Chris A. Mack

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EDUCATION

University of Texas, Austin, TX
Doctorate in Chemical Engineering — December 1998
Thesis Title: "Modeling Solvent Effects in Optical Lithography"

University of Maryland, College Park, MD
Master of Science in Electrical Engineering — December 1989

Rose-Hulman Institute of Technology, Terre Haute, IN
Bachelor of Science degrees in Physics, Electrical Engineering, Chemistry, and Chemical Engineering — May 1982

EXPERIENCE

Fractilia, LLC, Austin, TX

1/17 – present *Cofounder and Chief Technical Officer*

- Developing software and algorithms to analyze SEM images of nanoscale features to measure edge roughness and stochastic variability for the semiconductor industry.

Lithoguru.com, Austin, TX

11/05 – present *Gentleman Scientist*

- Pursuing intellectual interests, research, writing, and teaching, as reflected on the website www.lithoguru.com.
- Current major research interest: understanding the mathematical characterization of roughness, and developing an approximate analytical stochastic model of lithography line-edge and linewidth roughness.
- Consulting in the fields of optics, semiconductor lithography, and semiconductor manufacturing, including legal expert witness services and business consultation.
- Delivering in-person and on-line training in semiconductor manufacturing, lithography, and data analysis.

University of Texas at Austin, Austin, TX

8/91 – present *Adjunct Faculty (part time)*

- Teaching graduate and undergraduate courses in the Electrical Engineering and Chemical Engineering departments. Graduate courses include Semiconductor Microlithography, Chemical Processes for Microelectronics, Fourier Optics, and Statistics. Undergraduate courses include Electronic Circuits, Solid State Electronics, and Modern Optics. Served on the committees of numerous PhD dissertations.
- Teaching loads have varied but have been in the range of 1 – 4 courses per year.

University of Canterbury, Christchurch, NZ

6/11 – 8/11 *Erskine Visiting Fellow*

- Taught undergraduate course in the Electrical Engineering department: Semiconductor Microlithography. Participated in research on evanescent interferometric lithography.

University of Notre Dame, South Bend, IN

8/06 – 12/06 *Melchor Visiting Chair Professor*

- Taught two graduate courses in the Electrical Engineering department: Semiconductor Microlithography, and Data Analysis and Modeling in the Real World.

KLA-Tencor, Austin, TX

2/00 – 11/05 *Vice President of Lithography Technology*

- Provided strategic vision in all lithography related products for KLA-Tencor, a $2B Fortune 500 supplier of equipment to the semiconductor industry.
- Directed research efforts for four product divisions across two continents, including lithography simulation, optical and SEM critical dimension metrology, and optical overlay metrology. Obtained funding and managed resource allocation and strategic planning for critical long-term projects.
- Provided and oversaw successful turn-around strategies for two failing product lines.
- Provided internal consulting services in lithography to other KLA-Tencor divisions.
- Oversaw the acquisition of FINLE Technologies by KLA-Tencor and its transition to a successful product division.

FINLE Technologies, Austin, TX

2/90 – 2/00 *CEO, President and Chief Technical Officer*

- Founded company in 1990, pursuing it full time by the end of 1991.
- Responsible for overall corporate management, vision, strategic planning, technical direction, budgeting, new product development, and lithography research. Grew the company from one person and $60,000 in revenue in 1990 to 25 people and $2.5M in revenue in 2000.
- Developed the industry standard PROLITH Toolkit of lithography simulation software and the ProDATA suite of data analysis software.
- Provided consulting services to the semiconductor industry.
- Taught numerous short courses on optical lithography.

SEMATECH, Austin, TX

8/90 – 12/91 *Lithography Engineer*

- As an assignee of the department of defense to SEMATECH, provided lithography expertise to SEMATECH on a variety of different projects, including modeling and process development for deep-UV resist systems, processes optimization of the i-line production process, advanced development activities in phase-shifting mask technologies, and lithographic lens design.
- Taught short-term and long-term courses on lithography to SEMATECH staff and assignees.

