Frances Anne Houle

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Research Interests

Chemical modification of nanoparticle, semiconductor, metal and polymer interfaces, surfaces and films. Oxidative processes in aerosols. Nanoscale pattern formation. Development of novel experimental methods for characterization of nanoparticle, thin film, surface and interface physics and chemistry including nanoscale composition, reaction mechanisms, nanomechanical properties. Stochastic simulation methods for complex chemical reactions including transport.

Education

Ph.D. Chemistry	California Institute of Technology, 1979
B.A. Chemistry	University of California at Irvine, *cum laude*, 1974
	Whittier College, Whittier, California (1970 - 1972)

Employment

10/2015-present	Deputy Director for Science and Research Integration, Joint Center for Artificial Photosynthesis, Lawrence Berkeley National Laboratory
3/2013-9/2015	Department Head, Joint Center for Artificial Photosynthesis, LBNL
2/2015-present	Senior Scientist, Chemical Sciences Division, LBNL
3/2013-2/2015	Staff Scientist, Chemical Sciences Division, LBNL
8/2011-3/2013	Director of Strategic Initiatives, Chemical Sciences Division, LBNL
5/2011-present	Principal, Columbia Hill Technical Consulting, Fremont, CA
4/2009 – 4/2011	Manager, Materials Development InVisage Technologies, Inc, Menlo Park, CA
12/80 – 3/2009	Research Staff Member, Research Division Science and Technology Department International Business Machines Corporation, San Jose, CA
5/79 - 11/80	Postdoctoral Research Associate University of California at Berkeley Department of Chemistry and Lawrence Berkeley Laboratory

Technical Leadership Experience

Joint Center for Artificial Photosynthesis, a DOE Energy Innovation Hub

- Responsible for oversight of JCAP's technical programs in partnership with the Director and Deputy Director for Programs at California Institute of Technology
- Management of LBNL administrative matters for an organization of about 90 people with a budget of approximately $6.5 million per year
- