

Publications about EUV lithography

Iacopo Mochi

May 23, 2018

References

- [1] Sara Fernandez et al. *A comparative study of EUV absorber materials using lensless actinic imaging of EUV photomasks*. 2018. DOI: [10.1117/12.2297381](https://doi.org/10.1117/12.2297381).
- [2] Patrick Helfenstein et al. “Beam drift and partial probe coherence effects in EUV reflective-mode coherent diffractive imaging”. In: *Opt. Express* 26.9 (2018), pp. 12242–12256. DOI: [10.1364/OE.26.012242](https://doi.org/10.1364/OE.26.012242).
- [3] Iacopo Mochi et al. “Through-pellicle inspection of EUV masks”. In: *Extrem. Ultrav. Lithogr. IX*. Ed. by Nelson M. Felix and Kenneth A. Goldberg. SPIE, Mar. 2018, p. 51. DOI: [10.1117/12.2297436](https://doi.org/10.1117/12.2297436).
- [4] Zuhail Tasdermir et al. *Chemically amplified EUV resists approaching 11nm half-pitch*. 2018. DOI: [10.1117/12.2299643](https://doi.org/10.1117/12.2299643).
- [5] Shushuke Yoshitake et al. “A comparative study of EUV absorber materials using lensless actinic imaging of EUV photomasks”. In: *Extrem. Ultrav. Lithogr. IX*. Ed. by Nelson M. Felix and Kenneth A. Goldberg. Vol. 10583. March. SPIE, Mar. 2018, p. 50. DOI: [10.1117/12.2297381](https://doi.org/10.1117/12.2297381).
- [6] Elizabeth Buitrago et al. “State-of-the-art EUV materials and processes for the 7nm node and beyond”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 10143. 2017, 101430T. DOI: [10.1117/12.2260153](https://doi.org/10.1117/12.2260153).
- [7] R. Fallica et al. “Lithographic performance of ZEP520A and mr-PosEBR resists exposed by electron beam and extreme ultraviolet lithography”. In: *J. Vac. Sci. Technol. B Nanotechnol. Microelectron.* 35.6 (2017). ISSN: 21662754. DOI: [10.1116/1.5003476](https://doi.org/10.1116/1.5003476).
- [8] Patrick Helfenstein et al. “A two-step method for fast and reliable EUV mask metrology”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 10143. 2017, 101431Q. DOI: [10.1117/12.2259961](https://doi.org/10.1117/12.2259961).
- [9] P. Helfenstein et al. “Coherent diffractive imaging methods for semiconductor manufacturing”. In: *Adv. Opt. Technol.* 6.6 (2017), pp. 439–448. ISSN: 21928584. DOI: [10.1515/aot-2017-0052](https://doi.org/10.1515/aot-2017-0052).

- [10] Iacopo Mochi et al. “RESCAN: an actinic lensless microscope for defect inspection of EUV reticles”. In: *J. Micro/Nanolithography, MEMS, MOEMS* 16.4 (July 2017), p. 041003. ISSN: 1932-5150. DOI: [10.1117/1.JMM.16.4.041003](https://doi.org/10.1117/1.JMM.16.4.041003).
- [11] Rajeev Rajendran et al. “Towards a stand-alone high-throughput EUV actinic photomask inspection tool: RESCAN”. In: *Proc. SPIE*. Vol. 10145. 2017, 101450N–101450N–12. DOI: [10.1117/12.2258379](https://doi.org/10.1117/12.2258379).
- [12] Y. Ekinici et al. “Scanning coherent scattering methods for actinic EUV mask inspection”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 9985. 2016, 99851P. DOI: [10.1117/12.2242961](https://doi.org/10.1117/12.2242961).
- [13] Iacopo Mochi et al. “Assist features: placement, impact, and relevance for EUV imaging”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Ed. by Eric M. Panning and Kenneth A. Goldberg. Vol. 9776. Mar. 2016, 97761S. DOI: [10.1117/12.2220025](https://doi.org/10.1117/12.2220025).
- [14] Iacopo Mochi and Kenneth A. Goldberg. “Modal wavefront reconstruction from its gradient”. In: *Appl. Opt.* 54.12 (Apr. 2015), p. 3780. ISSN: 0003-6935. DOI: [10.1364/AO.54.003780](https://doi.org/10.1364/AO.54.003780).
- [15] Mihir Upadhyaya et al. “Evaluating printability of buried native extreme ultraviolet mask phase defects through a modeling and simulation approach”. In: *J. Micro/Nanolithography, MEMS, MOEMS* 14.2 (2015), p. 023505. ISSN: 1932-5150. DOI: [10.1117/1.JMM.14.2.023505](https://doi.org/10.1117/1.JMM.14.2.023505).
- [16] Mihir Upadhyaya et al. “Level-set multilayer growth model for predicting printability of buried native extreme ultraviolet mask defects”. In: *J. Vac. Sci. Technol. B, Nanotechnol. Microelectron. Mater. Process. Meas. Phenom.* 33.2 (2015), p. 021602. ISSN: 2166-2746. DOI: [10.1116/1.4913315](https://doi.org/10.1116/1.4913315).
- [17] Kenneth A. Goldberg et al. “Actinic mask imaging: recent results and future directions from the SHARP EUV microscope”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 9048. 2014, 90480Y. DOI: [10.1117/12.2048364](https://doi.org/10.1117/12.2048364).
- [18] Kenji Yamazoe, Iacopo Mochi, and Kenneth a Goldberg. “Gradient descent algorithm applied to wavefront retrieval from through-focus images by an extreme ultraviolet microscope with partially coherent source”. In: *J. Opt. Soc. Am. A* 31.12 (2014), B34. ISSN: 1084-7529. DOI: [10.1364/JOSAA.31.000B34](https://doi.org/10.1364/JOSAA.31.000B34).
- [19] Markus P Benk et al. “Increased depth of field through wave-front coding: using an off-axis zone plate lens with cubic phase modulation in an EUV microscope”. In: *Proc. SPIE*. Vol. 8880. 2013, 88801R. DOI: [10.1117/12.2025954](https://doi.org/10.1117/12.2025954).
- [20] Rene A Claus et al. “Recovering effective amplitude and phase roughness of EUV masks”. In: *Proc. SPIE*. Vol. 8880. 2. 2013, 88802B. DOI: [10.1117/12.2027828](https://doi.org/10.1117/12.2027828).

- [21] Kenneth Alan Goldberg et al. “Commissioning an EUV mask microscope for lithography generations reaching 8 nm”. In: *Extrem. Ultrav. Lithogr. IV* 8679 (2013), pp. 867919–867919–10. ISSN: 0277786X. DOI: [10.1117/12.2011688](https://doi.org/10.1117/12.2011688).
- [22] Kenneth A. Goldberg et al. “The SEMATECH high-NA actinic reticle review project (SHARP) EUV mask-imaging microscope”. In: *Proc. SPIE*. Ed. by Thomas B. Faure and Paul W. Ackmann. Vol. 8880. Sept. 2013, 88800T. DOI: [10.1117/12.2026496](https://doi.org/10.1117/12.2026496).
- [23] Iacopo Mochi et al. “Pupil shaping and coherence control in an EUV mask-imaging microscope”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Ed. by Thomas B. Faure and Paul W. Ackmann. Vol. 8880. Sept. 2013, p. 888022. DOI: [10.1117/12.2026498](https://doi.org/10.1117/12.2026498).
- [24] Lei Sun et al. “Application of phase shift focus monitor in EUVL process control”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Ed. by Patrick P. Naulleau. Vol. 8679. Apr. 2013, 86790T. DOI: [10.1117/12.2011342](https://doi.org/10.1117/12.2011342).
- [25] Kenneth A Goldberg et al. “Creating an EUV Mask Microscope for Lithography Generations Reaching 8 nm”. In: *Proc. - ASPE 2012 Summer Top. Meet. Precis. Eng. Mechatronics Support. Semicond. Ind.* 7969.2011 (2012).
- [26] Tae-geun Kim et al. “Printability Study of Pattern Defects in the EUV Mask as a Function of hp Nodes”. In: *Proc. SPIE*. Vol. 8322. 2012, pp. 1–7. DOI: [10.1117/12.916052](https://doi.org/10.1117/12.916052).
- [27] Hyuk Joo Kwon et al. “EUV mask multilayer defects and their printability under different multilayer deposition conditions”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 8322. 2012, p. 832209. DOI: [10.1117/12.916374](https://doi.org/10.1117/12.916374).
- [28] Pei-Yang Yan, Iacopo Mochi, and Kenneth Alan Goldberg. “EUV Actinic Imaging Tool Aerial Image Evaluation of EUVL Embedded Phase Shift Mask Performance”. In: *SPIE Adv. Lithogr.* Vol. 8322. 2012, 83221P–83221P–8. DOI: [10.1117/12.919710](https://doi.org/10.1117/12.919710).
- [29] Simi a. George et al. “Replicated mask surface roughness effects on EUV lithographic patterning and line edge roughness”. In: *EUV Lithogr. II* 7969 (2011), 79690E–79690E–10. ISSN: 0277786X. DOI: [10.1117/12.881524](https://doi.org/10.1117/12.881524).
- [30] Kenneth A. Goldberg and Iacopo Mochi. “Actinic characterization of extreme ultraviolet bump-type phase defects”. In: *J. Vac. Sci. Technol. B, Nanotechnol. Microelectron. Mater. Process. Meas. Phenom.* 29.6 (2011), 06F502. ISSN: 2166-2746. DOI: [10.1116/1.3653257](https://doi.org/10.1116/1.3653257).
- [31] Kenneth a Goldberg et al. “An EUV Fresnel zoneplate mask-imaging microscope for lithography generations reaching 8 nm”. In: *Proc. SPIE* 7969.March (2011), p. 796910. ISSN: 0277786X. DOI: [10.1117/12.881651](https://doi.org/10.1117/12.881651).

- [32] Sungmin Huh et al. “Printability and Inspectability of Defects on the EUV Mask for sub32nm Half Pitch HVM Application”. In: *EUV Lithogr. II* 7969 (2011), pp. 796902–796902–9. ISSN: 0277786X. DOI: [10.1117/12.879384](https://doi.org/10.1117/12.879384).
- [33] Hyuk Joo Kwon et al. “Printability of native blank defects and programmed defects and their stack structures”. In: *Proc. SPIE* 8166 (2011), 81660H. ISSN: 0277786X. DOI: [10.1117/12.897165](https://doi.org/10.1117/12.897165).
- [34] Iacopo Mochi et al. “Quantitative evaluation of mask phase defects from through-focus EUV aerial images”. In: *EUV Lithogr. II*. Ed. by Bruno M. La Fontaine and Patrick P. Naulleau. Vol. 7969. Mar. 2011, p. 79691X. DOI: [10.1117/12.881652](https://doi.org/10.1117/12.881652).
- [35] Patrick P. Naulleau, Iacopo Mochi, and Kenneth A. Goldberg. “Optical modeling of Fresnel zoneplate microscopes”. In: *Appl. Opt.* 50.20 (2011), p. 3678. ISSN: 0003-6935. DOI: [10.1364/AO.50.003678](https://doi.org/10.1364/AO.50.003678).
- [36] Patrick P Naulleau et al. “Accelerating EUV learning with synchrotron light: Mask roughness challenges ahead”. In: *Proc. SPIE*. Vol. 8166. 2011, 81660F–81660F–7. DOI: [10.1117/12.900488](https://doi.org/10.1117/12.900488).
- [37] Patrick P Naulleau et al. “Using synchrotron light to accelerate EUV resist and mask materials learning”. In: *Proc. SPIE*. Vol. 7985. 2011, pp. 798509–798509–10. DOI: [10.1117/12.885420](https://doi.org/10.1117/12.885420).
- [38] Patrick Naulleau et al. “Mask roughness challenges in extreme ultraviolet mask development”. In: *J. Vac. Sci. Technol. B, Nanotechnol. Microelectron. Mater. Process. Meas. Phenom.* 29.6 (2011), 06F501. ISSN: 2166-2746. DOI: [10.1116/1.3632989](https://doi.org/10.1116/1.3632989).
- [39] A. J. R. van den Boogaard et al. “EUV-multilayers on grating-like topographies A.” In: *Proc. SPIE*. Vol. 7636. 100. 2010, 76362S–76362S–5. DOI: [10.1117/12.846564](https://doi.org/10.1117/12.846564).
- [40] Fernando Brizuela et al. “Extreme ultraviolet laser-based table-top aerial image metrology of lithographic masks.” In: *Opt. Express* 18.14 (2010), pp. 14467–14473. ISSN: 1094-4087. DOI: [10.1364/OE.18.014467](https://doi.org/10.1364/OE.18.014467).
- [41] Yu-Jen Fan et al. “Carbon contamination topography analysis of EUV masks.” In: *Proc. SPIE* 7636 (2010), 76360G/1–76360G/8. ISSN: 0277-786X. DOI: [10.1117/12.846996](https://doi.org/10.1117/12.846996).
- [42] Yu-Jen Fan et al. “Effect of carbon contamination on the printing performance of extreme ultraviolet masks”. In: *J. Vac. Sci. Technol. B Microelectron. Nanom. Struct.* 28.2 (2010), p. 321. ISSN: 10711023. DOI: [10.1116/1.3333434](https://doi.org/10.1116/1.3333434).
- [43] Simi a. George et al. “Extreme ultraviolet mask substrate surface roughness effects on lithographic patterning”. In: *J. Vac. Sci. Technol. B Microelectron. Nanom. Struct.* 28.6 (2010), C6E23. ISSN: 10711023. DOI: [10.1116/1.3502436](https://doi.org/10.1116/1.3502436).

- [44] K. A. Goldberg and I. Mochi. “Wavelength-specific reflections: A decade of extreme ultraviolet actinic mask inspection research”. In: *J. Vac. Sci. Technol. B, Nanotechnol. Microelectron. Mater. Process. Meas. Phenom.* 28.6 (2010), C6E1–C6E10. ISSN: 2166-2746. DOI: [10.1116/1.3498757](https://doi.org/10.1116/1.3498757).
- [45] Sungmin Huh et al. “A study of defects on EUV masks using blank inspection, patterned mask inspection, and wafer inspection”. In: *EUV Lithogr.* 7636 (2010), 76360K–76360K–7. ISSN: 0277786X. DOI: [10.1117/12.846922](https://doi.org/10.1117/12.846922).
- [46] Sungmin Huh et al. “Study of Real Defects on EUV Blanks and a Strategy for EUV Mask Inspection”. In: *26th Eur. Mask Lithogr. Conf.* 7545 (2010), 75450N–75450N–8. ISSN: 0277786X. DOI: [10.1117/12.863559](https://doi.org/10.1117/12.863559).
- [47] In-Yong Kang et al. “Printability and inspectability of programmed pit defects on the masks in EUV lithography”. In: *Simulation* 7636 (2010), 76361B–76361B–9. ISSN: 0277786X. DOI: [10.1117/12.847956](https://doi.org/10.1117/12.847956).
- [48] Iacopo Mochi, Kenneth A. Goldberg, and Sungmin Huh. “Actinic imaging and evaluation of phase structures on extreme ultraviolet lithography masks”. In: *J. Vac. Sci. Technol. B, Nanotechnol. Microelectron. Mater. Process. Meas. Phenom.* 28.6 (Nov. 2010), C6E11–C6E16. ISSN: 2166-2746. DOI: [10.1116/1.3498756](https://doi.org/10.1116/1.3498756).
- [49] I. Mochi et al. “Actinic imaging of native and programmed defects on a full-field mask”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Ed. by Bruno M. La Fontaine. Vol. 7636. Mar. 2010, 76361A. DOI: [10.1117/12.846670](https://doi.org/10.1117/12.846670).
- [50] Abbas Rastegar et al. “Particle removal challenges with EUV patterned masks for the sub-22 nm HP node”. In: *Spie* 7636 (2010), 76360N–76360N–11. ISSN: 0277786X. DOI: [10.1117/12.847056](https://doi.org/10.1117/12.847056).
- [51] Daniel T. Wintz et al. “Photon flux requirements for extreme ultraviolet reticle imaging in the 22- and 16-nm nodes”. In: *J. Micro/Nanolithography, MEMS, MOEMS* 9.4 (2010), p. 041205. ISSN: 1932-5150. DOI: [10.1117/1.3491512](https://doi.org/10.1117/1.3491512).
- [52] D.T. Wintz et al. “Photon flux requirements for EUV reticle imaging microscopy in the 22- and 16nm nodes”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 7636. 2010. DOI: [10.1117/12.846528](https://doi.org/10.1117/12.846528).
- [53] Chris H Clifford et al. “Comparison of fast three-dimensional simulation and actinic inspection for extreme ultraviolet masks with buried defects and absorber features”. In: *J. Vac. Sci. Technol. B Microelectron. Nanom. Struct.* 27.6 (2009), p. 2888. ISSN: 10711023 (ISSN). DOI: [10.1116/1.3244624](https://doi.org/10.1116/1.3244624).
- [54] Chris H Clifford et al. “Investigation of buried EUV mask defect printability using actinic inspection and fast simulation”. In: *Proc. SPIE* 7488 (2009), pp. 1–10. ISSN: 0277786X. DOI: [10.1117/12.829716](https://doi.org/10.1117/12.829716).
- [55] Yu-Jen Fan et al. “Carbon contamination of extreme ultraviolet (EUV) masks and its effect on imaging”. In: *Proc. SPIE* 7271 (2009), 72713U–72713U–9. ISSN: 0277786X. DOI: [10.1117/12.814196](https://doi.org/10.1117/12.814196).

- [56] K. a. Goldberg et al. “EUV pattern defect detection sensitivity based on aerial image linewidth measurements”. In: *J. Vac. Sci. Technol. B Microelectron. Nanom. Struct.* 27.6 (2009), p. 2916. ISSN: 10711023. DOI: [10.1116/1.3264676](https://doi.org/10.1116/1.3264676).
- [57] Kenneth Alan Goldberg, Iacopo Mochi, and Sungmin Huh. “Collecting EUV mask images through focus by wavelength tuning”. In: *Altern. Lithogr. Technol.* 7271 (2009), 72713N–72713N–8. ISSN: 0277786X. DOI: [10.1117/12.824433](https://doi.org/10.1117/12.824433).
- [58] Sungmin Huh et al. “EUV Actinic Defect Inspection and Defect Printability at the Sub-32 nm Half-pitch”. In: *Proc. SPIE*. Vol. 7470. 2009, 74700Y–74700Y–7. DOI: [10.1117/12.835196](https://doi.org/10.1117/12.835196).
- [59] Sungmin Huh et al. “Mask defect verification using actinic inspection and defect mitigation technology”. In: *Proc. SPIE* 7271 (2009), 72713J–72713J–9. ISSN: 0277786X. DOI: [10.1117/12.814249](https://doi.org/10.1117/12.814249).
- [60] H. Mizuno et al. “Thorough characterization of a EUV mask”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 7379. 2009. DOI: [10.1117/12.824260](https://doi.org/10.1117/12.824260).
- [61] Iacopo Mochi et al. “Improving the performance of the Actinic Inspection Tool with an optimized alignment procedure”. In: *Altern. Lithogr. Technol.* 7271 (2009), pp. 727123–727123–11. ISSN: 0277786X. DOI: [10.1117/12.814261](https://doi.org/10.1117/12.814261).
- [62] I. Mochi et al. “High-precision CTE measurement of aluminum-alloys for cryogenic astronomical instrumentation”. In: *Exp. Astron.* 27.1-2 (Dec. 2009), pp. 1–7. ISSN: 0922-6435. DOI: [10.1007/s10686-009-9172-7](https://doi.org/10.1007/s10686-009-9172-7).
- [63] S. Yuan et al. “At-wavelength and optical metrology of bendable X-ray optics for nanofocusing at the ALS”. In: *Opt. InfoBase Conf. Pap.* 2009.
- [64] K A Goldberg et al. “Actinic extreme ultraviolet mask inspection beyond 0.25 numerical aperture”. In: *J. Vac. Sci. Technol. B Microelectron. Nanom. Struct.* 26.6 (2008), p. 2220. ISSN: 10711023. DOI: [10.1116/1.3002490](https://doi.org/10.1116/1.3002490).
- [65] Kenneth A. Goldberg et al. “Benchmarking EUV mask inspection beyond 0.25 NA”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* 7122 (2008), 71222E. ISSN: 0277786X. DOI: [10.1117/12.801529](https://doi.org/10.1117/12.801529).