National Security Agency, Fort Meade, MD

11/82 – 8/90 *Senior Engineer - Lithography*

- As a member of the Microelectronics Research Laboratory (MRL), was tasked with performing research for present and future agency needs in the area of microlithography for semiconductor processing. This work provided a unique blend of theoretical research (e.g., a mechanism for the development reaction, diffraction theory for proximity printing and aerial imaging) and experimental work (measurement of resist properties, model verification). Performed numerous practical and theoretical studies, e.g., resist coating uniformity on wafer tracks, mask bias effects for step-and-repeat printing, exposure optimization, image reversal techniques, and focus effects for submicron lithography. The results of this work have been published in numerous journals and presented at technical conferences, including invited papers at international conferences in Japan and Europe.

EXPERT WITNESS EXPERIENCE

November, 2016– present
Expert witness, Morrison & Foerster for Nikon Corporation
Case: Patent litigation, The Netherlands
Testimony: expert declarations

October, 2016 – May, 2017
Expert witness, Thompson & Knight for Broadcom Corporation
Case: 2:16-cv-134 in the Eastern District of Marshall, Texas
Testimony: expert declaration, provided deposition testimony

May, 2015– July, 2016
Expert witness, Morrison & Foerster for Nikon Corporation
Case: Arbitration
Testimony: expert declaration, deposition testimony, testimony at arbitration hearing

November, 2014 – May, 2015
Expert witness, Morrison & Foerster for Nikon Corporation
Case: IPRs filed by Nikon (Cases IPR2015-00002 and IPR2015-00003)
Testimony: expert declaration, provided deposition testimony

October, 2013 – May, 2015
Expert witness, DSS Technology
Case: Civil Action No. 2:14-cv-00199 against Samsung Electronics Co., Taiwan Semiconductor Corporation, and NEC Corporation of America
Testimony: expert declaration, provided deposition testimony.
Case: Defending patent in IPR, Case IPR2014-01030
Testimony: expert declaration, provided deposition testimony.

November, 2013 – January, 2015
Expert witness, Winston & Strawn for Macronix
Case: ITC Inv. No. 337-TA-893, Certain Flash Memory Chips and Products Containing the Same

Testimony: expert reports and expert rebuttal reports, gave three deposition testimonies, and testified at trial.
Case: IPR filed by Macronix
Testimony: expert declaration, provided deposition testimony.

March, 2007 – July 2013
Expert witness, Morrison & Foerster for Nikon Corporation
Case: Anvik Corp. vs. Nikon Corp., United States District Court Sourthern District of New York, Civ. No. 7:05-7891 (SCR) (LMS)
Testimony: Markman hearing (March 2010), wrote expert report and rebuttal report, provided deposition testimony

February, 2013 – May 2013
Expert witness, McKool Smith for Ericsson
Case: ITC Inv. No. 337-TA-862, Certain Electronic Devices, Including Wireless Communication Devices, Tablet Computers, Media Players, And Televisions, And Components Thereof
Testimony: none

March, 2008 – April, 2013
Expert witness and expert consultant, Stadheim & Grear for the University of New Mexico
Case: Pursue licensing of University of New Mexico patents, Patent litigation, infringement action against Intel: STC.UNM vs. Intel, United States District Court District of New Mexico, Civ. No. 10-CV-01077-RB-WDS
Testimony: expert report on claim construction, provided deposition testimony

January, 2011 – June 2011
Expert witness, Fish and Richardson for Samsung
Case: ITC Inv. No. 337-TA-735, Certain Flash Memory Chips And Products Containing The Same
Testimony: wrote expert report and rebuttal report, provided deposition testimony

August, 2006 – February, 2008
Expert witness, Milbank, Tweed, Hadley & McCloy LLP for Renesas.
Case: ITC Inv. No. 337-TA-595, Certain Dynamic Random Access Memory Devices And Products Containing Same
Testimony: expert reports and expert rebuttal reports, gave two deposition testimonies, and testified at trial

COURSES TAUGHT AT THE UNIVERSITY OF TEXAS AT AUSTIN

EE 411	**Circuit Theory (undergraduate)**
EE 323	**Network Theory II (undergraduate)**
EE 325	**Electromagnetic Engineering (undergraduate)**
EE 338	**Electronic Circuits I (undergraduate)**
EE 339	**Solid State Electronics (undergraduate)**
PHY 333/EE 347	**Modern Optics (undergraduate)**
SSC306	**Statistics in Market Analysis (undergraduate)**
CHE 323/384	**Chemical Engineering for Micro- and Nanofabrication (undergraduate/graduate)**
CHE 379/384	**From Data to Decisions (undergraduate/graduate)**
EE 383P	**Fourier Optics (graduate)**
EE 396K/CHE 385C	**Semiconductor Microlithography (graduate)**
SSC380D	**Statistical Methods II (graduate)**

COURSES TAUGHT AT THE UNIVERSITY OF NOTRE DAME

EE 60598	**Semiconductor Microlithography (graduate)**
EE 60596	**Data Analysis and Modeling in the Real World (graduate)**

AWARDS

SPIE Frits Zernike Award for Microlithography, for contributions in lithography modeling and education, 2009

SEMI Award for North America, for contributions in lithography modeling and education, 2003

Best Paper Award, *18th Annual BACUS Symposium on Photomask Technology and Management*, 1998.

INDUSTRIAL AND PROFESSIONAL SOCIETIES

Member of the Board of Trustees, Rose-Hulman Institute of Technology, 2008 – present

Member of the Board of Advisors to the Physics Department, Rose-Hulman Institute of Technology, 2000 – 2008

Member of the Board of Advisors to the Chemistry Department, Rose-Hulman Institute of Technology, 2003 – 2008

Member of the Board of Advisors to the MEMS Laboratory, Rose-Hulman Institute of Technology, 2004 – 2008

Member of the Board of Directors, SPIE, 2018 – present

Associate Editor, *Journal of Micro/Nanolithography, MEMS, and MOEMS (JM^3)*, 2002 – 2011

Editor-in-Chief, *Journal of Micro/Nanolithography, MEMS, and MOEMS (JM^3)*, 2012 – present

Fellow of SPIE, 2006

Fellow of IEEE, 2010

Senior Member of the Optical Society of America

Chairman of the Lithography Technical Working Group of the Optical Society of America, 1992 – 1996.

Conference Chair, *Microlithographic Techniques in IC Fabrication*, SPIE Conference, 1997 and 2000, Singapore

Conference Chair, *Lithography for Semiconductor Manufacturing,* SPIE Conference, 1999 and 2001, Edinburgh, Scotland

Conference Chair, *Advanced Microlithography Technology,* SPIE Conference, 2007, Beijing, China

Plenary Speaker, *SPIE 2003 Symposium on Microlithography*.

Member of the Board of Advisors to *Semiconductor International* magazine, 1993 – 2004

Member of the Board of Advisors to *Microlithography World* magazine, 2003 – 2008

Contributing Columnist for *Microlithography World* magazine, 1993 – 2008

OTHER PROFESSIONAL EXPERIENCE

Expert witness consulting in the field of lithography and semiconductor design and manufacturing.

PUBLICATIONS

Books

Chris A. Mack, How to Write a Good Scientific Paper, SPIE (January, 2018)

Chris A. Mack, Fundamental Principles of Optical Lithography: The Science of Microfabrication, John Wiley & Sons (November, 2007).

Chris A. Mack, Field Guide to Optical Lithography, SPIE Field Guide Series Vol. FG06, (Bellingham, WA: 2006). Also available in Japanese.

Chris A. Mack, Inside PROLITH: A Comprehensive Guide to Optical Lithography Simulation, FINLE Technologies (Austin, TX: 1997). – Out of Print.

