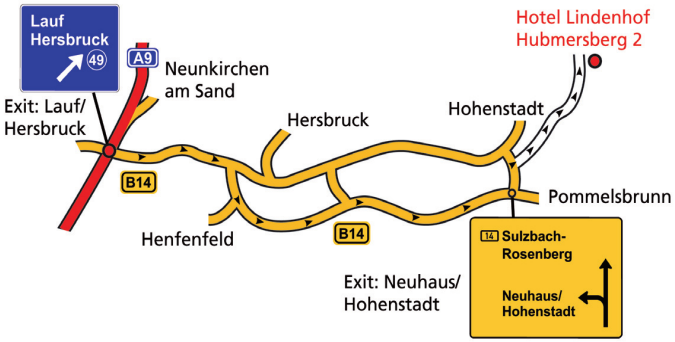
- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Mask modeling and optimization for EUV and optical lithography: accuracy versus performance, integration into OPC, exploration of new mask concepts.
- Lithography materials and processes: Will they kill or save us? From line edge roughness and pattern collapse to multiple patterning and directed self-assembly.
- Computational lithography for inverse problems: new developments in source mask optimization, defect and aberration retrieval, resist model parameter calibration.



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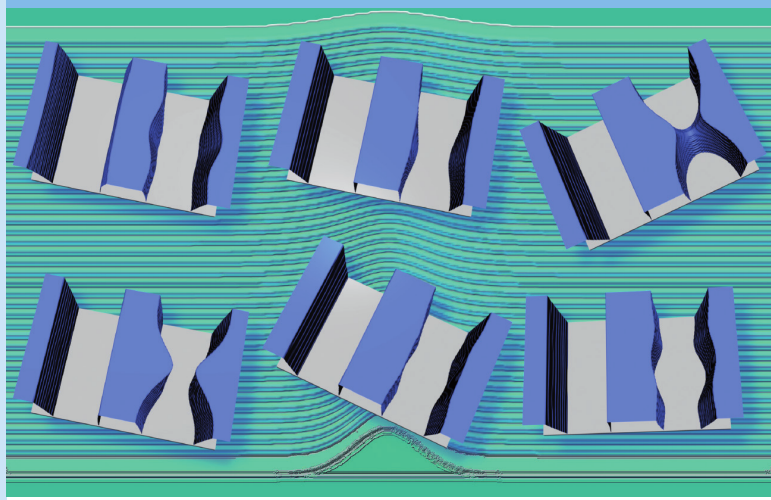
11TH FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 26–28, 2013, Hersbruck, Germany



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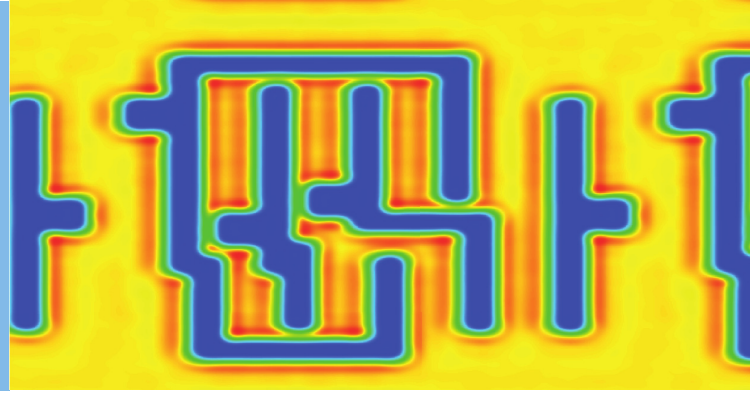


Thursday, September 26

06:00 p.m. Welcome reception

08:00 – 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:30 – 09:15 p.m. **Evolution of modeling in OPC: Modeling complex physical phenomena at large scale and keeping up with ever tighter accuracy requirements,** K. Adam, Y. Granik, M. Lam, N. Cobb (Mentor Graphics)

Friday, September 27

09:00 – 09:25 a.m. **High NA Chapter II – The Journey into EUV Land,** D. Flagello (Nikon)

09:25 – 09:50 a.m. **Modeling and optimization of EUV-masks for future technology generations,** A. Erdmann[1], T. Fühner[1], K. Motzek[1], J.T. Neumann[2], P. Gräupner[2] ([1]Fraunhofer IISB, [2]Zeiss SMT)

09:00 – 09:25 a.m. **Assessing native defect printability and repair on EUV lithographic masks,** U. Okoroanyanwu[1], P. Mangat[1], P. Nesladek[2], X. Zhu[1], T. Bret[3], T. Wallow[1], O. Wood[1], L. Sun[1], K. Goldberg[4], R. Ghaskadev[5] ([1]Globalfoundries, [2]AMTC, [3]Zeiss SMS, [4]Lawrence Berkeley Nat. Lab., [5]KLA Tencor)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Stochastic effects in chemically amplified resists,** T. Kozawa (Osaka University)

11:10 – 11:35 a.m. **Topographic and other Effects on DUV/EUV pattern fidelity,** C. Sarma (Sematech)

11:35 – 12:00 a.m. **Measurement and modeling of light scattering from optical components for lithographic systems,** S. Schröder, M. Trost, A. Duparré (Fraunhofer IOF)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **Simulation of EUV proximity printing and interference lithography with plasma–based laboratory EUV sources,** S. Danylyuk[1], P. Loosen[1], K. Bergmann[2], H. Kim[1], L. Juschkin[1] ([1]RWTH Aachen, [2]Fraunhofer ILT)

01:55 – 02:20 p.m. **Design and Source Shaping for micron–size lithography,** U. Hofmann[1], N. Ünal[1], M. Hennemeyer[2], R. Voelkel[3] ([1]GenISys GmbH, [2]SUSS MicroTec, [3]SUSS MicroOptics)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Physical DSA model based on Cahn–Hilliard equation for grapho–epitaxy applications,** S. Moulis[1], R. Orobtchou[2], A. Gharbi[3], M. Argoud[3], X. Chevalier[4], R. Tiron[3], J. Belledent[3], V. Farys[1] ([1]STMicroelectronics, [2]INL, [3]LETI, [4]Arkema)

03:15 – 03:40 p.m. **Modeling the directed assembly of copolymer materials: a coarse–grained approach,** M. Müller, U. Welling (Uni Göttingen)

04:00 p.m. Special event and dinner

Saturday, September 28

09:00 – 09:25 a.m. **Adaptive optics by phase retrieval algorithm with minimum number of defocused intensity measurements,** A. Polo, S.F. Pereira, H.P. Urbach (TU Delft)

09:25 – 09:50 a.m. **Source representation for SMO using genetic algorithm,** X. Wang, S. Li, C. Yang, G. Yan (SIOM)

09:50 – 10:15 a.m. **Efficient source and mask optimization with augmented Lagrangian methods in optical lithography,** J. Li, S. Liu, E.Y. Lam (Hongkong University)

10:15 – 10:45 a.m. Coffee break

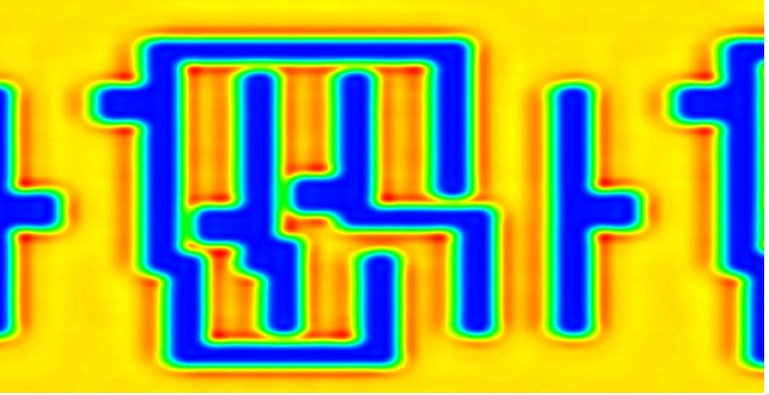
10:45 – 11:10 a.m. **20nm logic node computational lithography: From calibration to verification at Litho & Etch,** J. Mailfert, J. Van De Kerkhove, W. Gillijns, K. De Meyer, P. De Bisschop (IMEC)

11:10 – 11:35 a.m. **Overlay metrology for low–k1: Simulation challenges and solutions,** J.T. Neumann, P. Gräupner, B. Geh (Zeiss SMT)

11:35 – 12:00 a.m. **Double patterning-specific process variations and electrical performance of a 6T SRAM cell,** P. Evanschitzky (Fraunhofer IISB)

12:00 – 12:30 p.m. **Final discussions and concluding remarks**

12:30 p.m. Lunch



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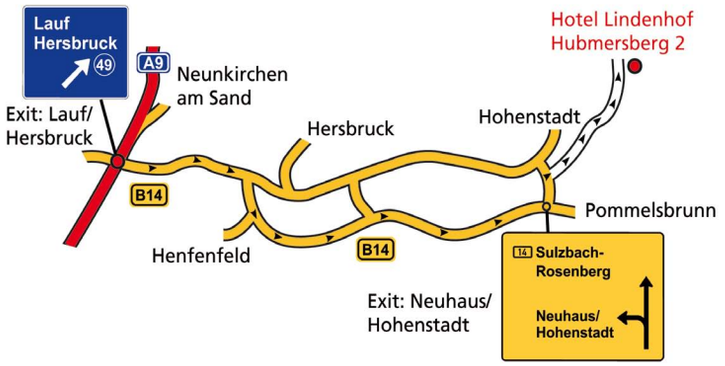
- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Modeling, characterization, and optimization of masks for optical and EUV lithography
- Requirements and use cases for future lithography simulation infrastructure
- Lithographic patterning for micro and nano optics
- Lithographic techniques for the fabrication of micro and nanooptical components



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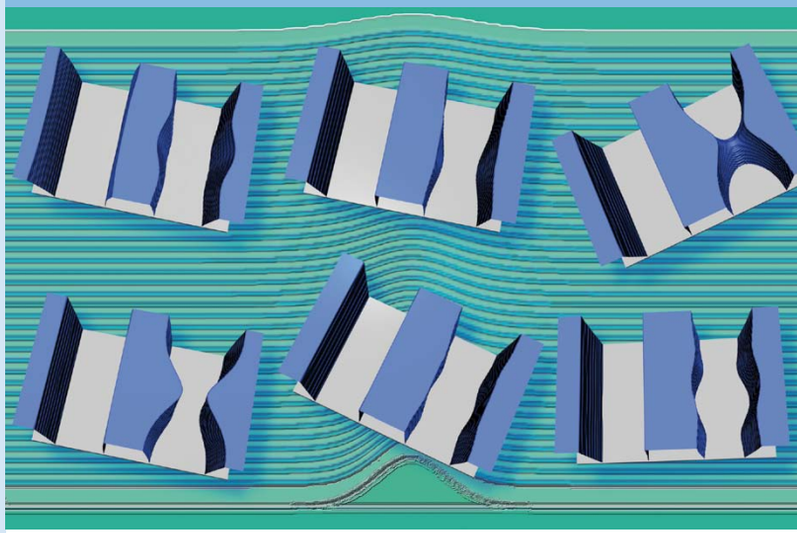
10TH FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 20–22, 2012, Hersbruck, Germany



Lithography Simulation

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PROGRAM

Thursday, September 20

06:00 p.m. *Welcome reception*

08:00 – 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:30 – 09:15 p.m. **Computational lithography for EverMoore,** V. Singh (Director Computational Lithography, Intel Corporation, USA)

Friday, September 21

09:00 – 09:25 a.m. **How to model imaging in EUV lithography,** P. Gräupner (Carl Zeiss SMT)

09:25 – 09:50 a.m. **Efficient simulation of EUV multilayer defects with a rigorous data base approach,** P. Evanschitzky (Fraunhofer IISB)

09:50 – 10:15 a.m. **Resist properties required for 6.67 nm extreme ultraviolet lithography,** T. Kozawa[1], A. Erdmann[2] ([1]Osaka University, Japan; [2]Fraunhofer IISB)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **New design methods for high-quality optical systems,** F. Bociort (TU Delft, Netherlands)

11:10 – 11:35 a.m. **Feature type dependent contrast limits of Focus Drilling for DoF enhancement in HR lithography,** C. Kohler, J. van Schaik (ASML, Netherlands)

11:35 – 12:00 a.m. **SMARTER microscopy: sparsity mediated algorithmic reconstruction technique for enhanced resolution,** A. Szameit[1], Y. Shechtman[1], E. Osherovich[2], E. Bullkich[1], P. Sidorenko[1], H. Dana[2], S. Steiner[1], E.-B. Kley[1], S. Gazit[1], S. Shoham[2], M. Zibulevsky[2], I. Yavneh[2], Y. C. Eldar[2], O. Cohen[2], M. Segev[1] ([1]University of Jena; [2]Technion Haifa, Israel)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **Challenges for e-Beam direct write proximity effect correction at the 28nm node,** C. Hohle, K.H. Choi, M. Freitag, M. Gutsch, K. Steidel, X. Thrun (Fraunhofer CNT)

01:55 – 02:20 p.m. **Enhanced model calibration for e-beam lithography: from pattern selection to parameter optimization,** P. Schiavone[1], T. Figueiro[1], M. Saib[1], J.H. Tortai[2], K. H. Choi[3],C. Hohle[3] ([1]Aselta Nanographics, France; [2]CNRS LTM France; [3]Fraunhofer CNT)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Computer simulation of directed self assembly, equilibrium and kinetics,** U. Welling, C. Daoulas, M. Müller (University of Göttingen)

03:15 – 03:40 p.m. **Kinetics of volume hologram formation in epoxy based photopolymers,** T. Sabel (TU Berlin)

04:00 p.m. Special event and dinner

Saturday, September 22

09:00 – 09:25 a.m. **Numerical calculation of LER scatter signatures in the presence of side-wall angle and roundings,** K. Frenner, B. Bilski, W. Osten (TU Stuttgart)

09:25 – 09:50 a.m. **Research on in-situ aberration measurement of lithographic projection lenses,** X. Wang, S. Li, L. Duan, J. Yang, and G. Yan (SIOM, China)

09:50 – 10:15 a.m. **White light Fourier scatterometry for sub-wavelength metrology,** V. Ferreras Paz, S. Peterhänsel, K. Frenner, W. Osten (TU Stuttgart)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Recent progress in fast rigorous electromagnetic modeling by the Generalized Source Method and perspectives for optical lithography,** A. Tishchenko (CNRS UMR, France)

11:10 – 11:35 a.m. **Application of an artificial neural network to a compact mask model optimization,** V. Agudelo-Moreno (Fraunhofer IISB)

11:35 – 12:00 a.m. **Rigorous real-time simulation of topographic masks effects,** J. Pomplun[1], J. Tyminski[2], L. Zschiedrich[1], S. Burger[1], F. Schmidt[1] ([1]JCMwave GmbH; [2]Nikon Research Corporation of America, USA)

12:00 – 12:30 p.m **Final discussions and concluding remarks**

12:30 p.m. Lunch

AGENDA

The workshop brings together experts from various fields of lithography simulation. It provides an excellent opportunity to exchange ideas and discuss results and developments in:

- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Modeling challenges of EUV lithography
- Photoresist modeling from sub-20-nm to 10-µm structures
- Lithographic patterning for micro- and nano-optics
- Modeling approaches to complement standard lithography simulation

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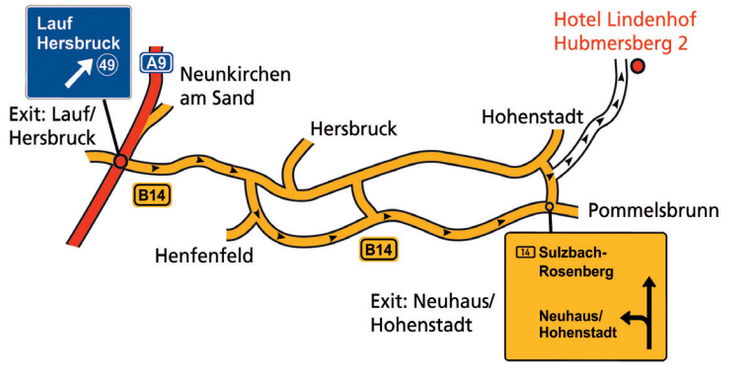

DIRECTIONS AND CONTACT

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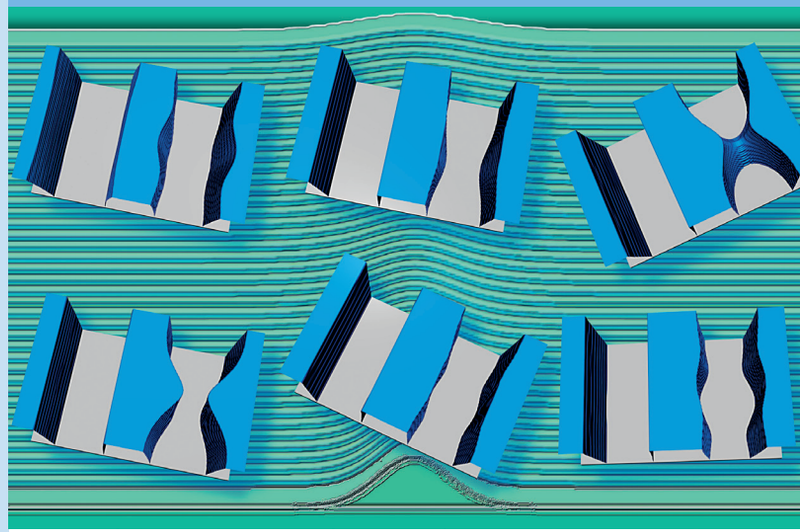
Fraunhofer IISB

FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY

9TH FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 15 – 17, 2011, Hersbruck, Germany



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PROGRAM

Thursday, September 15

06:00 p.m. Welcome reception

08:00 – 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB)

08:30 – 09:15 p.m. **3D direct laser writing: Optical lithography without limits?,** M. Wegener (Karlsruhe Institute of Technology)

Friday, September 16

09:00 – 09:25 a.m. **Extension of the domain decomposition method for modeling through-slit variations of mask shadowing,** K. Adam, M.C. Lam, M. Oliver, J. Word (Mentor Graphics, USA)

09:25 – 09:50 a.m. **Analytical model for EUV mask diffraction field calculation,** Y. Cao[1], X. Wang, P. Bu[1], Y. Bu[1], A. Erdmann[2] ([1]SIOM, China; [2]IISB)

09:50 – 10:15 a.m. **Exploration and understanding EUV multilayer defects by simulation,** A. Erdmann[1], P. Evanschitzky[1], T. Bret[2], R. Jonkheere[3] ([1]IISB; [2]Zeiss SMS; [3]IMEC, Belgium)

10:15 – 10:45 a.m. Coffee break

10:45 – 11:10 a.m. **Theoretical study of 11-nm-fabrication using 6.67-nm EUV lithography,** T. Kozawa[1], A. Erdmann[2] ([1]Osaka University, Japan; [2]IISB)

11:10 – 11:35 a.m. **Modeling photoresist development and optimizing resist profiles for mask aligner lithography,** K. Motzek[1], S. Partel[2] ([1]IISB; [2]FH Vorarlberg, Austria)

11:35 – 12:00 a.m. **Design and verification of a fast physical photoresist imaging and development model from an optical engineering perspective,** D. Flagello (Nikon Research Corporation of America, USA)

12:00 – 01:30 p.m. Lunch

01:30 – 01:55 p.m. **Alternative methods to determine the e-beam process proximity function,** R. Galler[1], D. Melzer[1], M. Krüger[1], M. Sülzle[1], U. Weidenmüller[2], L.E. Ramos[2] ([1]EQUIcon; [2]Vistec)

01:55 – 02:20 p.m. **Complementary e-beam lithography (CEBL) – The "dark zebra" in the sub-20 nm lithography race,** M.C. Smayling[1], D.K. Lam[2], David Liu[2] ([1]Tela Innovations, Inc., USA; [2]Multibeam Corporation, USA)

02:20 – 02:50 p.m. Coffee break

02:50 – 03:15 p.m. **Photonics on the move: Tunable micro-optics and micro-optical systems,** H. Zappe (IMTEK)

03:15 – 03:40 p.m. **Nano-optical devices generated by double patterning,** D. Lehr[1], T. Weber[1], K. Dietrich[1], T. Käsebier[1], S. Babin[2], E.B. Kley[1], A. Tünnermann[1] ([1]FSU Jena; [2]Abeam Technologies, USA)

04:00 p.m. Special event and dinner

Saturday, September 17

09:00 – 09:25 a.m. **Real-time inverse scatterometry with the reduced basis method,** J. Pomplun[1], B.H. Kleemann[2], J. Kurz[3], J. Hetzler[2], S. Burger[1,4], L. Zschiedrich[1], F. Schmidt[1,4] ([1]JCMWave; [2]Zeiss; [3]KIT; [4]Zuse-Institut)

09:25 – 09:50 a.m. **Mask model optimization in spatial and frequency domains: Enhancement of the scalar model to retrieve EMF effects,** V. Agudelo (IISB)

09:50 – 10:15 a.m. **Simulations in nano-optics: Better description of nanostructures permittivities and optimization of resonant properties of metallic nanoparticles**, A. Vial, D. Macias (CNRS, Troyes, France)

10:15 – 10:45 a.m. Coffee break

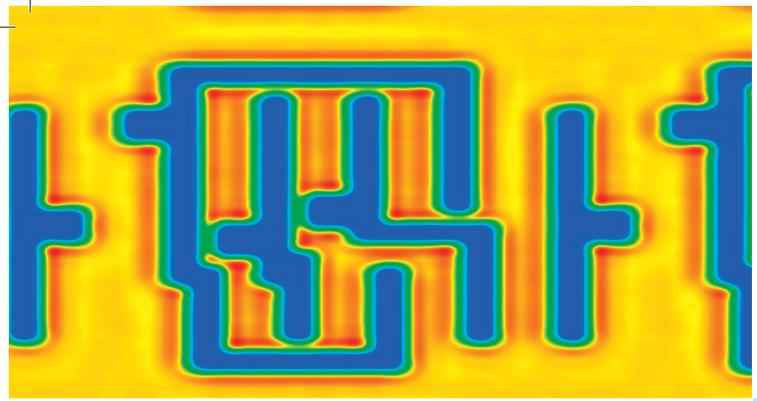
10:45 – 11:10 a.m. **How to make radially polarized light for higher resolution lithography,** P. Urbach (TU Delft, Netherlands)

11:10 – 11:35 a.m. **Modeling and analysis of diffraction effects at lens surface errors with high spatial frequencies in lithographic inspection systems**, H. Schweitzer[1], F. Wyrowski[2] ([1]LightTrans; [2]FSU Jena)

11:35 – 12:00 a.m. **Alternative application of predictive image simulation: Speckle techniques for surface characterization,** P. Evanschitzky (IISB)

12:00 – 12:30 p.m **Final discussion and concluding remarks**

12:30 p.m. Lunch



AGENDA

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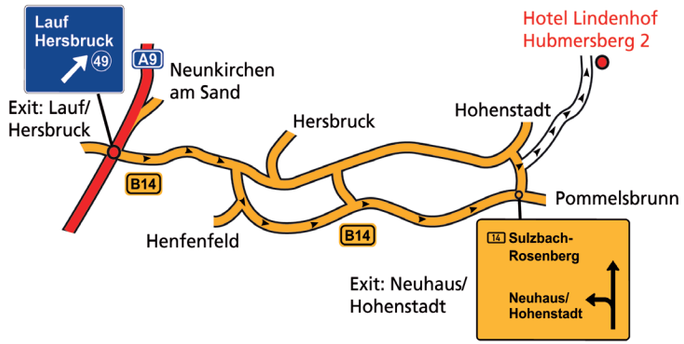
- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Modeling challenges of EUV lithography
- Advanced mask and image models for projection lithography
- Modeling and metrology for mask aligner lithography
- Pattern generation beyond standard thin film technology



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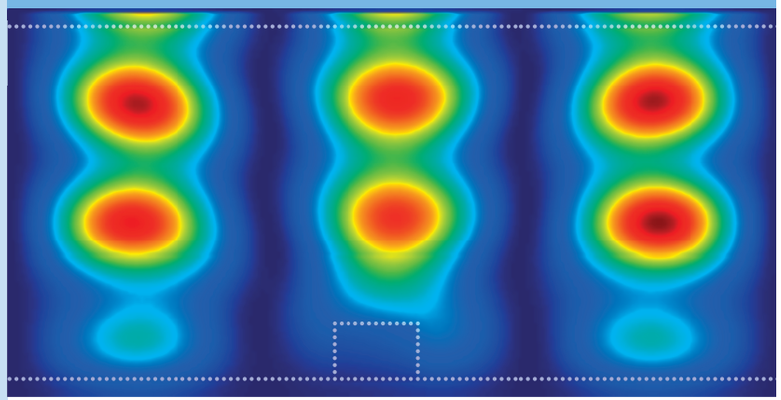
8TH FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 23 – 25, 2010, Hersbruck, Germany



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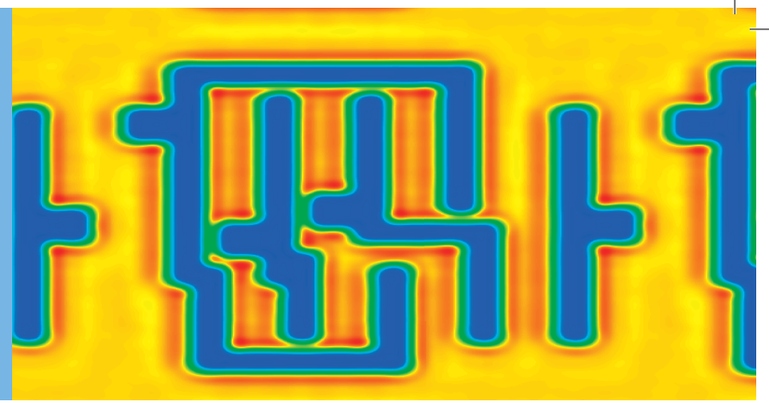


Thursday, September 23

06:00 p.m. Welcome reception

08:00 - 08:30 p.m. **Welcome and introduction,** A. Erdmann (Fraunhofer IISB, Germany)

08:30 - 09:15 p.m. **Simulating for food and the evolution of lithographic simulation,** D. Flagello (Nikon Research Corporation of America, USA)

Friday, September 24

09:00 - 09:25 a.m. **Resist parameter extraction from line and space patterns of chemically amplified resist for extreme ultraviolet lithography,** T. Kozawa[1], H. Oizumi[2], T. Itani[2], S. Tagawa[1] ([1]Osaka University, Japan, [2]Selete, Japan)

09:25 - 09:50 a.m. **Impact of mask topography and multilayer stack on high NA imaging of EUV masks,** J. Ruoff, R. Stützle (Carl Zeiss SMT, Germany)

09:50 - 10:15 a.m. **Prediction of the printing behavior of EUV multilayer defects using different simulation methods,** F. Shao, P. Evanschitzky, K. Motzek, A. Erdmann (Fraunhofer IISB, Germany)

10:15 - 10:45 a.m. Coffee break

10:45 - 11:10 a.m. **Adaptive optics and polarization in lithography,** P. Urbach (TU Delft, The Netherlands)

11:10 - 11:35 a.m **Kernel convolution for fast aerial image estimation,** M. Miller, K. Yamazoe, A. Neureuther (University of California Berkeley, USA)

11:35 - 12:00 a.m. **Compensation of mask-induced aberration focus shifts by projector wavefront control,** P. Evanschitzky, F. Shao, T. Fühner, A. Erdmann (Fraunhofer IISB, Germany)

12:00 - 01:30 p.m. Lunch

01:30 - 01:55 p.m. **Innovation in mask aligner lithography – MO exposure optics,** R. Voelkel[1], U. Vogler[1], M. Hornung[2] ([1]SUSS Microoptics, Switzerland, [2]SUSS Microtec, Germany)

01:55 - 02:20 p.m. **Sub-micrometer pattern generation by diffractive proximity lithography,** U.D. Zeitner, L. Stürzebecher, T. Harzendorf (Fraunhofer IOF, Germany)

02:20 - 02:45 p.m. **Optical proximity correction and source mask optimization for mask aligner lithography,** K. Motzek, A. Erdmann (Fraunhofer IISB, Germany)

02:45 - 03:15 p.m. Coffee break

03:15 - 03:40 p.m. **New extraction technique of the Dill parameters for thick resist,** S. Liu, G. Roeder, P. Evanschitzky, A. Erdmann (Fraunhofer IISB, Germany)

03:40 - 04:05 p.m. **A new flexible development rate monitor,** M. Mayer, S. Partel, R. Schneider, P. Hudek (FH Vorarlberg, Austria)

04:30 p.m. Special event and dinner

Saturday, September 25

09:00 - 09:25 a.m. **Structure origination by complex interference lithography processes,** M. Nitsche, M. Peters, O. Höhn, B. Bläsi (Fraunhofer ISE, Germany)

09:25 - 09:50 a.m. **Measuring amplitude and phase of light emerging from microstructures with the high resolution interference microscope,** T. Scharf, M. Kim, H.P. Herzig (EPFL Neuchatel, Switzerland)

09:50 - 10:15 a.m. **First steps towards traceability in scatterometry**, H. Groß, B. Bodermann, F. Scholze (PTB, Germany)

10:15 - 10:45 a.m. Coffee break

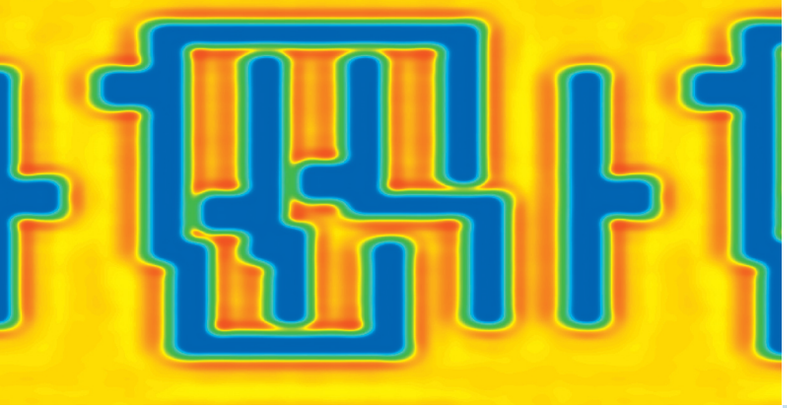
10:45 - 11:10 a.m. **Modal method based on spline expansion for electromagnetic modeling,** A.M. Armeanu[1,2], K. Edee[2], G. Granet[2], P. Schiavone[1] ([1]LTM/CNRS, France, [2]LASMEA Clermont-Ferrand, France)

11:10 - 11:35 a.m. **Mask models for the imaging of contact holes in optical projection lithography**, V. Agudelo, F. Shao, P. Evanschitzky, A. Erdmann (Fraunhofer IISB, Germany)

11:35 - 12:00 a.m. **From 2D lithography to 3D patterning,** H.W. van Zeijl, J. Wei, C. Shen, T.M. Verhaar, P.M. Sarro (TU Delft, The Netherlands)

12:00 - 12:30 p.m **Final discussion and concluding remarks**

12:30 p.m. Lunch



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- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

This year's workshop will focus on:

- Lithography below the Rayleigh limit: double exposure/patterning and other tricks
- Lithography at shorter wavelengths: physical effects and modeling approaches for EUV
- Modeling of lithographic fabrication methods for micro- and nanosystems
- Modeling approaches for advanced imaging materials

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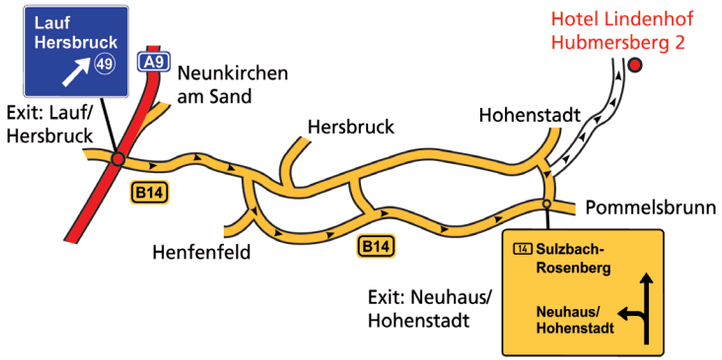

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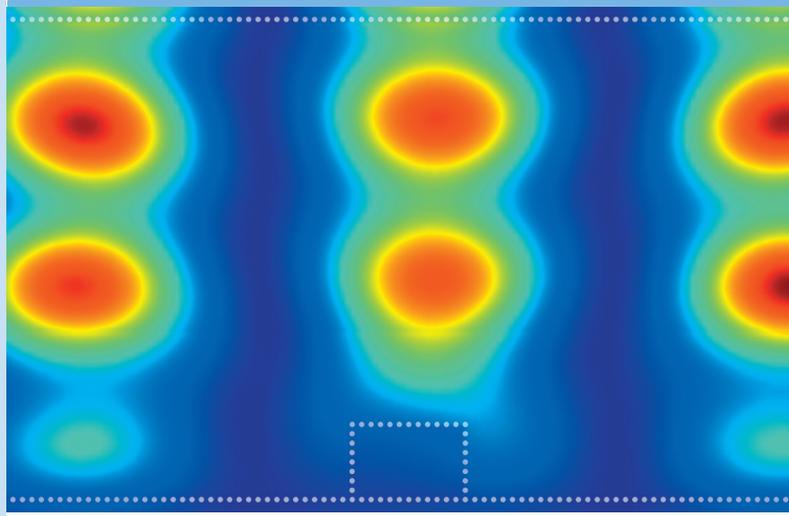
7TH FRAUNHOFER IISB LITHOGRAPHY SIMULATION WORKSHOP

September 25–27, 2009, Hersbruck, Germany



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PROGRAM

Friday, September 25

06:00 p.m. Welcome reception

08:00 - 08:30 p.m. **Welcome and introduction**, A. Erdmann (Fraunhofer IISB, Germany)

08:30 - 09:15 p.m. **Optical imaging using metamaterials**, E. Shamonina (University Erlangen-Nuremberg, Germany)

Saturday, September 26

09:00 - 09:25 a.m. **Wafer topography and multiple exposure effects in dual resist double patterning processes**, A. Erdmann, F. Shao, P. Evanschitzky, T. Fühner (Fraunhofer IISB, Germany)

09:25 - 09:50 a.m. **Modeling and simulation of post exposure bake processes in double patterning**, J. Fuhrmann[1], A. Fiebach[1], A. Erdmann[2] ([1]WIAS, Germany; [2]Fraunhofer IISB, Germany)

09:50 - 10:15 a.m. **Optimization of the field in focus for applications in imaging on polarization-sensitive media**, S.F. Pereira, H.P. Urbach (TU Delft, The Netherlands)

10:15 - 10:45 a.m. Coffee break

10:45 - 11:10 a.m. **Two photon polymerization – a versatile tool for nanotechnology**, G. von Freymann (Forschungszentrum Karlsruhe, Germany)

11:10 - 11:35 a.m. **Near-field lithography with noble metal nanostructures and photosensitive silanes**, M. Alvarez, A. Best, K. Koynov, J.M. Alonso, G. Rodriguez, A. del Campo, M. Kreiter (MPI for Polymer Research, Germany

11:35 – 12:00 a.m. **Near-field optical and interferometric methods for the fabrication of molecular nanostructures**, G. Leggett (University Sheffield, UK)

12:00 - 01:30 p.m Lunch

01:30 - 01:55 p.m. **EUV interference lithography at the limits of patterning with photons**, H. Solak, V. Auzelyte, A. Langner, Y. Ekinci, C. David, J. Gobrecht (Paul Scherrer Institute, Switzerland)

01:55 - 02:20 p.m. **Diffraction effects in an EUV interferometer**, M. Saib, M. Besacier, P. Michallon, C. Constancias (LTM/CNRS, France)

02:20 - 02:45 p.m. **Efficient analysis of threedimensional EUV mask-induced imaging artifacts using the waveguide decomposition method**, F. Shao, P. Evanschitzky, A. Erdmann (Fraunhofer IISB, Germany)

02:45 - 03:15 p.m. Coffee break

03:15 - 03:40 p.m. **Modeling and simulation of chemically amplified resists for EUV lithography**, T. Kozawa, S. Tagawa (Osaka University, Japan)

03:40 - 04:05 p.m. **Investigation of the E-beam resist FEP171 by modeling and experiments**, S. Ratzsch (University Jena, Germany)

04:30 p.m. Special event and dinner

Sunday, September 27

09:00 - 09:25 a.m. **Examination of Maxwell solver selection in deep sub-wavelength**, R.T. Greenway, J.S. Petersen (DFMSim, USA)

09:25 - 09:50 a.m. **Finite-Integration method for simulating optical waves in lithography masks**, Z. Rahimi[1], C. Pflaum[2], A. Erdmann[1] ([1]Fraunhofer IISB; [2]University Erlangen-Nuremberg, Germany)

09:50 - 10:15 a.m. **Diffraction of EUV radiation at EUV masks – experimental results and first interpretation**, F. Scholz (PTB, Germany)

10:15 - 10:40 a.m. **Simulation based sensitivity analysis and LER effects for future scaterrometry applications**, V. Ferreras-Paz, H. Gilbergs, T. Schuster, K. Frenner, W. Osten (University Stuttgart, Germany)

10:40 - 11:10 a.m. Coffee break

11:10 - 11:35 a.m. **Design and fabrication of structured thin films and multilayer gratings**, J. Shao (Shanghai Institute of Optics and Fine Mechanics, China)

11:35 – 12:00 a.m. **3D topography effects in mask aligner lithography**, B. Meliorisz[1], H. Lerch[2], D. Ritter[1] ([1]GenISys GmbH, Germany; [2]AMO GmbH, Germany)

12:00 - 12:25 p.m. **Optimizing illumination pupil and mask layout in mask aligner lithography**, K. Motzek, A. Erdmann (Fraunhofer IISB, Germany)

12:25 - 01:00 *p.m.* **Final discussion and concluding remarks**

01:00 p.m. Lunch

Organizational Information

Address of the institute:
Fraunhofer Institute of Integrated
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Schottkystrasse 10
91058 Erlangen, Germany

