Bibliography

[1] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, sixth ed. (1980).

[2] J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill (1968).

[3] H. Ito and C. G. Willson, "Chemical amplification in the design of dry developing resist materials," *Polymer Engineering Science*, vol. 23, pp. 1012–1018 (1983).

[4] C. G. Willson, R. A. Dammel, and A. Reiser, "Photoresist materials: A historical perspective," in *Proc. SPIE* (1997), vol. 3049, pp. 28–41.

[5] M. J. Bowden, "The lithographic process: The physics," in L. F. Thompson, C. G. Willson, and M. J. Bowden, eds., *Introduction to Microlithography*, American Chemical Society, chapter 2, pp. 19–138 (1994).

[6] M. S. Hibbs, "System overview of optical steppers and scanners," in J. R. Sheats and B. W. Smith, eds., *Microlithography: Science and Technology*, Mercel Dekker, Inc., section 11.5, pp. 80–82 (1998).

[7] L. Geppert, "Solid state," *IEEE Spectrum*, pp. 23–28 (Jan. 1998).

[8] W. R. Runyan and K. E. Bean, *Semiconductor Integrated Circuit Processing Technology*, Addison-Wesley, section 10.7, p. 560 (1990).

[9] P. Yan, R. Hainsey, J. Farnsworth, and J. Neff, "Sub-micron low-k_1 imaging characteristics using a DUV printing tool and binary masks," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 270–276.

[10] F. Lo, G. Dao, M. Berube, N. Tam, R. Hainsey, J. Farnsworth, J. Dewitt, R. LaVoy, and S. Daugherty, "Ever-increasing role of mask technology in deep submicron lithography," in *Proc. SPIE* (1994), vol. 2254, pp. 2–13.

[11] P. Yan and J. Langston, "Mask CD control requirement at 0.18 μm design rules for 193 nm lithography," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 164–169.

[12] J. Wiley and J. Reynolds, "Device yield and reliability by specification of mask defects," *Solid State Technology*, vol. 36, no. 7, pp. 65–66,70,72,74,77 (Jul. 1993).

[13] A. Wong, R. Ferguson, L. Liebmann, S. Mansfield, A. Molless, and M. Neisser, "Lithographic effects of mask critical dimension error," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 106–116.

[14] A. Wong, R. Ferguson, and S. Mansfield, "The mask error factor in optical lithography," *IEEE Transactions on Semiconductor Manufacturing*, vol. 13, no. 2, pp. 235–242 (May 2000).

[15] B. J. Lin, "The attenuated phase-shifting mask," *Solid State Technology*, vol. 35, no. 1, pp. 43–47 (Jan. 1992).

[16] T. Terasawa, N. Hasegawa, and H. Fukuda, "Imaging characteristics of multi-phase-shifting and halftone phase-shifting masks," *Jpn. J. Appl. Phys.*, vol. 30, no. 11B, pp. 2991–2997 (Nov. 1991).

[17] A. Nitayama, T. Sato, and K. Hashimoto, "New phase shifting mask with self-aligned phase shifters for a quarter micron photolithography," in *Technical Digest—International Electron Devices Meeting* (1989), pp. 3.3.1–3.3.4.

[18] M. Levenson, N. Viswanathan, and R. Simpson, "Improving resolution in photolithography with a phase-shifting mask," *IEEE Transactions on Electron Devices*, vol. 29, no. 12, pp. 1812–1846 (Dec. 1982).

[19] L. Liebmann, I. Graur, W. Leipold, J. Oberschmidt, D. O'Grady, and D. Regaill, "Alternating phase shifted mask for logic gate levels, design and mask manufacturing," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 27–37.

[20] H.-Y. Liu, L. Karklin, Y.-T. Wang, and Y. C. Pati, "The application of alternating phase-shifting masks to 140 nm gate patterning: Line width control improvements and design optimization," in *Proc. SPIE* (1998), vol. 3236, pp. 328–337.

[21] S. Nakao, A. Nakae, K. Tsujita, and W. Wakamiya, "Impact of spherical aberrations on printing characteristics of irregularly aligned patterns of alternating phase shift mask," *Jpn. J. Appl. Phys.*, vol. 38, no. 4A, pp. 1919–1926 (Apr. 1999).

[22] R. Schenker, "Effects of phase shift masks on across field linewidth control," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 18–26.

[23] K. Toh, G. Dao, R. Singh, and H. Gaw, "Chromeless phase-shifted masks: A new approach to phase-shifting masks," in *Proc. SPIE* (1990), vol. 1496, pp. 27–53.

[24] W. S. Deforest, *Photoresist Materials and Processes*, McGraw-Hill (1975).

[25] W. M. Moreau, *Semiconductor Lithography: Principles, Practices, and Materials*, Plenum Press (1988).

[26] M. J. Bowden, "The lithographic process: The physics," in L. F. Thompson, C. G. Willson, and M. J. Bowden, eds., *Introduction to Microlithography*, American Chemical Society, section 2.1.1, pp. 22–23 (1994).

[27] M. J. Bowden, "The lithographic process: The physics," in L. F. Thompson, C. G. Willson, and M. J. Bowden, eds., *Introduction to Microlithography*, American Chemical Society, section 2.1.2, p. 24 (1994).

[28] R. M. Scott, "Annular field optical imaging system," (Jun. 1974), U. S. patent #3821763.

[29] A. Offner and C. T. Darien, "Unit power imaging catoptric anastigmat," (Jul. 1973), U. S. patent #3748015.

[30] D. A. Markle, "The future and potential of optical scanning systems," *Solid State Technology*, vol. 27, no. 9, pp. 159–166 (Sep. 1984).

[31] V. Pol, "High resolution optical lithography: A deep ultraviolet laser-based wafer stepper," *Solid State Technology*, vol. 30, no. 1, pp. 71–76 (1987).