Book Chapters

C.A. Mack, “Microlithography”, Chapter 9, Semiconductor Manufacturing Handbook, Hwaiyu Geng, Ed., McGraw Hill (New York: 2005).

Contributed “Microlithography” entry for the McGraw Hill Encyclopedia of Science & Technology, 9th Edition (2005).

Contributed lithography terms for: Comprehensive Dictionary of Electrical Engineering, Phillip A. Laplante, Ed., (CRC Press and IEEE Press, 1999).

C.A. Mack, "Optical Lithography Modeling," Chapter 2, Microlithography Science and Technology, J. R. Sheats and B. W. Smith, editors, Marcel Dekker (New York: 1998) pp. 109-170.

C.A. Mack and A. R. Neureuther, "Optical Lithography Modeling," Chapter 7, Handbook of Microlithography, Micromachining, and Microfabrication, Volume 1: Microlithography, P. Rai-Choudhury, editor, SPIE Press (Bellingham, WA: 1997) pp. 597-680.

R. Hershel and Chris A. Mack, "Lumped Parameter Model for Optical Lithography," Chapter 2, Lithography for VLSI, VLSI Electronics - Microstructure Science Volume 16, R. K. Watts and N. G. Einspruch, eds., Academic Press (New York:1987) pp. 19-55.

Conference Chair/Proceedings Editor

Quantum Optics, Optical Data Storage, and Advanced Microlithography, Proceedings of SPIE Volume 6827 (2007)
Editors: Guangcan Guo; Songhao Liu; Guofan Jin; Kees A. Schouhamer Immink; Keiji Shono; Chris A. Mack; Jinfeng Kang; Jun-en Yao

Lithography for Semiconductor Manufacturing II, Proceedings of SPIE Volume 4404 (2001)
Editors: Chris A. Mack; Tom Stevenson

Microlithographic Techniques in Integrated Circuit Fabrication II, Proceedings of SPIE Volume 4226 (2000)
Editors: Chris A. Mack; XiaoCong Yuan

Lithography for Semiconductor Manufacturing, Proceedings of SPIE Volume 3741 (1999)
Editors: Chris A. Mack; Tom Stevenson

Microlithographic Techniques in IC Fabrication, Proceedings of SPIE Volume 3183 (1997)
Editors: Soon Fatt Yoon; Raymond Yu; Chris A. Mack

Patents

U.S. Patent 5,363,171, Photolithography exposure tool and method for in situ photoresist measurements and exposure control, November 8, 1994

U.S. Patent 6,968,253, Computer-implemented method and carrier medium configured to generate a set of process parameters for a lithography process, November 22, 2005

U.S. Patent 7,075,639, Method and Mark for Metrology of Phase Errors on Phase Shift Masks, July 11, 2006

U.S. Patent 7,142,941, Computer-implemented Method and Carrier Medium Configures to Generate a Set of Process Parameters and/or a List of Potential Causes of Deviations for a Lithography Process, November 28, 2006.

U.S. Patent 7,297,453, Systems and Methods for Mitigating Variances on a Patterned Wafer Using a Prediction Model, November 20, 2007.

U.S. Patent 7,300,725, Method for Determining and Correcting Reticle Variations, November 27, 2007.

U.S. Patent 7,300,729, Method for Monitoring a Reticle, November 27, 2007.

U.S. Patent 7,303,842, Systems and Methods for Modifying a Reticle's Optical Properties, December 4, 2007.

U.S. Patent 7,352,453, Method for Process Optimization and Control by Comparison Between 2 or More Measured Scatterometry Signals, April 1, 2008.

U.S. Patent 7,368,208, Measuring Phase Errors on Phase Shift Masks, May 6, 2008.

U.S. Patent 7,382,447, Method for Determining Lithographic Focus and Exposure, June 3, 2008.

U.S. Patent 7,528,953, Target Acquisition and Overlay Metrology Based on Two Diffracted Orders Imaging, May 5, 2009.

U.S. Patent 7,566,517, Feature Printability Optimization by Optical Tool, July 28, 2009.

U.S. Patent 7,804,994, Overlay Metrology and Control Method, September 28, 2010.

Refereed Papers

1. Chris A. Mack, "Analytical Expression for the Standing Wave Intensity in Photoresist", *Applied Optics*, Vol. 25, No. 12 (15 June 1986) pp. 1958-1961.
2. Chris A. Mack, "Development of Positive Photoresists," *Journal of the Electrochemical Society*, Vol. 134, No. 1 (Jan. 1987) pp. 148-152.
3. Chris A. Mack, "Contrast Enhancement Techniques for Submicron Optical Lithography," *Journal of Vacuum Science & Technology*, Vol. A5, No. 4 (Jul./Aug. 1987) pp. 1428-1431.
4. Chris A. Mack, "Dispelling the Myths about Dyed Photoresist," *Solid State Technology*, Vol. 31, No. 1 (Jan. 1988) pp. 125-130.
5. Chris A. Mack, "Absorption and Exposure in Positive Photoresist," *Applied Optics*, Vol. 27, No. 23 (1 Dec. 1988) pp. 4913-4919.
6. Chris A. Mack and P. M. Kaufman, "Mask Bias in Submicron Optical Lithography," *Journal of Vacuum Science & Technology*, Vol. B6, No. 6 (Nov./Dec. 1988) pp. 2213-2220.
7. Chris A. Mack, "Understanding Focus Effects in Submicron Optical Lithography", *Optical Engineering*, Vol. 27, No. 12 (1 Dec 1988) pp. 1093-1100.
8. Chris A. Mack, "Lithographic Optimization Using Photoresist Contrast," *Microelectronics Manufacturing Technology*, Vol. 14, No. 1 (Jan. 1991) pp. 36-42.
9. D. H. Ziger and Chris A. Mack, "Generalized Approach toward Modeling Resist Performance," *AICHE Journal*, Vol. 37, No. 12 (Dec 1991) pp. 1863-1874.

10. Chris A. Mack, E. Capsuto, S. Sethi, and J. Witowski, "Modeling and Characterization of a 0.5μm Deep Ultraviolet Process," *Journal of Vacuum Science & Technology*, Vol. B 9, No. 6 (Nov / Dec 1991) pp. 3143-3149.
11. D. Ziger, Chris A. Mack, and R. Distasio, "Generalized Characteristic Model for Lithography: Application to Negative Chemically Amplified Resists," *Optical Engineering*, Vol. 31, No. 1 (1 Jan 1992) pp.98-104.
12. Chris A. Mack and J. E. Connors, "Fundamental Differences Between Positive and Negative Tone Imaging," *Microlithography World*, Vol. 1, No. 3 (Jul/Aug 1992) pp. 17-22.
13. D. W. Johnson and Chris A. Mack, Modeling the Continuing Realm of Optical Lithography" *Semiconductor International*, Vol. 15, No. 6 (June 1992) pp. 134-139.
14. Chris A. Mack, "New Kinetic Model for Resist Dissolution," *Journal of the Electrochemical Society*, Vol. 139, No. 4 (Apr. 1992) pp. L35-L37.
15. Chris A. Mack, "Understanding Focus Effects in Submicrometer Optical Lithography: a Review," *Optical Engineering*, Vol. 32, No. 10 (Oct. 1993) pp. 2350-2362.
16. E. W. Charrier, C. J. Progler and Chris A. Mack, "Comparison of Simulated and Experimental CD-Limited Yield for a Submicron I-Line Process," *Solid State Technology*, Vol. 38, No. 11 (Nov. 1995) pp. 105-112.
17. Chris A. Mack, "Lithographic Effects of Acid Diffusion in Chemically Amplified Resists," Microelectronics Technology: Polymers for Advanced Imaging and Packaging, ACS Symposium Series 614, E. Reichmanis, C. Ober, S. MacDonald, T. Iwayanagi, and T. Nishikubo, eds., ACS Press (Washington: 1995) pp. 56-68.
18. Chris A. Mack, "Evaluating Proximity Effects Using 3-D Optical Lithography Simulation," *Semiconductor International* (July, 1996) pp. 237-242.
19. Chris A. Mack, "Trends in Optical Lithography," *Optics and Photonics News* (April, 1996) pp. 29-33.
20. Chris A. Mack, G. E. Flores, W. W. Flack, and E. Tai, "Lithographic Modeling Speeds Thin-Film-Head Development," *Data Storage* (May/June, 1996) pp. 55-58.
21. Chris A. Mack, "Reducing Proximity Effects in Optical Lithography," *Japanese Journal of Applied Physics*, Vol. 35 (1996) pp. 6379-6385.
22. Chris A. Mack and G. Arthur, "Notch Model for Photoresist Dissolution," *Electrochemical and Solid State Letters*, Vol. 1, No. 2, (August, 1998) pp. 86-87.
23. Chris A. Mack, K. E. Mueller, A. B. Gardiner, J. P. Sagan, R. R. Dammel, and C. G. Willson "Modeling Solvent Diffusion in Photoresist," *Journal of Vacuum Science & Technology*, Vol. B16, No. 6, (Nov., 1998) pp. 3779-3783.
24. Chris A. Mack, D. A. Legband, S. Jug, "Data Analysis for Photolithography" *MicroElectronic Engineering*, Vol. 46, Issues 1-4 (May 1999) pp. 65-68.
25. Chris A. Mack, "Electron Beam Lithography Simulation for Mask Making" *MicroElectronic Engineering*, Vol. 46, Issues 1-4 (May 1999) pp. 283-286.
26. Sergey Babin, Igor Yu. Kuzmin and Chris A. Mack, "Comprehensive Simulation of Electron-beam Lithography Processes Using PROLITH 3/D and TEMPTATION Software Tools," *MicroElectronic Engineering,* Volumes 57-58 (September 2001) pp. 343-348.

27. J. Byers, C. Mack, R. Huang, S. Jug, “Automatic Calibration of Lithography Simulation Parameters Using Multiple Data Sets,” *MicroElectronic Engineering,* Volumes 61-62 (July 2002) pp. 89-95.
28. Chris A. Mack, “Charting the Future (and Remembering the Past) of Optical Lithography Simulation,” *Journal of Vacuum Science & Technology*, Vol. B 23, No. 6 (Nov / Dec 2005) pp. 2601-2606.
29. Chris A. Mack, "Accuracy, speed, new physical phenomena: The future of litho simulation," *Solid State Technology*, February, 2006.
30. Chris A. Mack, “The Future of Semiconductor Lithography: After Optical, What Next?”, *Future Fab International*, Vol. 23 (7/9/2007).
31. Chris A. Mack, “Fab Future”, *SPIE Professional* (Oct. 2008) pp. 10-11.
32. Chris A. Mack, “Seeing Double”, *IEEE Spectrum* (Nov. 2008) pp. 46-51.
33. Chris A. Mack, “Stochastic approach to modeling photoresist development”, *Journal of Vacuum Science & Technology*, Vol. B27, No. 3 (May/Jun. 2009) pp. 1122-1128.
34. Chris A. Mack, “Stochastic Modeling in Lithography: Autocorrelation Behavior of Catalytic Reaction-Diffusion Systems,” *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 8, No. 2 (Apr/May/Jun 2009) p. 029701.
35. Chris A. Mack, “Stochastic Modeling in Lithography: The Use of Dynamical Scaling in Photoresist Development,” *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 8, No. 3 (Jul/Aug/Sep 2009) p. 033001.
36. Chris A. Mack, “A Simple Model of Line-Edge Roughness”, *Future Fab International*, Vol. 34 (July 14, 2010).
37. Chris A. Mack, “Stochastic modeling of photoresist development in two and three dimensions”, *Journal of Micro/Nanolithography, MEMS, and MOEMS* , Vol. 9, No. 4 (Oct-Dec, 2010) p. 041202.
38. Chris A. Mack, “Fifty Years of Moore’s Law”, *IEEE Transactions On Semiconductor Manufacturing*, Vol. 24, No. 2 (May, 2011) pp. 202-207.
39. Chris A. Mack, James W. Thackeray, John J. Biafore, and Mark D. Smith, “Stochastic Exposure Kinetics of EUV Photoresists: A Simulation Study”, *Journal of Micro/Nanolithography, MEMS, and MOEMS* , Vol. 10, No. 3 (Jul-Sep, 2011) p. 033019.
40. Chris A. Mack, “Analytic form for the power spectral density in one, two, and three dimensions” *Journal of Micro/Nanolithography, MEMS, and MOEMS* , Vol. 10, No. 4 (Oct-Dec, 2011) p. 040501.
41. Chris A. Mack, “Reaction-diffusion power spectral density” *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 11, No. 4 (Oct-Dec, 2012) p. 043007.
42. Chris A. Mack, "Generating random rough edges, surfaces, and volumes", *Applied Optics*, Vol. 52, No. 7 (1 March 2013) pp. 1472-1480.
43. Chris A. Mack, John J. Biafore, and Mark D. Smith, “Stochastic Exposure Kinetics of Extreme Utraviolet Photoresists: Trapping Model ”, *Journal of Vacuum Science & Technology B*, Vol. 31, No. 6 (Nov/Dec, 2013) p. 06F603-1.

44. Siddharth Chauhan, et al., “Mesoscale modeling: a study of particle generation and line-edge roughness”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 13, No. 1 (Jan–Mar, 2014) p. 013012.

45. Chris A. Mack, “Analytical Expression for Impact of Linewidth Roughness on Critical Dimension Uniformity”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 13, No. 2 (Apr-Jun, 2014) p. 020501.

46. Chris A. Mack, “Analytical Expression for Impact of Linewidth Roughness on Critical Dimension Uniformity”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 13, No. 2 (Apr-Jun, 2014) p. 020501.

47. Chris A. Mack, “The Multiple Lives of Moore’s Law”, *IEEE Spectrum*, pp. 30-37 (Apr. 2015).

48. Chris A. Mack, “More systematic errors in the measurement of power spectral density”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 14, No. 3 (Jul-Sep, 2015) p. 033502.

49. Chris A. Mack, “Understanding the efficacy of linewidth roughness post-processing”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, Vol. 14, No. 3 (Jul-Sep, 2015) p. 033503.

50. Chris A. Mack, "Biases and uncertainties in the use of autocovariance and height–height covariance functions to characterize roughness", *Journal of Vacuum Science & Technology B*, Vol. 34, No. 6 (Nov/Dec, 2016) p. 06K701.

51. Chris A. Mack, “Uncertainty in roughness measurements: putting error bars on line-edge roughness,” *J. Micro/Nanolith. MEMS MOEMS*, **16**(1), 010501 (2017).

52. Gian F. Lorusso, Vito Rutigliani, Frieda Van Roey, and Chris A. Mack, “Unbiased Roughness Measurements: Subtracting out SEM Effects”, *Microelectronic Engineering*, **190**, 33–37 (2018).

53. Chris A. Mack, “Shot noise: a 100-year history, with applications to lithography”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, **17**(4), 041002 (2018).

54. Chris A. Mack, “Reducing roughness in extreme ultraviolet lithography”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, **17**(4), 041006 (2018).

55. Gian Francesco Lorusso, Takumichi Sutani, Vito Rutigliani, Frieda van Roey, Alain Moussa, Anne-Laure Charley, Chris Mack, Patrick Naulleau, Chami Perera, Vassilios Constantoudis, Masami Ikota, Toru Ishimoto, Shunsuke Koshihara, “Need for LWR metrology standardization: the imec roughness protocol”, *Journal of Micro/Nanolithography, MEMS, and MOEMS*, **17**(4), 041009 (2018).