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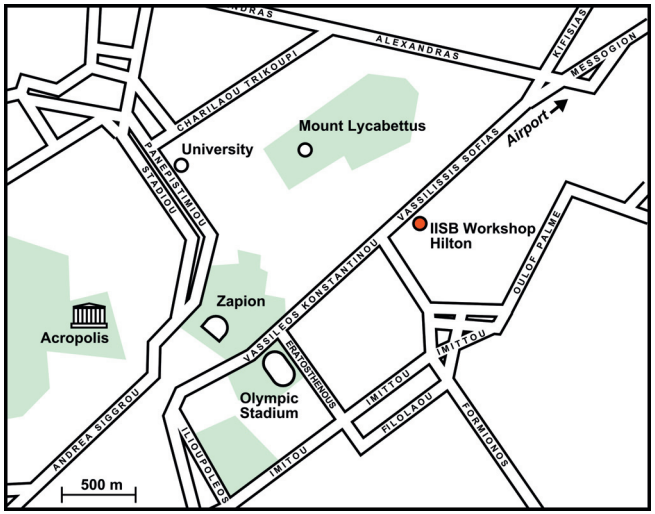
See also:
www.litho-workshop.com

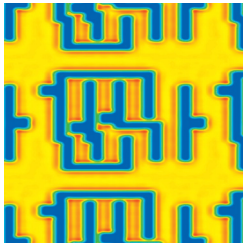
Venue:
Hilton Hotel Athens
Room Thalia 3
46 Vassilissis Sofias Avenue
11528 Athens, Greece
phone +30 210 728-1000
fax +30 210 728-1111
www.hilton.com

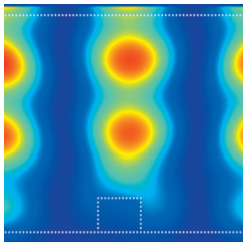
Directions:

By car:
From the Athens International Airport take Attiki Odos Avenue, which leads to Messogion Avenue.
At the end turn left into Vassilissis Sofias Avenue.
Follow the road for 1 km (0.6 miles).
The Hilton Athens Hotel is located on the left-hand side.

By public transport:
You can use the metro (Line 3, get off at station Evangelismos). The ride is about 25 minutes from the Airport.







Lithography Simulation

6th Fraunhofer
IISB Lithography
Simulation Workshop
September 18 – 20, 2008
at MNE in Athens, Greece

Fraunhofer Institut
Integrierte Systeme und
Bauelementetechnologie

Supported by: PUBLICIS PRO
The B t B Group

6th Fraunhofer IISB Lithography Simulation Workshop

Agenda

The workshop brings together experts from various fields of lithography simulation.

It provides an excellent opportunity to exchange ideas and discuss results and developments in the areas of:

- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Sharing experience and ideas from various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

The 2008 workshop will focus on:

- Lithography simulation for 32 nm and below: Double patterning or EUV?
- Lithography simulation and OPC: Which effects have to be covered?
- Lithography simulation for alternative applications: From MEMS to photonic crystals
- Computational lithography

Program

Thursday, September 18

6:00 p.m.	Welcome reception

Friday, September 19

9:15 – 9:50 a.m.	**Welcome and introduction,** A. Erdmann (Fraunhofer IISB, Germany)
9:50 – 10:15 a.m.	**The future for EUV and its impact on lithography simulations,** A. Göhnermeier, W. Kaiser, M. Lowisch, and M. Bienert (Carl Zeiss SMT, Germany)
10:15 – 10:45 a.m.	Coffee break
10:45 – 11:10 a.m.	**Fast simulation methods for EUV masks with buried defects,** C.H. Clifford and A.R. Neureuther (Univ. of California Berkeley, USA)
11:10 – 11:35 a.m.	**Heuristic optimization of EUV lithography process conditions,** T. Fühner, A. Erdmann, and P. Evanschitzky (Fraunhofer IISB, Germany)
11:35 a.m. – 12:00 p.m.	**Mask aligner lithography simulation for layout verification and optimization using OPC methdology,** H. Lerch[1], B. Meliorisz[2,3], D. Ritter[2] ([1]AMO GmbH, Germany; [2]GenISys GmbH, Germany; [3]Fraunhofer IISB, Germany)
12:00 – 1:30 p.m.	Lunch
1:30 – 1:55 p.m.	**An alternative method for advanced lithographic imaging: the Extended Nijboer-Zernike formalism,** S. van Haver, O.T.A. Janssen, J.J.M. Braat, and S.F. Pereira (TU Delft, Netherlands)
1:55 – 2:20 p.m.	**Design, implementation, and application of a novel Extended Abbe approach,** P. Evanschitzky and T. Fühner (Fraunhofer IISB, Germany)
2:20 – 2:45 p.m.	**PEB simulation: Benchmarking of numerical solvers for 2D and 3D geometries**, A. Fiebach[1], T. Schnattinger[2], A. Erdmann[2], J. Fuhrmann[1], M. Uhle[1] ([1]WIAS, Germany; [2]Fraunhofer IISB, Germany)
2:45 – 3:10 p.m.	Coffee break
3:10 – 3:35 p.m.	**Determination of proximity effect correction parameters for fabrication of nanoimprint templates using variable shaped beam lithography,** H. Sailer, J. Butschke, M. Irmscher, and M. Pritschow (IMS Chips, Germany)
3:35 – 4:00 p.m.	**Patterning of lithium niobate for the fabrication of novel micro- and nano-optical devices by means of ion beam enhanced etching,** F. Schrempel, T. Gischkat, H. Hartung, E.B. Kley, A. Tünnermann, and W. Wesch (Univ. Jena, Germany)
4:00 – 4:30 p.m.	Coffee break
4:30 – 4:55 p.m.	**Design, fabrication, and application of leaky-mode resonant waveguide gratings,** R. Magnusson (Univ. Connecticut, USA)
4:55 – 5:20 p.m.	**Investigating the effect of topography on stitching strategies for pitch splitting double patterning using rigorous physical simulation,** S. Robertson, J. Biafore, T. Graves, and M. Smith (KLA-Tencor, USA)
5:20 – 5:45 p.m.	**Investigation of wafer topography effects in double patterning using rigorous diffraction simulations,** F. Shao, P. Evanschitzky, A. Erdmann (Fraunhofer IISB, Germany)

Saturday, September 20

9:00 – 9:25 a.m.	**Stochastic lithography simulation. Updated material models,** G. Patsis (IMEL, Greece)
9:25 – 9:50 a.m.	**Kinetic Monte Carlo simulation of molecular resists,** R.A. Lawson and C.L. Henderson (Georgia Institute of Technology, USA)
9:50 – 10:15 a.m.	**LWR measurements and its effects on transistor performance**, V. Constandoudis (IMEL, Greece)
10:15 – 10:45 a.m.	Coffee break
10:45 – 11:10 a.m.	**Fieldstitching method comprising Kirchhoff's approximation for description of small perturbations of perfectly periodic structures,** T. Schuster, S. Rafler, V.F. Paz, K. Frenner, and W. Osten (TU Stuttgart, Germany)
11:10 – 11:35 a.m.	**Evolution of the domain decomposition method – present and future research to enable 3D mask modeling of mask features smaller than the wavelength (DUV-193nm) or many wavelengths tall (EUV-13nm),** K. Adam (Mentor Graphics, USA)
11:35 a.m. – 12:00 p.m.	**Benchmarking of rigorous methods for electromagnetic field simulations,** P. Evanschitzky[1], S. Burger[2], S. Zschiederich[2], F. Schmidt[2], Z. Rahimi[1], A. Erdmann[1] ([1]Fraunhofer IISB, Germany; [2]JCMWave, Germany)
12:00 – 12:45 p.m.	**Final discussion and concluding remarks**

Organizational Information

Address of the institute:
Fraunhofer Institute of Integrated
Systems and Device Technology
Schottkystrasse 10
91058 Erlangen, Germany

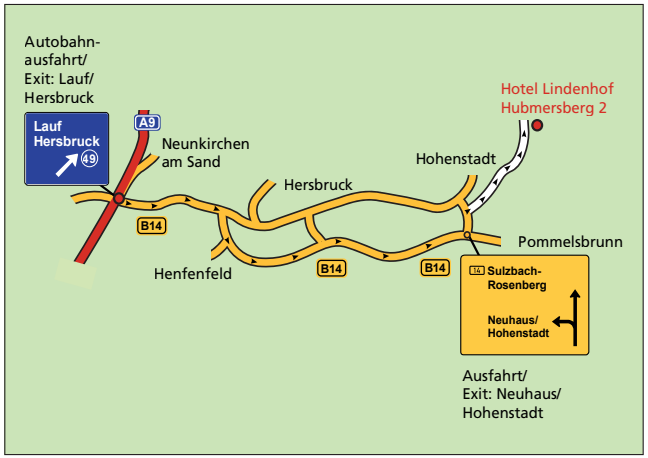
Contact:
Andreas Erdmann
phone +49 (0) 9131 / 761-258
fax +49 (0) 9131 / 761-212
lithography@iisb.fraunhofer.de

Hotel:
Hotel Lindenhof
Ringhotel Hersbruck
Hubmersberg 2
91224 Pommelsbrunn

To register and for more information, visit:
www.litho-workshop.com

Directions – arrival by car:

- follow highway A9 (Munich - Nuremberg - Berlin), take exit Lauf/Hersbruck,
- pass Hersbruck, follow the B14 to exit Neuhaus-Hohenstadt
- after 3 km take the second road on the right



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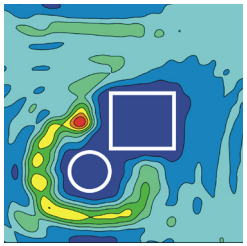
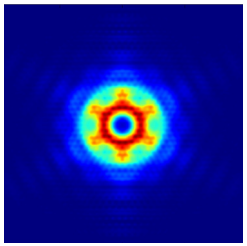
Sponsored by: PUBLICIS ERLANGEN





Lithography Simulation

5th Fraunhofer
IISB Lithography
Simulation Workshop
September 28 – 30, 2007
in Hersbruck, Germany

Fraunhofer Institut
Integrierte Systeme und
Bauelementetechnologie

5th Fraunhofer IISB Lithography Simulation Workshop

Agenda

The workshop brings together experts from various fields of lithography simulation. It provides an excellent opportunity to exchange ideas and discuss results and developments in the areas of:

- Latest research activities and future developments in lithography and lithography simulation
- Limitations of present simulation models and required model extensions
- Various fields of expertise (modeling, tool & material suppliers, and semiconductor manufacturing)

The 2007 workshop will focus on :

- Electromagnetic field modeling
- Photoresists
- Process, tool, and wafer fab perspective
- Model development and software integration

Accommodation during the workshop:

The workshop is being held in Hersbruck at the Conference Hotel Lindenhof, located in a typical Franconian landscape.