[32] A. I. Ershov, T. Hofmann, W. N. Partlo, I. V. Fomenkov, G. Everage, P. R. Das, and D. Myers, "Feasibility studies of operating KrF lasers at ultra-narrow spectral bandwidths for 0.18 μm line widths," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 1021–1030.

[33] U. Stamm, R. Pätzel, J. Kleinschmidt, K. Volger, W. Zschocke, I. Bragin, and D. Basting, "ArF excimer laser for 193 nm lithography," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 1010–1013.

[34] S. Hirukawa, K. Matsumoto, and K. Takemasa, "New projection optical system for beyond 150 nm patterning with KrF and ArF sources," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 414–422.

[35] D. Cote, K. Andresen, D. Cronin, H. Harrold, M. Himel, J. Kane, J. Lyons, L. Markoya, C. Mason, D. McCafferty, M. McCarthy, G. O'Connor, H. Sewell, and D. Williamson, "Micrascan III—performance of a third generation, catadioptric step and scan lithographic tool," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 806–816.

[36] J. van Schoot, F. Bornebroek, M. Suddendorf, M. Mulder, J. van der Spek, J. Stoeten, and A. Hunter, "0.7 NA step and scan system for 150 nm imaging with improved overlay," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 448–463.

[37] N. Deguchi and S. Uzawa, "150 nm generation lithography equipment," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 464–472.

[38] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, section 3.3, p. 132, sixth ed. (1980).

[39] R. Dammel, *Diazonaphthoquinone-based Resists*, SPIE (1993).

[40] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, sections 1.6 and 13.4, pp. 51–70,627–633, sixth ed. (1980).

[41] D. G. Flagello, T. Milster, and A. E. Rosenbluth, "Theory of high-NA imaging in homogeneous thin films," *J. Opt. Soc. Am. A*, vol. 13, no. 1, pp. 53–64 (Jan. 1996).

[42] T. A. Brunner, "Optimization of optical properties of resist processes," in H. Ito, ed., *Proc. SPIE* (1991), vol. 1466, pp. 297–308.

[43] C. G. Willson, "Organic resist materials," in L. F. Thompson, C. G. Willson, and M. J. Bowden, eds., *Introduction to microlithography*, American Chemical Society, section 3.11, pp. 251–257 (1994).

[44] J. A. Sethian, "Fast marching level set methods for three-dimensional photolithography development," in G. Fuller, ed., *Proc. SPIE* (1996), vol. 2726, pp. 262–272.

[45] H. Kirchauer and S. Selberherr, "Rigorous three-dimensional photoresist exposure and development simulation over nonplanar topography," *IEEE Transactions on Computer-aided Design of Integrated Circuits and Systems*, vol. 16, no. 12, pp. 1431–1438 (Dec. 1997).

[46] M. Zuniga, N. Rau, and A. Neureuther, "Application of a general reaction/diffusion resist model to emerging materials with extension to non actinic exposure," in *Proc. SPIE* (1997), vol. 3049, pp. 256–268.

[47] T. Brunner and R. Ferguson, "Simple models for resist processing effects," *Solid State Technology*, pp. 95–96,98,100,103 (Jun. 1996).

[48] C. A. Mack, "Enhanced lumped parameter model for photolithography," in *Proc. SPIE* (1994), vol. 2197, pp. 501–510.

[49] G. Fürter, "High-resolution high-apertured objective," (Apr. 1997), U. S. patent #5880891.

[50] A. Wong, T. Farrell, R. Ferguson, G. Lu, S. Mansfield, A. Molless, M. Neisser, R. Nunes, D. Samuels, and A. Thomas, "Deep-UV lithographic approaches for 1 Gb DRAM," in *Digest of Technical Papers—Symposium on VLSI Technology* (1997), pp. 127–128.

[51] A. Wong, R. Ferguson, S. Mansfield, A. Molless, D. Samuels, R. Schuster, and A. Thomas, "Level-specific lithography optimization for 1 Gb DRAM," *IEEE Transactions on Semiconductor Manufacturing*, vol. 13, no. 1, pp. 76–87 (Feb. 2000).

[52] R. Longo, S. Chaloux, A. Krasnoperova, S. Lee, G. Murphy, A. Thomas, C. Wasik, M. Weybright, and G. Bronner, "An evaluation of X ray lithography using 0.175 μm (0.245 μm^2 cell area) 1 Gb DRAM technology," in *Digest of Technical Papers—Symposium on VLSI Technology* (1998), pp. 82–83.

[53] M. Sanchez, W. Hinsberg, F. Houle, J. Hoffnagle, H. Ito, and C. Nguyen, "Aerial image contrast using interferometric lithography: Effect on line-edge roughness," in W. Conley, ed., *Proc. SPIE* (1999), vol. 3678, pp. 160–171.

[54] M. A. Lieberman and A. J. Lichtenberg, *Principles of Plasma Discharges and Materials Processing*, John Wiley & Sons (1994).

[55] M. Sugawara, *Plasma Etching: Fundamentals and Applications*, Oxford University Press (1998).

[56] M. Aoki, T. Ozaki, T. Yamada, H. Kawaguichiya, Y. Ishibashi, and T. Hamamoto, "Fully self-aligned $6F^2$ cell technology for low cost 1 Gb DRAM," in *Digest of Technical Papers—Symposium on VLSI Technology* (1996), pp. 22–23.

[57] M. Aoki, T. Ozaki, T. Yamada, and T. Hamamoto, "NAND-structured DRAM cell with lithography-oriented design," *IEEE Transactions on Electronics*, vol. 79-C, no. 6, pp. 792–797 (Jun. 1996).

[58] B. J. Lin, "Methods to print optical images at low-k_1 factors," in V. Pol, ed., *Proc. SPIE* (1990), vol. 1264, pp. 2–13.

[59] T. A. Brunner, "Pushing the limits of lithography for IC production," in *Proceedings of the IEEE Electron Devices Meeting*, IEEE (1997), pp. 9–13.

