

Publications about EUV lithography

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References

- [1] 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. ISBN: 9781510607378. DOI: 10.1117/12.2260153. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2260153>.
- [2] 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.
- [3] 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. ISBN: 9781510607378. DOI: 10.1117/12.2259961. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2259961>.
- [4] 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.
- [5] Iacopo Mochi et al. “RESCAN: an actinic lensless microscope for defect inspection of EUV reticles”. In: *J. Micro/Nanolithography, MEMS, MOEMS* 16.4 (2017), p. 041003. ISSN: 1932-5150. DOI: 10.1117/1.JMM.16.4.041003. URL: <http://nanolithography.spiedigitallibrary.org/article.aspx?doi=10.1117/1.JMM.16.4.041003>.
- [6] Rajeev Rajendran et al. “Towards a stand-alone high-throughput EUV actinic photomask inspection tool: RESCAN”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 10145. 2017, 101450N. ISBN: 9781510607415. DOI: 10.1117/12.2258379. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2258379>.

- [7] Y. Ekinici et al. “Scanning coherent scattering methods for actinic EUV mask inspection”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 9985. 2016, 99851P. ISBN: 9781510603745. DOI: 10.1117/12.2242961. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2242961>.
- [8] Iacopo Mochi et al. “Assist features: placement, impact, and relevance for EUV imaging”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 9776. 2016, 97761S. ISBN: 9781510600119. DOI: 10.1117/12.2220025. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2220025>.
- [9] Iacopo Mochi and Kenneth A. Goldberg. “Modal wavefront reconstruction from its gradient”. In: *Appl. Opt.* 54.12 (2015), p. 3780. ISSN: 0003-6935. DOI: 10.1364/AO.54.003780. URL: <http://www.osapublishing.org/viewmedia.cfm?uri=ao-54-12-3780%7B%5C%7Dseq=0%7B%5C%7Dhtml=true>.
- [10] Mihir Upadhyaya et al. “2 3 4 5”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* 9422 (2015), pp. 1–14. ISSN: 1996756X 0277786X. DOI: 10.1117/12.2175842.
- [11] 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. URL: <http://nanolithography.spiedigitallibrary.org/article.aspx?doi=10.1117/1.JMM.14.2.023505>.
- [12] 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. URL: <http://scitation.aip.org/content/avs/journal/jvstb/33/2/10.1116/1.4913315>.
- [13] 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. ISBN: 9780819499714. DOI: 10.1117/12.2048364. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2048364>.
- [14] 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. URL: <http://www.ncbi.nlm.nih.gov/pubmed/25606778%7B%7D5Cnhttps://www.osapublishing.org/abstract.cfm?URI=josaa-31-12-B34>.

- [15] 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. ISBN: 9780819495457. DOI: 10.1117/12.2025954. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2025954>.
- [16] Rene A Claus et al. “Recovering effective amplitude and phase roughness of EUV masks”. In: *Proc. SPIE*. Vol. 8880. 2. 2013, 88802B. ISBN: 9780819495457. DOI: 10.1117/12.2027828. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2027828>.
- [17] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2011688>.
- [18] Kenneth A. Goldberg et al. “The SEMATECH high-NA actinic reticle review project (SHARP) EUV mask-imaging microscope”. In: *Proc. SPIE* 8880 (2013), 88800T. ISSN: 0277786X 1996756X. DOI: 10.1117/12.2026496. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2026496>.
- [19] I. Mochi et al. “Pupil shaping and coherence control in an EUV mask-imaging microscope”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 8880. 2013. ISBN: 9780819495457. DOI: 10.1117/12.2026498.
- [20] Lei Sun et al. “Application of phase shift focus monitor in EUVL process control”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 8679. 2013, 86790T. ISBN: 9780819494610. DOI: 10.1117/12.2011342. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.2011342>.
- [21] Kenneth A Goldberg et al. “CREATING AN EUV MASK MICROSCOPE FOR LITHOGRAPHY GENERATIONS REACHING 8 NM Lawrence Berkeley National Laboratory”. In: *Proc. - ASPE 2012 Summer Top. Meet. Precis. Eng. Mechatronics Support. Semicond. Ind.* 7969.2011 (2012), p. 796902.
- [22] 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. ISBN: 9780819489784. DOI: 10.1117/12.916052.
- [23] 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. ISBN: 9780819489784. DOI: 10.1117/12.916374. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.916374>.

- [24] 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. ISBN: 9780819489784. DOI: 10.1117/12.919710. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1310806>.
- [25] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=727024>.
- [26] 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. URL: <http://spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.881651>.
- [27] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1350025>.
- [28] 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. URL: <http://link.aip.org/link/PSISDG/v8166/i1/p81660H/s1%7B%5C%7DAgg=doi>.
- [29] Iacopo Mochi et al. “Quantitative evaluation of mask phase defects from through-focus EUV aerial images”. In: *EUV Lithogr. II* 7969 (2011), pp. 79691X–79691X–10. ISSN: 0277786X. DOI: 10.1117/12.881652. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=727219>.
- [30] 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. URL: <https://www.osapublishing.org/abstract.cfm?URI=ao-50-20-3678>.
- [31] Patrick P Naulleau et al. “Accelerating EUV learning with synchrotron light: Mask roughness challenges ahead”. In: *Proc. SPIE*. Vol. 8166. 2011, 81660F–81660F–7. ISBN: 9780819487919. DOI: 10.1117/12.900488. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1269099>.
- [32] 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. ISBN: 9780819485533. DOI: 10.1117/12.885420. URL: <http://spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.885420>.

- [33] 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. URL: <http://avs.scitation.org/doi/10.1116/1.3632989>.
- [34] 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. ISBN: 9780819480507. DOI: 10.1117/12.846564. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=1340768>.
- [35] 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.
- [36] 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.
- [37] 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.
- [38] 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.
- [39] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=755449>.
- [40] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=778084>.
- [41] 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. URL: <http://link.aip.org/link/PSISDG/v7636/i1/p76361B/s1%7B%5C%7DAgg=doi>.
- [42] 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 (2010), C6E11–C6E16. ISSN: 2166-2746. DOI:

- 10.1116/1.3498756. URL: <http://avs.scitation.org/doi/10.1116/1.3498756>.
- [43] I. Mochi et al. “Actinic imaging of native and programmed defects on a full-field mask”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 7636. 2010, 76361A. ISBN: 9780819480507. DOI: 10.1117/12.846670. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.846670>.
- [44] 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. URL: <http://spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.847056>.
- [45] 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. ISBN: 9780819480507. DOI: 10.1117/12.846528.
- [46] 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. URL: <http://link.aip.org/link/JVTBD9/v27/i6/p2888/s1%7B%5C%7DAgg=doi%7B%7D5Cnpapers2://publication/doi/10.1116/1.3244624>.
- [47] 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.
- [48] C.H. Clifford et al. “Comparison of fast 3D simulation and actinic inspection for EUV masks with buried defects”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 7271. 2009. ISBN: 9780819475244. DOI: 10.1117/12.813846.
- [49] 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.
- [50] 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.
- [51] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=817364>.

- [52] 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. ISBN: 9780819477705. DOI: 10.1117/12.835196. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=788428>.
- [53] 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. URL: <http://link.aip.org/link/PSISDG/v7271/i1/p72713J/s1%7B%5C%7DAgg=doi>.
- [54] H. Mizuno et al. “Thorough characterization of a EUV mask”. In: *Proc. SPIE - Int. Soc. Opt. Eng.* Vol. 7379. 2009. ISBN: 9780819476562. DOI: 10.1117/12.824260.
- [55] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?articleid=817459>.
- [56] I. Mochi et al. “High-precision CTE measurement of aluminum-alloys for cryogenic astronomical instrumentation”. In: *Exp. Astron.* 27.1-2 (2009), pp. 1–7. ISSN: 09226435. DOI: 10.1007/s10686-009-9172-7.
- [57] 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. ISBN: 9781557528780.
- [58] 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. URL: <http://link.aip.org/link/JVTBD9/v26/i6/p2220/s1%7B%5C%7DAgg=doi%7B%7D5Cnpapers2://publication/doi/10.1116/1.3002490>.
- [59] 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. URL: <http://proceedings.spiedigitallibrary.org/proceeding.aspx?doi=10.1117/12.801529>.