Program

	Friday, September 28
6:00 pm	Dinner
7:00 pm	**Welcome and introduction** A. Erdmann (IISB)
7:45 pm	**Recent progress in resist materials design for sub-45 nm node lithography applications: Analysis of the limits and possibilities for future resists** C.L. Henderson, R. Lawson, C.T. Lee, L.M. Tolbert, R. Whetsell (Georgia Institute of Technology), K. Gonsalves, M. Wang (University of North Carolina Charlotte), W. Yueh, and J. Roberts (Intel Corporation)
8:30 pm	**Welcome reception**

	Saturday, September 29
8:00 am	Breakfast
9:00 am	**Discrete and continuous simulation of photoresist processing** T. Schnattinger (IISB)
9:25 am	**Mechanistic simulation of line-edge roughness** J. Biafore, M. Smith, S. Robertson, and T. Graves (KLA-Tencor)
9:50 am	**Polymeric and molecular glass resist models for stochastic lithography simulation** D. Drygiannakis, G. P. Patsis, I. Raptis, and E. Gogolides (IMEL Demokritos)
10:15 am	Discussion on resist modeling
10:30 am	Coffee break
11:00 am	**The diffraction of dielectric transmission gratings in Littrow mounting – a physical investigation** T. Clausnitzer and E.B. Kley (University of Jena)
11:25 am	**Coupled eigenmode theory for EMF modeling of grating reticles** G. Allen and P. Davids (Intel Corporation)
12:15 pm	**Extraordinary high transmission effects – can we exploit them to make better masks?** D. Reibold, A. Erdmann (IISB), K. Bubke, and C. Pierrat (AMTC)
12:40 pm	Lunch
2:00 pm	**Comparison of convergence behaviour of RCWA and Differential Method** S. Rafler (University of Stuttgart)
2:25 pm	**Simulation of larger mask areas using the Waveguide Method with a fast decomposition technique** F. Shao and P. Evanschitzky (IISB)
2:50 pm	Coffee break
3:20 pm	**On the validity of 3-D mask simulations** V. Philipsen, P. De Bisschop (IMEC), A. Erdmann, G. Citarella, and P. Evanschitzky (IISB)
3:45 pm	**Real time scatterometry for process control** S. Soulan, M. Besacier, and P. Schiavone (Laboratoire des Technologies de la Microélectronique CNRS)
4:10 pm	**Discussion on rigorous EMF modeling**
5:00 pm	Special event and dinner

	Sunday, September 30
8:00 am	Breakfast
9:00 am	**The portability of full physical resist models across illumination conditions and between exposure tools** S. Robertson, J. Biafore, and M. Smith (KLA-Tencor)
9:25 am	**Modeling three-dimensional EMF mask effects during full-chip OPC** M. Lam and K. Adam (Mentor Graphics)
9:50 am	**32 nm half pitch node OPC process model development for three dimensional mask effects using rigorous simulation** L.S. Melvin III, T. Schmöller, and J. Li (Synopsys)
10:15 am	Coffee break
10:45 am	**Root causes of pattern position shift and asymmetry of printed image by non-telecentric optics in EUV lithography** M. Sugawara (SONY Electronics Inc.)
11:10 am	**Impact of mask pellicle effects on OPC quality** H. Koop, T. Schmöller (Synopsys), and W. Cheng (Intel Corporation)
11:35 am	**Interference lithography for components in compact integrated spectral sensors and beam shaping optics** M. Burkhardt, R. Steiner, K. Rudolf, H.-J. Dobschal, M. Helgert, and R. Brunner (Carl Zeiss AG)
12:00	**Discussion and closing remarks**
1:00 pm	Lunch
2:00 pm	**Departure**

Fax registration

to
Fraunhofer Institute of Integrated Systems and Device Technology

fax +49 (0) 9131 / 761-212

☐ I will participate
☐ I will arrive by train in Hersbruck at _____

Deadline for registration September 8, 2006

Participation fee 475,- €
The fee covers board, lodging and the evening program. You will receive a confirmation of registration. We will invoice you for the fee.

Cancellation In case of cancellations after the expiration of the deadline you will be charged 75% of the fee. Standing in for a registered participant is possible.

Sender

Title, First-Name, Name

Company / Institution

Street

City

Phone, Fax

E-mail

Date, Signature

Use one form per person please.

Organizational information

Address of the institute Fraunhofer Institute of Integrated Systems and Device Technology
Schottkystrasse 10
91058 Erlangen, Germany

Organization of the workshop Andreas Erdmann
phone +49 (0) 9131 / 761-258
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lithography@iisb.fraunhofer.de

Hotel Hotel Lindenhof
Ringhotel Hersbruck
Hubmersberg 2
91224 Pommelsbrunn

Directions – arrival by car

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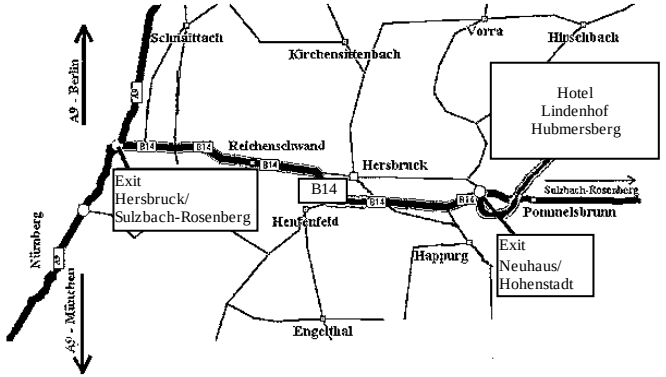

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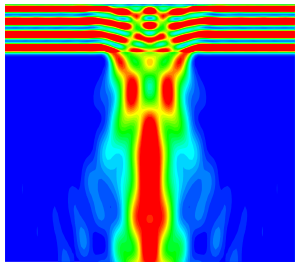
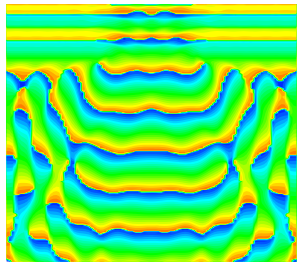
Lithography Simulation

4th IISB Lithography Simulation Workshop





September 29 – October 1, 2006

in Hersbruck, Germany

IISB

Fraunhofer Institut
Integrierte Systeme und
Bauelementetechnologie

Lithography simulation workshop

Content

The workshop will provide an excellent opportunity to discuss

- the results of the latest research activities and future developments in lithography and lithography simulation
- strong and weak points of present simulation models and necessary model extensions
- various topics from different points of view, as the participants have different backgrounds (modeling, tool & material suppliers, and semiconductor manufacturing)

Focal topics of the 2006 workshop are:

- **Alternative lithographies**
  Simulation of lithographic processes besides from standard projection printing (proximity and near field lithography, nanoimprint, direct e-beam or laser writing, ...)
- **Optimization and its application**
  Optimization methods and their applications in lithography simulation
- **Extensions of electromagnetic field simulation (EMF)**
  Extensions of 3D electromagnetic field simulations of light diffraction from lithographic masks (material properties, impact of evanescent waves, surface plasmons, ...)

In order to have a fruitful exchange of ideas, the number of participants is limited to 35.

Workshop accomodations

The workshop takes place in Hersbruck at the Conference Hotel Lindenhof, which is located in a typical Franconian landscape.