Invited Papers

1. Chris A. Mack, “Lithographic Simulation: A Review,” *Lithographic and Micromachining Techniques for Optical Component Fabrication, Proc.,* SPIE Vol. 4440 (2001) pp. 59-72.

2. Chris A. Mack, “The End of the Semiconductor Industry as We Know It,” *Optical Microlithography XVI*, Plenary Address, SPIE Vol. 5040 (2003) pp. xxi-xxxi.

3. Chris A. Mack, “The New, New Limits of Optical Lithography,” *Emerging Lithographic Technologies VIII, Proc.*, SPIE Vol. 5374 (2004) pp. 1-8.

4. Chris A. Mack, “Thirty Years of Lithography Simulation,” *Optical Microlithography XVIII, Proc.*, SPIE Vol. 5754-1 (2005), pp. 1-12.

5. Chris A. Mack, “What's So Hard About Lithography?,” *presented at the ICMTS* (March, 2006), available at http://www.lithoguru.com/scientist/papers_recent.html.
6. Chris A. Mack, "Line-Edge Roughness and the Ultimate Limits of Lithography", presented at the *SPIE Advanced Lithography Conference*, February, 2012, available at http://www.lithoguru.com/scientist/papers_recent.html.
7. Chris A. Mack, “The future of lithography and its impact on design”, presented at the *SPIE Advanced Lithography Conference*, February 27, 2013, available at http://www.lithoguru.com/scientist/papers_recent.html.
8. Chris A. Mack, “Understanding the efficacy of linewidth roughness post-processing”, *Advances in Resist Technology and Processing XXXII, Proc*. SPIE Vol. 9425 (2015).

Contributed Papers

1. Chris A. Mack, “PROLITH: A Comprehensive Optical Lithography Model,” *Optical Microlithography IV, Proc.*, SPIE Vol. 538 (1985) pp. 207-220.
2. Chris A. Mack and R. T. Carback, “Modeling the Effects of Prebake on Positive Resist Processing,” *Kodak Microelectronics Seminar, Interface ’85, Proc.*, (1985) pp. 155-158.
3. Chris A. Mack, “Advanced Topics in Lithography Modeling,” *Advances in Resist Technology and Processing III, Proc.*, SPIE Vol. 631 (1986) pp. 276-285.
4. Chris A. Mack, A. Stephanakis, R. Hershel, “Lumped Parameter Model of the Photolithographic Process,” *Kodak Microelectronics Seminar, Interface ’86, Proc.*, (1986) pp. 228-238.
5. Chris A. Mack, “Photoresist Process Optimization,” *KTI Microelectronics Seminar, Interface ’87, Proc.*, (1987) pp. 153-167.
6. T. Brown and Chris A. Mack, “Comparison of Modeling and Experimental Results in Contrast Enhancement Lithography,” *Advances in Resist Technology and Processing V, Proc.*, SPIE Vol. 920 (1988) pp. 390-403.
7. Chris A. Mack, “Understanding Focus Effects in Submicron Optical Lithography,” *Optical/Laser Microlithography, Proc.*, SPIE Vol. 922 (1988) pp. 135-148.
8. D. H. Ziger and Chris A. Mack, “Lithographic Characterization of a Rapid Ammonia Catalyzed Image Reversal Process,” *KTI Microelectronics Seminar, Interface ’88, Proc.*, (1988) pp. 165-175.
9. Chris A. Mack and P. M. Kaufman, “Understanding Focus Effects in Submicron Optical Lithography, part 2: Photoresist effects,” *Optical/Laser Microlithography II, Proc.*, SPIE Vol. 1088 (1989) pp. 304-323.
10. Chris A. Mack and P. M. Kaufman, “Focus Effects in Submicron Optical Lithography, Optical and Photoresist Effects,” *The International Congress on Optical Science & Engineering*, Proc., Paris, France, SPIE Vol. 1138 (1989) pp. 88-105.
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