[60] J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, section 3.3, pp. 37–42 (1968).

[61] J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, section 6.2, pp. 110–113 (1968).

[62] S. Gasiorowicz, *Quantum Physics*, John Wiley & Sons, appendix A, pp. 489–494 (1974).

[63] H. H. Hopkins, "On the diffraction theory of optical images," in *Proc. Royal Soc. of London* (1953), vol. 217A, pp. 408–432.

[64] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, chapter 10, pp. 491–555, sixth ed. (1980).

[65] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, section 10.5.3, pp. 530–532, sixth ed. (1980).

[66] J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, section 6.3, pp. 113–120 (1968).

[67] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, section 10.4, pp. 505–518, sixth ed. (1980).

[68] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, section 8.6.2, pp. 414–418, sixth ed. (1980).

[69] D. Halliday and R. Resnick, *Physics*, John Wiley & Sons, section 46.5, pp. 1034–1037, extended ed. (1986).

[70] D. G. Flagello, H. van der Lann, and B. Geh, "Understanding systematic and random CD variations in optical lithography using predictive modeling techniques," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 162–175.

[71] M. D. Levenson, "The phase-shifting mask II: Imaging simulations and submicrometer resist exposures," *IEEE Transactions on Electron Devices*, vol. 31, no. 6, pp. 753–763 (Jun. 1984).

[72] C. A. Mack, "Understanding focus effects in submicron optical lithography," in *Proc. SPIE* (1988), vol. 922, pp. 135–148.

[73] M. Born and E. Wolf, *Principles of Optics*, Pergamon Press, section 9.3, pp. 468–473, sixth ed. (1980).

[74] B. J. Lin, "Partially coherent imaging in two-dimensions and theoretical limits of projection printing in microfabrication," *IEEE Transactions on Electron Devices*, vol. 27, no. 5, pp. 931–938 (May 1980).

[75] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes in C*, Cambridge University Press, chapter 7, pp. 274–328, 2nd ed. (1992).

[76] K. Ronse, M. op de Beeck, A. Yen, K.-H. Kim, and L. van den Hove, "Characterization and optimisation of CD control for 0.25 μm CMOS applications," in G. Fuller, ed., *Proc. SPIE* (1996), vol. 2726, pp. 555–563.

[77] E. W. Charrier and C. A. Mack, "Yield modeling and enhancement for optical lithography," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 435–447.

[78] M. Noguchi, M. Muraki, Y. Iwasaki, and A. Suzuki, "Subhalf micron lithography system with phase-shifting effect," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 92–104.

[79] H.-Y. Kang, C.-H. Kim, J.-H. Lee, W.-S. Han, and Y.-B. Koh, "High performance lithography with advanced modified illumination," *IEEE Transactions on Electronics*, vol. 77-C, no. 3, pp. 432–437 (Mar. 1994).

[80] T. Ogawa, M. Uematsu, T. Ishimaru, and M. Kimura, "The effective light source optimization with the modified beam for the depth-of-focus enhancements," in T. Brunner, ed., *Proc. SPIE* (1994), vol. 2197, pp. 19–30.

[81] G. O. Reynolds, "A concept for a high resolution optical lithographic system for producing one-half micron linewidths," in H. L. Stover, ed., *Proc. SPIE* (1986), vol. 633, pp. 228–238.

[82] K. Kamon, T. Miyamoto, Y. Myoi, H. Nagata, M. Tanaka, and K. Horie, "Photolithography system using annular illumination," *Jpn. J. Appl. Phys.*, vol. 30, no. 11B, pp. 3021–3029 (Nov. 1991).

[83] T. Brunner, "Impact of lens aberrations on optical lithography," *IBM J. Res. Develop.*, vol. 41, no. 1/2, pp. 57–67 (Jan. 1997).

[84] J. Kirk and C. Progler, "Pupil illumination: In-situ measurement of partial coherence," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 281–288.

[85] J. Kirk and C. Progler, "Pinholes and pupil fills," *Microlithography World*, vol. 6, no. 4, pp. 25–28,34 (1997).

[86] J. Iba, K. Hashimoto, R. A. Ferguson, T. Yanagisawa, and D. J. Samuels, "Electrical characterization of across field lithographic performance for 256 Mbit DRAM technologies," in *Proc. SPIE* (1995), vol. 2512, pp. 218–225.

[87] R. Ferguson, R. Martino, and T. Brunner, "Data analysis methods for evaluating lithographic performance," *J. Vac. Sci. Technol. B*, vol. 15, no. 6, pp. 2387–2393 (Nov. 1997).

[88] K. H. Nakagawa, F. Chen, R. Socha, T. Laidig, K. E. Wampler, D. van den Broeke, M. Dusa, and R. Caldwell, "Halftone biasing OPC technology: An approach for achieving fine bias control on raster-scan systems," in *Proc. SPIE* (1999), vol. 3748, pp. 315–323.

[89] P. G. Engeldrum, "Color gamut limits of halftone printing with and without the paper spread function," *Journal of Imaging Science and Technology*, vol. 40, no. 3, pp. 239–244 (May 1996).

[90] A. K. Wong, "Asymmetric biasing for subgrid pattern adjustment," in C. Progler, ed., *Proc. SPIE* (2001), vol. 4346.

[91] M. D. Prouty and A. R. Neureuther, "Optical imaging with phase shift masks," in *Proc. SPIE* (1984), vol. 470, pp. 228–232.

[92] J. Garofalo, C. Biddick, R. Kostelak, and S. Vaidya, "Mask assisted off axis illumination technique for random logic," *J. Vac. Sci. Technol. B*, vol. 11, no. 6, pp. 2651–2658 (Nov. 1993).

[93] J. Garofalo, O. Otto, R. Cirelli, R. Kostelak, and S. Vaidya, "Automated layout of mask assist-features for realizing $0.5k_1$ ASIC lithography," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 302–312.

[94] J. F. Chen, T. Laidig, K. Wampler, and R. Caldwell, "Optical proximity correction for intermediate-pitch features using sub-resolution scattering bars," *J. Vac. Sci. Technol. B*, vol. 15, no. 6, pp. 2426–2433 (Nov. 1997).

[95] S. M. Mansfield, L. W. Liebmann, A. F. Molless, and A. K. Wong, "Lithographic comparison of assist feature design strategies," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 63–76.

[96] "Techniques on microphotography," (1963), Kodak sales service publication P-52.

[97] A. C. Thomas, A. K. Wong, R. A. Ferguson, D. J. Samuels, R. Longo, F. X. Zach, J. Zhu, and C. Feild, "Approach to pattern aspect ratio control," in *Proc. SPIE* (1999), vol. 3679, pp. 839–846.

[98] O. Otto and R. Henderson, "Advances in process matching for rules-based optical proximity correction," in *Proc. SPIE* (1996), vol. 2884, pp. 425–434.

[99] N. Cobb and A. Zakhor, "Experimental results on optical proximity correction with variable threshold resist model," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 458–468.

[100] M. Rieger and J. Stirniman, "Mask fabrication rules for proximity corrected patterns," in *Proc. SPIE* (1996), vol. 2884, pp. 323–332.

[101] T. Waas, H. Eisenmann, and H. Hartmann, "Proximity correction for high CD-accuracy and process tolerance," in *Proc. Symposium on Nanocircuit Engineering* (1994).

[102] H.-Y. Liu, L. Karklin, Y.-T. Wang, and Y. C. Pati, "Application of alternating phase-shifting masks to 140 nm gate patterning II: Mask design and manufacturing tolerances," in *Proc. SPIE* (1998), vol. 3334, pp. 2–14.

[103] J. P. Stirniman and M. L. Rieger, "Fast proximity correction with zone sampling," in T. Brunner, ed., *Proc. SPIE* (1994), vol. 2197, pp. 294-301.

[104] J. P. Stirniman and M. L. Rieger, "Spatial filter models to describe IC lithographic behavior," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 469–478.

[105] M. Yeung, "Modeling aerial images in two and three dimensions," in *Proc. Kodak Microelectronics* (1985), pp. 115–126.

[106] K. Toh, *Two-dimensional Images with Effects of Lens Aberrations in Optical Lithography*, Master's thesis, University of California, Berkeley (May 1988), memorandum No. UCB/ERL M88/30.

[107] Y. C. Pati, A. A. Ghazanfarian, and R. F. Pease, "Exploiting structure in fast aerial image computation for integrated circuit patterns," *IEEE Transactions on Semiconductor Manufacturing*, vol. 10, no. 1, pp. 62–74 (Feb. 1997).

[108] C. Progler and D. Wheeler, "Optical lens specifications from the users' perspective," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 256–268.

[109] D. G. Flagello, J. de Klerk, G. Davies, and R. Rogoff, "Towards a comprehensive control of full-field image quality in optical lithography," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 672–685.

[110] J. Kirk, "Scattered light in photolithographic lenses," in T. Brunner, ed., *Proc. SPIE* (1994), vol. 2197, pp. 566–572.

[111] L. Liebmann, A. Molless, R. Ferguson, A. Wong, and S. Mansfield, "Understanding across chip line width variation: The first step toward optical proximity correction," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 124–136.

[112] C. Progler and A. Wong, "Zernike coefficients: are they really enough?" in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 40–52.

[113] D. Goodman and A. Rosenbluth, "Condenser aberrations in Köhler illumination," in *Proc. SPIE* (1988), vol. 922, pp. 108–134.

[114] Y. Borodovsky, "Impact of local partial coherence variations on exposure tool performance," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 750–770.

[115] T. Terasawa, N. Hasegawa, and S. Katagiri, "The effect of condenser tilt on projection images produced by a phase-shifting mask," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 127–137.

[116] T. Uchiyama, T. Hashimoto, M. Fujimoto, S. Matsuura, T. Yamazaki, and K. Kasama, "Effect of stage synchronization error of KrF scan on 0.18 μm patterning," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 67–76.

[117] R. Kostelak, C. Pierrat, J. Garofalo, and S. Vaidya, "Exposure characteristics of alternate aperture phase-shifting masks fabricated using a subtractive process," *J. Vac. Sci. Technol. B*, vol. 10, no. 6, pp. 3055–3061 (Nov. 1992).

[118] R. Ferguson, R. Martino, R. Budd, J. Staples, L. Liebmann, D. Dove, and T. Weed, "Application of an aerial image measurement system to mask fabrication and analysis," in *Proc. SPIE* (1993), vol. 2087, pp. 131–144.

[119] C.-M. Dai, H.-K. Lin, and D. H.-T. Lee, "Resist development mechanism study: its effect on the submicron microlithography process window," *Jpn. J. Appl. Phys.*, vol. 33, no. 12B, pp. 7001–7004 (Dec. 1994).

[120] C. Hedlund, H. Blom, and S. Berg, "Microloading effect in reactive ion etching," *J. Vac. Sci. Technol. A*, vol. 12, no. 4, pp. 1962–1965 (1994).

[121] G. Owen and R. Rissman, "Proximity effect correction for electron beam lithography by equalization of background dose," *Journal of Applied Physics*, vol. 54, no. 6, pp. 3573–3581 (1983).

[122] M. Mansuripur, "Distribution of light at and near the focus of high numerical aperture objectives," *J. Opt. Soc. Am. A*, vol. 3, no. 12, pp. 2086–2093 (Dec. 1986).

[123] A. K. Wong and A. R. Neureuther, "Polarization effects in mask transmission," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 193–200.

[124] A. K. Wong, A. F. Molless, T. A. Brunner, E. Coker, R. H. Fair, G. L. Mack, and S. M. Mansfield, "Characterization of line width variation," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 184–191.

[125] C. Pierrat, A. Wong, and S. Vaidya, "Phase-shifting mask topography effects on lithographic image quality," in *Technical Digest—International Electron Devices Meeting* (Dec. 1992), pp. 53–56.

[126] A. Wong and A. Neureuther, "Mask topography effects in projection printing of phase-shifting masks," *IEEE Transactions on Electron Devices*, vol. 41, no. 6, pp. 895–902 (Jun. 1994).

[127] S. Tanaka, H. Nakamura, K. Kawano, and S. Inoue, "Practical topography design for alternating phase-shifting mask," in G. Fuller, ed., *Proc. SPIE* (1996), vol. 2726, pp. 473–484.

[128] R. Ferguson, L. Liebmann, S. Mansfield, D. O'Grady, and A. Wong, "Exact transmission balanced alternating phase-shifting mask for photolithography," (Aug. 1999), U.S. patent #5932377.

[129] L. D. Landau, E. M. Lifshitz, and L. P. Pitaevskiĭ, *Electrodynamics of Continuous Media*, Pergamon Press, section 1.1, pp. 1–3, 2nd ed. (1984).

[130] D. Nyyssonen and C. P. Kirk, "Optical microscope imaging of lines patterned in thick layers with variable edge geometry: theory," *J. Opt. Soc. Am. A*, vol. 5, no. 8, pp. 1270–1280 (Aug. 1988).

[131] K. Lucas, C.-M. Yuan, and A. Strojwas, "A rigorous and practical vector model for phase shifting masks in optical lithography," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 252–263.

[132] T. Matsuzawa, A. Moniwa, N. Hasegawa, and H. Sunami, "Two-dimensional simulation of photolithography on relective stepped substrate," *IEEE Transactions on Computer-aided Design of Integrated Circuits and Systems*, vol. 6, no. 3, pp. 446–451 (May 1987).

[133] E. Barouch, B. Bradie, G. Karniadakis, and S. Orszag, "Comprehensive 3D simulator with non-planar substrates," in V. Pol, ed., *Proc. SPIE* (1990), vol. 1264, pp. 334–342.

[134] J. Bischoff, U. Glaubitz, and N. Haase, "New method of topography simulation in photolithography," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 423–434.

[135] M. Yeung and E. Barouch, "Three-dimensional nonplanar lithography simulation using a periodic fast multipole method," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 509–521.

[136] G. L. Wojcik, J. Mould, R. Ferguson, R. Martino, and K. K. Low, "Some image modeling issues for i-line 5x phase shifting masks," in T. Brunner, ed., *Proc. SPIE* (1994), vol. 2197, pp. 455–465.

[137] A. Wong and A. Neureuther, "Rigorous three-dimensional time-domain finite-difference electromagnetic simulation for photolithographic applications," *IEEE Transactions on Semiconductor Manufacturing*, vol. 8, no. 4, pp. 419–431 (Nov. 1995).

[138] R. Ferguson, A. Wong, T. Brunner, and L. Liebmann, "Pattern-dependent correction of mask topography effects for alternating phase-shifting masks," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 349–360.

[139] V. N. Mahajan, "Zernike circle polynomials and optical aberrations of systems with circular pupils," *Engineering & Laboratory Notes*, pp. S-21–S-24 (Aug. 1994).

[140] H. Watanabe, E. Suguira, T. Imoriya, and M. Inoue, "Detection and printability of shifter defects in phase shifting masks, II: Defocus characteristics," *Jpn. J. Appl. Phys.*, vol. 31, no. 12B, pp. 4155–4160 (1992).

[141] A. Neureuther, P. Flanner, and S. Shen, "Coherence of defect interactions with features in optical imaging," *J. Vac. Sci. Technol. B*, vol. 5, no. 1, pp. 308–312 (Jan. 1987).

[142] J. N. Wiley, T. Y. Fu, T. Tanaka, S. Takeuchi, S. Aoyama, J. Miyazaki, and Y. Watakabe, "Phase shift mask pattern accuracy requirements and inspection technology," in W. H. Arnold, ed., *Proc. SPIE*, SPIE (1991), vol. 1464, pp. 346–355.

[143] R. Ferguson and A. Wong, "Detection of phase defects on photomasks by differential imaging," (Jun. 1999), patent pending.

[144] S. Nagashige, K. Hayashi, S. Akima, K. Chiba, Y. Yamada, and Y. Matsuzawa, "Detection and repair of multiphase defects on alternating phase-shift masks for DUV lithography," in F. Abboud and B. Grenon, eds., *Proc. SPIE* (1999), vol. 3873, pp. 127–137.

[145] L. Liebmann, S. Mansfield, A. Wong, J. Smolinski, S. Peng, K. Kimmel, M. Rudzinski, J. Wiley, and L. Zurbrick, "High-resolution ultraviolet defect inspection of DAP (darkfield alternate phase) reticles," in F. Abboud and B. Grenon, eds., *Proc. SPIE* (1999), vol. 3873, pp. 148–161.

[146] L. Liebmann (Mar. 2000), private communication.

[147] T. Haruki, R. Tsujimura, J. Tomida, Y. Machida, S. Asai, and I. Hanju, "Development of total support CAD system for alternate-type PSMs with optical proximity correction," in *Proc. SPIE* (1999), vol. 3748, pp. 222–232.

[148] A. Moniwa, T. Terasawa, K. Nakajo, J. Sakemi, and S. Okazaki, "Heuristic method for phase-conflict minimization in automatic phase-shift mask design," *Jpn. J. Appl. Phys.*, vol. 34, no. 12B, pp. 6584–6589 (Dec. 1995).

[149] K. Ooi, K. Koyama, and M. Kiryu, "Method of designing phase-shifting masks utilizing a compactor," *Jpn. J. Appl. Phys.*, vol. 33, no. 12B, pp. 6774–6778 (Dec. 1994).

[150] Y. C. Pati and T. Kailath, "Phase-shifting masks for microlithography: automated design and mask requirements," *J. Opt. Soc. Am. A*, vol. 11, no. 9, pp. 2438–2452 (Sep. 1994).

[151] L. Liebmann, S. Mansfield, A. Wong, M. Lavin, W. Leipold, and T. Dunham, "TCAD/EDA development for lithography resolution enhancement," *IBM J. Res. Develop.* (2001).

[152] H. Ohtsuka, T. Onodera, K. Kuwahara, and T. Taguchi, "Conjugate twin-shifter masks with multiple focal planes," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 53–64.

[153] J. Nistler, G. Hughes, A. Murray, and J. Wiley, "Issues associated with commercialization of phase-shifting masks," in *Proc. SPIE* (1991), vol. 1604, pp. 236–264.

[154] A. K. Pfau, E. W. Scheckler, D. M. Newmark, and A. R. Neureuther, "Gradient phase-shifter transitions fabricated by ion milling," in J. D. Cuthbert, ed., *Proc. SPIE* (1992), vol. 1674, pp. 585–593.

[155] C. A. Spence, "Mask for optical lithography using phase shift masking and integrated circuit produced therefrom," (Dec. 1997), U. S. patent #5702848.

[156] T. Brunner, P. Sanda, M. Wordeman, and T. Lii, "170 nm gates fabricated by phase-shift mask and top anti-reflector process," in J. Cuthbert, ed., *Proc. SPIE* (1993), vol. 1927, pp. 182–189.

[157] E. Hewitt and R. Hewitt, "The Gibbs-Wilbraham phenomenon: An episode in Fourier analysis," *Hist. Exact Sci.*, vol. 21, pp. 129–160 (1979).

[158] D. Gottlieb and C.-W. Shu, "On the Gibbs phenomenon and its resolution," *SIAM Review*, vol. 39, no. 4, pp. 644–668 (Dec. 1997).

[159] A. Otaka, Y. Kawai, and Y. Sakakibara, "Effect of lens aberration on hole pattern fabrication using halftone phase-shifting masks," in *Proc. SPIE* (1997), vol. 3096, pp. 298–307.

[160] M. Kohzuma, K. Chiba, H. Unno, Y. Kikuchi, and Y. Yamada, "The investigation of tri tone PSM and its performance," in *Proc. SPIE* (1998), vol. 3236, pp. 250–263.

[161] R. J. Socha, W. E. Conley, X. Shi, M. V. Dusa, J. S. Petersen, F. Chen, K. Wampler, T. Laidig, and R. Caldwell, "Resolution enhancement with high transmission attenuating phase shifting masks," in *Proc. SPIE* (1999), vol. 3748, pp. 290–314.

[162] O. Popa and R. Jonckheere, "Attenuated phase shift masks using MoSi as an opaque layer," in *Proc. International Semiconductor Conference*, IEEE (1995), pp. 171–174.

[163] F. D. Kalk, R. H. French, H. U. Alpay, and G. Hughes, "Attenuated phase-shifting photomasks fabricated from Cr-based embedded shifter blanks," in *Proc. SPIE* (1994), vol. 2254, pp. 64–70.

[164] H. Mohri, K. Hashimoto, T. Tominaga, Y. Morikawa, J. Fujikawa, H. Inomata, Y. Iimura, W. Gotoh, M. Takahashi, and H. Sano, "Manufacturing of half-tone phase-shift masks I: Blank," in *Proc. SPIE* (1994), vol. 2254, pp. 238–247.

[165] A. Callegari, K. Babich, S. Purushothaman, S. Mansfield, R. Ferguson, A. Wong, W. Adair, D. O'Grady, and V. Chao, "Lithographic evaluation of DUV carbon attenuated phase shift mask," in *Proc. Symposium on Nanocircuit Engineering* (1997), vol. 41–42, pp. 107–110.

[166] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes in C*, Cambridge University Press, chapter 10, pp. 394–455, 2nd ed. (1992).

[167] W. Conley, G. Breyta, R. DePietro, D. Hofer, S. Holmes, H. Ito, and R. Nunes, "The lithographic performance of an environmentally stable chemically amplified photoresist (ESCAP)," in *Proc. SPIE* (1996), vol. 2724, pp. 34–60.

[168] W. Brunsvold, W. Conley, P. Varanasi, M. Khojasteh, N. Patel, A. Molless, M. Neisser, and G. Breyta, "PHS with inert blocking groups for DUV negative resist," in *Proc. SPIE* (1997), vol. 3049, pp. 372–384.

[169] J. W. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, section 5.3, pp. 90–96 (1968).

[170] J. Gambino, D. Dobuzinsky, M. Armacost, B. Cunningham, T. Ohiwa, and S. Yoshikawa, "A Si_3N_4 etch stop process for borderless contacts in 0.25 μm devices," in *Proc. VMIC* (1995), p. 558.

[171] S. Nakao, K. Tsujita, I. Arimoto, and W. Wakamiya, "Imaging characteristics of 0.12 μm dynamic random access memory pattern by KrF excimer laser lithography," *Jpn. J. Appl. Phys.*, vol. 38, no. 12B, pp. 6985–6993 (Dec. 1999).

[172] E. Kawamura, K. Nagai, H. Kanemitsu, Y. Tabata, and S. Inoue, "130-nm KrF lithography for DRAM production with 0.68-NA scanner," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 927–934.

[173] Y. T. Chen, C. H. Lin, H. T. Lin, H. C. Hsieh, S. S. Yu, and A. Yen, "0.13-μm optical lithography for random logic devices using 248-nm attenuated phase-shifting masks," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 99–110.

[174] A. Misaka, A. Goda, S. Odanaka, S. Kobayashi, and H. Watanabe, "A statistical gate CD control including OPC," in *Digest of Technical Papers—Symposium on VLSI Technology* (1998), pp. 170–171.

[175] T. Saito, H. Watanabe, and Y. Okuda, "Effect of variable sigma aperture on lens distortion and its pattern size dependence," in S. Jones, ed., *Proc. SPIE* (1996), vol. 2725, pp. 414–423.

[176] T. Saito, H. Watanabe, and Y. Okuda, "Overlay error of fine patterns by lens aberrations using modified illumination," in G. Fuller, ed., *Proc. SPIE* (1997), vol. 3051, pp. 686–696.

[177] G. E. Moore, "Lithography and the future of Moore's law," in T. Brunner, ed., *Proc. SPIE* (1995), vol. 2440, pp. 2–17.

[178] Y. A. Borodovsky, "Lithographic enhancement method and apparatus for randomly spaced structures," (Jun. 1995), U. S. patent #5424154.

[179] X. Chen and S. R. J. Brueck, "Imaging interferometric lithography: A wavelength division multiplex approach to extending optical lithography," *J. Vac. Sci. Technol. B*, vol. 16, no. 6, pp. 3392–3397 (Nov. 1998).

[180] H. Fukuda, N. Hasegawa, and S. Okazaki, "Improvement of defocus tolerance in a half-micron optical lithography by the focus latitude enhancement exposure method: Simulation and experiment," *J. Vac. Sci. Technol. B*, vol. 7, no. 4, pp. 667–674 (Jul. 1989).

[181] H. Fukuda, T. Terasawa, and S. Okazaki, "Spatial filtering for depth of focus and resolution enhancement in optical lithography," *J. Vac. Sci. Technol. B*, vol. 9, no. 6, pp. 3113–3116 (Nov. 1991).

[182] H. Fukuda and S. Hotta, "0.3-μm pitch random interconnect patterning with node connection phase-shifting mask: experiments and simulations," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 149–159.

[183] G. E. Kunkel, S. J. Bukofsky, R. Wise, and A. Wong, "Multiple exposure process for formation of dense rectangular arrays," (Apr. 2000), patent pending.

[184] M. Neisser and A. Molless, "Simulation and experimental evaluation of double exposure techniques," in L. van den Hove, ed., *Proc. SPIE* (1998), vol. 3334, pp. 372–383.

[185] A. Suzuki, K. Saitoh, and M. Yoshii, "Multilevel imaging system realizing $k_1 = 0.3$ lithography," in L. van den Hove, ed., *Proc. SPIE* (1999), vol. 3679, pp. 396–407.

[186] A. E. Rosenbluth, S. Bukofsky, R. N. Singh, and A. Wong, "Optimum mask and source patterns to print a given shape," in C. Progler, ed., *Proc. SPIE* (2001), vol. 4346.

[187] T. Toyoshima, T. Ishibashi, A. Minanide, K. Sugino, K. Katayama, T. Shoya, I. Arimoto, N. Yasuda, H. Adachi, and Y. Matsui, "0.1 μm level contact hole pattern formation with KrF lithography by resolution enhancement lithography assisted by chemical shrink (RELACS)," in *Technical Digest—International Electron Devices Meeting* (Dec. 1998), pp. 333–336.

[188] A. K. Wong, L. W. Liebmann, and A. F. Molless, "Alternating phase-shifting mask with reduced aberration sensitivity: lithography considerations," in C. Progler, ed., *Proc. SPIE* (2001), vol. 4346.

[189] D. L. White, R. A. Cirelli, S. J. Spector, M. I. Blakey, and O. R. Wood, "Phase-mask effects by dark-field lithography," in C. Progler, ed., *Proc. SPIE* (2000), vol. 4000, pp. 366–372.

[190] C. Fonseca (May 2000), private communication.

[191] Y. Taur, D. A. Buchanan, W. Chen, D. J. Frank, K. E. Ismail, S.-H. Lo, G. A. Sai-Halasz, R. G. Viswanathan, H.-J. C. Wann, S. J. Wind, and H.-S. Wong, "CMOS scaling into the nanometer regime," *Proceedings of the IEEE*, vol. 85, no. 4, pp. 486–504 (Apr. 1997).

[192] C. Hu, "Ultra-large-scale integration device scaling and reliability," *J. Vac. Sci. Technol. B*, vol. 12, no. 6, pp. 3237–3241 (Nov. 1994).

[193] S. Asai and Y. Wada, "Technology challenges for integration near and below 0.1 μm," *Proceedings of the IEEE*, vol. 85, no. 4, pp. 505–520 (Apr. 1997).

[194] A. I. Kingon, J.-P. Maria, and S. K. Streiffer, "Alternative dielectrics to silicon dioxide for memory and logic devices," *Nature*, vol. 406, pp. 1032–1038 (Aug. 2000).

[195] B. Davari, "CMOS technology: Present and future," in *Digest of Technical Papers—Symposium on VLSI Technology* (1999).

[196] J. D. Meindl, "Gigascale integration: is the sky the limit?" *IEEE Circuis and Devices Magazine*, vol. 12, no. 6, pp. 19–24,32 (Nov. 1996).

[197] R. Isaac, "The future of CMOS technology," *IBM J. Res. Develop.*, vol. 44, no. 3, pp. 369–378 (May 2000).

[198] M. H. Devoret and R. J. Schoelkopf, "Amplifying quantum signals with the single-electron transistor," *Nature*, vol. 406, pp. 1039–1046 (Aug. 2000).

Additional references

On integrated circuit fabrication:

W. Glendinning and J. Helbert, eds., *Handbook of VLSI Microlithography: Principles, Technology and Applications,* Noyes Publications, ISBN 0-81551-281-3, (1991).

W. R. Runyan and K. E. Bean, *Semiconductor Integrated Circuit Processing Technology,* Addison-Wesley Publishing Company, ISBN 0-201-10831-3, (1990).

S. Wolf and R. Tauber, *Silicon Processing for the VLSI Era, vol. 1: Process Technology,* Lattice Press, Sunset Beach, California, ISBN 0-961672-3-7, (1986).

On microlithography and optical lithography:

Semiconductor Industry Association, *The National Technology Roadmap for Semiconductors,* (1997).

H. Levinson, *Lithography Process Control,* SPIE Press, Bellingham, Washington, TT28, ISBN 0-8194-3052-8, (1999).

J. Sheats and B. Smith, eds., *Microlithography: Science and Technology,* Marcel Dekker, ISBN 0-82479-953-4, (1998).

S. Nonogaki, T. Ito, and T. Ueno, *Microlithography Fundamentals in Semiconductor Devices and Fabrication Technology,* Marcel Dekker, ISBN 0-82479-951-8, (1998).

P. Rai-Choudhury, ed., *Handbook of Microlithography, Micromachining, and Microfabrication, vol. 1: Microlithography*, SPIE Press, Bellingham, Washington, ISBN 0-8529-6906-6, (1997).

G. Chiu and J. Shaw, eds., *IBM J. of Research and Development,* vol. 41, nos. 1/2, IBM, Armonk, New York, ISSN 0018-8646, (Jan/Mar 1997).

L. Thompson, C. Willson, and M. Bowden, eds., *Introdution to Microlithography,* American Chemical Society, ISBN 0-8412-2848-5, (1994).

On nonoptical lithography techniques:

http://www.sematech.org

D. Attwood, *Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications,* Cambridge University Press, Cambridge, (Sep 1999).

C. Gwyn, et al., "Extreme Ultraviolet Lithography: A White Paper," EUV Limited Liability Company, Livermore, California, (Nov 1998).

http://lasers.llnl.gov/lasers/IST/euvl.html

John Warlaumont, ed., *IBM J. of Research and Development,* vol. 37, no. 3, IBM, Armonk, New York, (May 1993).

http://www.xraylith.wisc.edu/homepage.html

K. Okamoto, K. Suzuki, H. C. Pfeiffer, and M. Sogard, "High-throughput e-beam stepper lithography," *Solid State Technology,* vol. 43, no. 5, pp. 118-122, (May 2000).

http://www.bell-labs.com/project/SCALPEL/index.html

R. Kaesmaier, H. Loschner, G. Stengl, and J. C. Wolfe, "Ion projection lithography: International development program," *J. Vac. Sci. Technol. B,* vol. 17, no. 6, pp. 3091–3097, (Nov 1999).

J. Melngailis, A. A. Mondelli, I. L. Berry, and R. Mohondro, "A review of ion projection lithography," *J. Vac. Sci. Technol. B,* vol. 16, no. 3, pp. 927–957, (May/Jun 1998).

G. Gross, "Ion projection lithography: next generation technology?" *J. Vac. Sci. Technol. B,* vol. 15, no. 6, pp. 2136–2138, (Dec 1997).

S. Y. Chou, T. R. Krauss, and P. J. Renstrom, "Imprint lithography with 25-nanometer resolution," *Science,* vol. 272, pp. 85–87, (Apr 1996).

H. C. Scheer, H. Schulz, T. Hoffmann, and C. M. S. Torres, "Problems of the nanoimprinting technique for nanometer scale pattern definition," *J. Vac. Sci. Technol. B,* vol. 16, no. 6, pp. 3917–3921, (Nov 1998).

M. Colburn, S. Johnson, M. Stewart, S. Damle, T. Bailey, B. Choi, M. Wedlake, T. Michaelson, S. V. Sreenivasan, J. Ekerdt, and C. G. Willson, "Step and flash imprint lithography: A new approach to high-resolution patterning," *Proc. SPIE,* vol. 3676, pp. 379–389, (1999).

Y. Hirai, Y. Kanemaki, K. Murata, and Y. Tanaka, "Novel mold fabrication for nanoimprint lithography to fabricate single electron tunneling devices," *Jpn. J. Appl. Phys.*, vol. 38, no. 12B, pp. 7272–7275, (Dec 1999).

D. Y. Khang and H. H. Lee, "Room-temperature imprint lithography by solvent vapor treatment," *Applied Physics Letters,* vol. 76, no. 7, pp. 870–872, American Institute of Physics, (Feb 2000).

William Oldham, "Lithography Evolution: The Continuing Challenge," http://diva.eecs.berkeley.edu/õldham/pubs/SPIEtalk.ppt

D. J. D. Carter, D. Gil, R. Menon, M. K. Mondol, H. I. Smith, and E. H. Anderson, "Maskless, parallel patterning with zone-plate array lithography," *J. Vac. Sci. Technol. B,* vol. 17, no. 6, pp. 3449–3452, (Nov/Dec 1999).

N. Choksi, D. S. Pickard, M. McCord, R. F. W. Pease, Y. Shroff, Y. J. Chen, W. Oldham, and D. Markle, "Maskless extreme ultraviolet lithography," *J. Vac. Sci. Technol. B,* vol. 17, no. 6, pp. 3047–3051, (Nov/Dec 1999).

On optical imaging:

M. Born and E. Wolf, *Principles of Optics,* Pergamon Press, (1980).

J. Goodman, *Introduction to Fourier Optics,* McGraw-Hill, (1968).

On electromagnetism:

Roger F. Harrington, *Time-harmonic Electr netic Fields,* McGraw-Hill, Inc., ISBN 0-7-026745-6, (1961).

J. D. Jackson, *Classical Electrodynamics,* J iley & Sons, ISBN 0-471-43132-X, (1975).

L. D. Landau, E. M. Lifshitz, and L. P. Pit *Electrodynamics of Continuous Media,* Pergamon Press, ISBN 0-0 -0, (1984).

S. Ramo, J. Whinnery, and T. van Duzer, *nd Waves in Communication Electronics,* John Wiley & Sons, ISB -58551-3, (1994).

OPC software companies:

http://www.aiss.com

http://www.masktools.com

http://www.avanticorp.com

http://www.mentor.com

http://www.numeritech.com

Index