This workshop is organized by
Fraunhofer IISB

Program

Friday, September 29, 2006

6:00 pm	Dinner
7:00 pm	**Welcome and introduction** A. Erdmann (IISB)
7:45 pm	**Breaking the diffraction limit using plasmonics** O. Martin (EPFL, Lausanne)
8:30 pm	**Welcome reception**

Saturday, September 30, 2006

8:00 am	Breakfast
9:00 am	**Theory and practice of polarized optical lithography: Implications for image simulation** M. Totzek, D. Krämer, O.Dittmann, A. Göhnermeier (Carl Zeiss)
9:30 am	**Fast optical and EUV mask near field simulation using the waveguide method** P. Evanschitzky (IISB)
10:00 am	Coffee break
10:30 am	**Convergence improvement for RCWA considering crossed gratings using normal vector fields** T. Schuster, N. Kerwien, S. Rafler, W. Osten (University of Stuttgart), J. Ruoff (Carl Zeiss)
11:00 am	**Sensitivity of lithography to scanner and reticle imperfections** P. De Bischop, V. Philipsen (IMEC), G. Citarella, A. Erdmann (IISB)
11:30 pm	**Discussion on EMF simulation**
12:00 pm	Lunch
1:30 pm	**Heuristic search methods: Optimization for real-world applications** G. Kokai (University of Erlangen / Nuremberg)
2:00 pm	**Optimization of lithographic process conditions by means of artificial evolution** T. Fühner (IISB)
2:30 pm	Coffee break
3:00 pm	**Simulation and optimization of optical nanostructures** Ch. Hafner (ETH Zurich)
3:30 pm	**Inverse lithographic imaging of two dimensional gratings** R. Köhle, B. Küchler, C. Nölscher (Qimonda)
4:00 pm	**ARC and swing optimization for high-NA photolithography** J. Bauer, U. Haak (IHP Frankfurt)
4:30 pm	**Discussion on optimization**
5:00 pm	Special event and dinner

Sunday, October 1, 2006

8:00 am	Breakfast
9:00 am	**Numerical simulations of electrostatic discharge effects on photomasks** S. Boschert (Siemens)
9:30 am	**Writing and exposure optimization in maskless direct e-beam lithography** P. Hudek (FH Vorarlberg)
10:00 am	**Combining flexibility, user-friendliness and automation for process simulation, optimization and verification tools** U. Hofmann, N. Ünal (GenISys)
10:30 am	Coffee break
11:00 am	**Mask proximity printing** B. Meliorisz (IISB)
11:30 am	**Wafer-scale simulation of nanoimprint** V. V. Sirotkin, A. A. Svintsov, S. I. Zaitsev (IMT RAS)
12:00 pm	**Discussion and summary**
1:00 pm	Lunch
2:00 pm	**Departure**

Fax registration

to
Fraunhofer Institute of Integrated Systems and Device Technology

fax +49 (0) 9131 / 761-212

☐ I will participate

Deadline for registration August 31, 2005

Participation fee 475,- €
The fee covers board, lodging and the evening program. You will receive a confirmation of registration. We will invoice you for the fee.

Cancellation In case of cancellations after the expiration of the deadline you will be charged 75% of the fee. Standing in for a registered participant is possible.

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Use one form per person please.

Organizational information

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91058 Erlangen, Germany

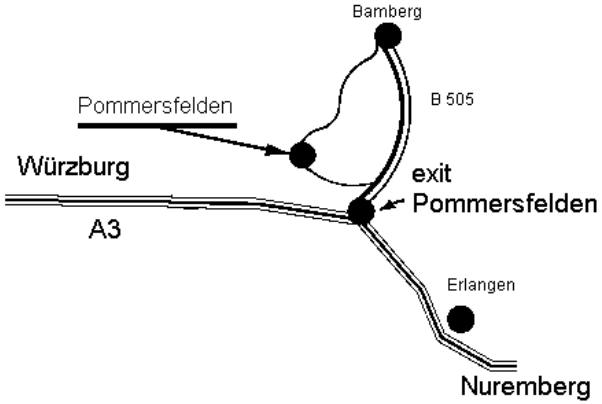
Organization of the workshop
Andreas Erdmann
phone +49 (0) 9131 / 761-258
fax +49 (0) 9131 / 761-212
lithography@iisb.fraunhofer.de

Contact
Bernd Tollkühn
phone +49 (0) 9131 / 761-216
fax +49 (0) 9131 / 761-212
lithography@iisb.fraunhofer.de

Hotel and work-shop location
Schlosshotel Pommersfelden
Schloss 1
96178 Pommersfelden
Phone: +49 (0) 9548 / 680

Directions – arrival by car

- follow highway A3 (Nuremberg – Würzburg), take exit *Pommersfelden/Bamberg*,
- follow the B505 to exit *Pommersfelden*



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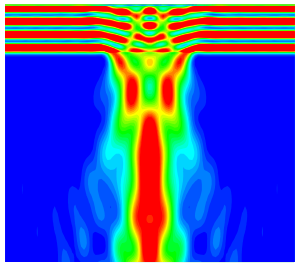
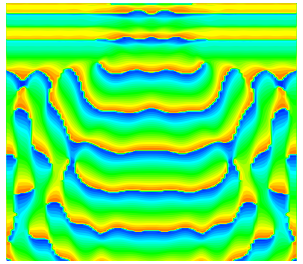
Lithography Simulation

3rd IISB Lithography Simulation Workshop





September 16 – 18, 2005

in Pommersfelden, Germany

IISB

Fraunhofer Institut Integrierte Systeme und Bauelementetechnologie

Lithography workshop

Content

The workshop will provide an excellent opportunity to discuss

- the results of the latest research activities and future developments in lithography and lithography simulation
- strong and weak points of present simulation models and necessary model extensions
- various topics from different points of view as the participants have different backgrounds (modeling, tool & material suppliers, and semiconductor manufacturing)

Focal topics of the 2005 workshop are:

- **Rigorous electromagnetic field modeling**
  Methods to compute light diffraction from advanced lithographic masks; mask and wafer topography effects in hyper NA lithography; applications
- **Predictivity of resists models**
  Coupled diffusion in kinetic systems and molecular effects; Line edge roughness and other factors restricting resolution; materials for immersion lithography and simulation issues
- **Further simulation issues**
  Which effects need to be considered in future? Are appropriate models available?

In order to have a fruitful exchange of ideas we will limit the number of participants to 35.

Workshop Accomodations

The workshop takes place at Pommersfelden in the Schlosshotel Pommersfelden which is located in a typical Franconian landscape.

This workshop is organized by

Fraunhofer IISB

Program

Friday, September 16, 2005

6:00 pm	Dinner
7:00 pm	**Welcome and introduction** A. Erdmann (IISB)
8:00 pm	**Lithographic image simulation for the 21st century with 19th century tools** R. Gordon (ORA), A. Rosenbluth (IBM)
8:30 pm	**Welcome reception**

Saturday, September 17, 2005

8:00 am	Breakfast
9:00 am	**Mask topography effects: historical perspective and future trends** C. Pierrat, K. Bubke, M. Sczyrba, S. Teuber (AMTC)
9:30 am	**3D rigorous electromagnetic simulation using modal methods: applications to EUV masks and scatterometry** P. Schiavone (CEA-Léti)
9:50 am	**Finite difference time domain and waveguide method beyond the Hopkins approach** J. Schermer, P. Evanschitzky (IISB)
10:10 am	Coffee break
10:30 am	**Electromagnetic diffraction methods: a comparison from the user perspective** J. Ruoff, B. Kleemann (Carl Zeiss)
11:00 am	**Finite elements for the rigorous simulation of time-harmonic waves** A. Rathsfeld (WIAS)
11:20 am	**Mask diffraction at conical off-axis illumination** R. Köhle (Infineon)
11:40 pm	**Discussion on EMF modeling**
12:45 pm	Lunch
2:00 pm	**Summary of discussion on EMF modeling**
2:30 pm	**Modeling photoresist in immersion lithography processes** S. Robertson (Rohm&Haas)
3:00 pm	**Numerical simulations of PEB processes** J. Fuhrmann (WIAS), B. Tollkühn (IISB)
3:20 pm	Coffee break
3:40 pm	**Challenges in applying molecular level models for resist processing simulation** T. Schnattinger (IISB)
4:00 pm	**Spin coating over topography** T. Mülders (Infineon)
4:20 pm	**Discussion on resist modeling**
5:30 pm	Sightseeing of the castle and dinner

Sunday, September 18, 2005

8:00 am	Breakfast
9:00 pm	**Summary of discussion on resist modeling**
9:30 am	**Simulation of photomasks as electromagnetic objects** F. Schellenberg, K. Adam (Mentor Graphics), J. Matteo, L. Hesselink (Stanford University)
10:00 am	**Simulation study of source polarization on imaging for attenuated PSM masks** P. De Bisschop (IMEC)
10:20 am	**Polarization effects of a partially coherent light field: applications in optical metrology** N. Kerwien, W. Osten (Stuttgart University, ITO), M. Totzek (Carl Zeiss)
10:50 am	**Prospects of scatterometry for shape and dimensional metrology on structured surfaces** B. Bodermann, M. Wurm (PTB)
11:10 am	**Discussion and summary**
12:15 pm	Lunch
1:00 pm	**Departure**

Fax registration

to
Fraunhofer Institute of Integrated Systems and Device Technology

fax +49 (0) 9131 / 761-212

☐ I will participate
☐ I will arrive by train in Hersbruck at _____

Deadline for registrations August 31, 2004

Participation fee 425,- €
The fee covers board, lodging and the evening program. You will receive a confirmation of registration. We will invoice you for the fee.

Cancellation In case of cancellations after the expiration of the deadline you will be charged 75% of the fee. Standing in for a registered participant is possible.

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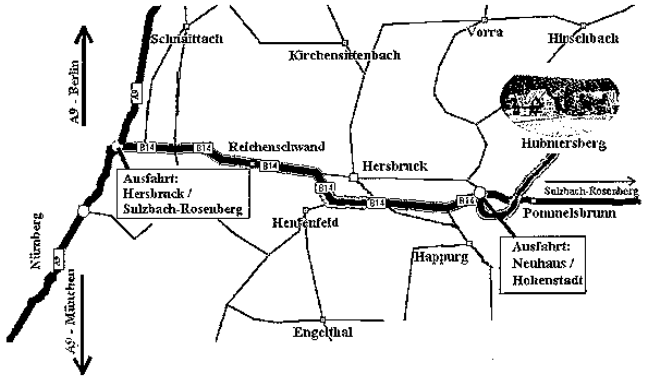
lithography@iisb.fraunhofer.de

Hotel
Hotel Lindenhof
Ringhotel Hersbruck
Hubmersberg 2
91224 Pommelsbrunn

Directions – arrival by car

- follow highway A9 (Munich – Nuremberg – Berlin), take exit *Hersbruck/Sulzbach-Rosenberg*,
- pass Hersbruck, follow the B14 to exit *Neuhaus-Hohenstadt*
- after 3 km take the second road on the right



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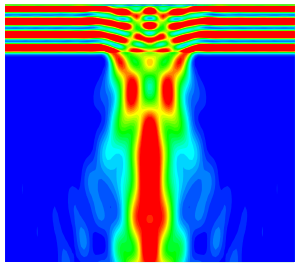
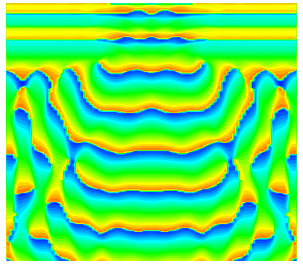
Lithography Simulation

2nd IISB Lithography Simulation Workshop





September 17 – 19, 2004

in Hersbruck, Germany

IISB

Fraunhofer Institut Integrierte Systeme und Bauelementetechnologie

Lithography workshop

Content

The workshop will provide an excellent opportunity to discuss

- the results of the latest research activities and future developments in lithography and lithography simulation
- the pros and cons of present simulation models and prospective model extensions
-

Participants from industry and public research with different background (modeling, tool & material suppliers, and semiconductor manufacturing) will discuss several topics from different points of view

The special topics for the 2004 workshop are:

- Immersed in Polarization Effects? Modeling of high NA, hyper NA projection lithography and other immersion issues
- Metrology and simulation - where are the error bars? Mask and wafer CD measurement, aberrations, flare, stack analysis
- Further simulation issues – what do we need for the future? e-beam and EUV lithography, correlation of process parameters

In order to have a fruitful exchange of ideas we will limit the number of participants to 30.

Workshop Accomodations

The workshop takes place at Hersbruck in the Conference Hotel Lindenhof which is located in a typical Franconian landscape.

This workshop is organized by

Fraunhofer IISB

Program

Friday, September 17, 2004

6:00 pm	Dinner
7:00 pm	**Welcome and introduction** A. Erdmann (IISB)
7:30 pm	**Aberration retrieval for a lithographic lens in the presence of focus variation and spatial diffusion** P. Dirksen, J. Braat, A. Janssen, D. van Steenwinckel, A. Leeuwestein (Philips)
8:00 pm	**Meeting**

Saturday, September 18, 2004

8:00 am	Breakfast
9:00 am	**New simulation challenges associated with upcoming high-NA exposure tools: a user perspective** P. De Bisschop, V. Philipsen, M. Opdebeeck (IMEC) A. Erdmann (IISB)
9:30 am	**High NA and polarization effects from the viewpoint of a DRAM manufacturer** R. Ziebold (Infineon)
10:00 am	**Polarization issues of high-NA lithography imaging** D. Krähmer, O. Dittmann, V. Kamerov, M. Totzeck (Zeiss)
10:30 am	Coffee break
10:45 am	**Extended Nijboer-Zernike aberration analysis applied to high-NA image projection systems** J. Braat (Delft University of Technology), P. Dirksen, A. Janssen (Philips Research Laboratories)
11:15 am	**High NA and mask induced polarization effects** P. Evanschitzky, A. Erdmann (IISB)
11:45 pm	**Discussion: Modeling high-NA lithography**
12:30 pm	Lunch
2:00 pm	**Getting it together - model - based optical, SEM and AFM CD metrology at PTB** B. Bodermann, H. Bosse, S. Czerkas, C. G. Frase, W. Haessler-Grohne, W. Mirandé (PTB)
2:30 pm	**Flare metrology used for PSD reconstruction ; theory, basic principles and most practicable PSD models** M. Arnz (Zeiss)
3:00 pm	Coffee break
3:15 pm	**Determination of optical constants using swing curves** J. Bauer, G. Drescher, U. Haak (IHP)
3:30 pm	**Optical scatterometry of 3D patterns** J. Bischoff (Timbre Technologies)
3:45 pm	**Line Edge Roughness: Measurement and Simulation** T. Mülders, T. Marschner (Infineon)
4:15 pm	**Discussion: Metrology and simulation**
5:30 pm	Short tour to a Franconian landmark and dinner

Sunday, September 19, 2004

8:00 am	Breakfast
9:00 am	**Exposure optimization in EBL** Peter Hudek, Dirk Beyer (Leica)
9:30 am	**Modal method by wavelet expansion, application to EUV lithography** P. Schiavone (CNRS)
9:45 am	**Correlation analysis - a new method for lithography simulation and process optimization** B. Tollkühn, A. Heubner (IISB)
10:30 am	**Discussion: Future tasks for lithography simulation**
12:00 pm	Lunch
1:00 pm	**Departure**

fax registration

to
Fraunhofer Institute of Integrated Systems and Device Technology

fax +49 (0) 9131 / 761- 212

☐ I'm registering! (binding)
☐ I will arrive by train in Hersbruck at _____

deadline for registrations August 29, 2003

participation fee 370,- €
The fee covers board and lodging and the evening program. You will receive a confirmation of registration. We will invoice you for the fee.

cancellations In case of cancellations after the expiration of the deadline you will be charged 75% of the fee. Standing in for a registered participant is possible.

sender

first name, last name

company, institution

street, house number, PO box

Zip code, city

phone, fax

e-mail

date, signature

Use only one form per person please.

organizational information

address of the institute
Fraunhofer Institute of Integrated Systems and Device Technology
Schottkystrasse 10
91058 Erlangen, Germany

organization of the workshop
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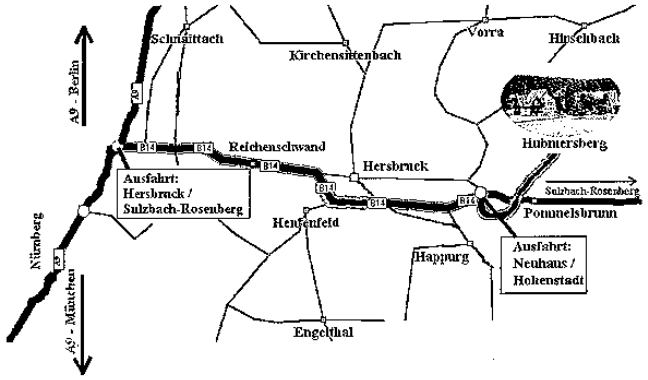

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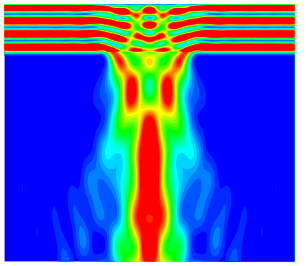
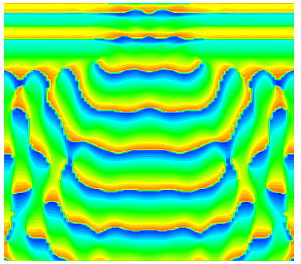
Lithography Simulation

1st IISB Lithography Simulation Workshop





September 19 – 21, 2003

in Hersbruck

IISB

Fraunhofer Institut Integrierte Systeme und Bauelementetechnologie

lithography workshop

Content

The workshop's emphasis will be on:

- results of the latest research activities and future developments in lithography and lithography simulation
- discussion on strengths and weaknesses of current simulation models
- discussion on essential model extensions
- opportunity to discuss the topics from different aspects and points of view

The topics of the workshop are:

- What kind of models do we need for modern resists? (effects that are not described by existing models, full resist models of diffused aerial images)
- How to calibrate our model parameters? (optical systems and resist parameters, experimental data for process characterization, target functions, optimization methods, standardization)
- What type of model extensions do we need for EUV-lithography? (light scattering from defective masks, flare, polarization effects, resist models)
- What are the future tasks for lithography simulation? (alternative techniques: immersion lithography, nanoimprint, coupling of simulation and experiment, application of lithography simulation in design)

In order to have a fruitful exchange of ideas we have limited the number of participants to 30 persons.

Workshop Accomodations

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This workshop is organized by

Fraunhofer IISB

program

Friday, September 19, 2003

6:00 pm	Dinner
7:00 pm	**Welcome** A. Erdmann
7:15 pm	**Lithography simulation at Fraunhofer IISB** A. Erdmann
8:00 pm	**Presentations of the members of the lithography simulation group at Fraunhofer IISB**

Saturday, September 20, 2003

8:00 am	Breakfast
9:00 am	**Is there a recompense for resist calibration efforts?** A. Semmler (Infineon)
9:30 am	**Diffused aerial image model, an accurate simplified resist model?** D. Fuard, P. Schiavone, J.H. Tortai (CNRS LETI)
10:00 am	**Resist models and calibration methods – what leads to predictive results?** B. Tollkühn, D. Matiut (IISB)
10:30 am	Coffee break
10:45 am	**Resist models: A practical guide to timely parameter determination and a review of model deficiencies** S. Robertson (Shipley)
11:45 am	**Discussion: Resist topics**
12:30 pm	Lunch
2:00 pm	**Image modeling for defect-free and defective EUV-masks** P. Evanschitzky, A. Erdmann (IISB)
2:30 pm	**EUV lithography modeling using a modal method** P. Schiavone, M. Besacier, V. Farys (CNRS), G. Granet (Université Blaise Pascal)
3:00 pm	Coffee break
3:15 pm	**Apodization effects of a multilayer coated mask** H.-J. Mann, M. Lowisch (Zeiss), U. Mickan (ASML)
3:45 pm	**Challenges for future EUV modeling** S. Hirscher (Infineon)
4:15 pm	**Discussion: EUV topics**
5:30 pm	Hike and Barbecue

Sunday, September 21, 2003

8:00 am	Breakfast
9:00 am	**Towards automatic mask and source optimization for optical lithography** A. Erdmann, T. Fühner (IISB)
9:45 am	**Hot topics in algorithms and models for lithography simulation** C. Noelscher, R. Koehle (Infineon)
10:15 am	**Discussion: Future tasks for lithography simulation**
12:00 pm	Lunch
1:00 pm	**Departure**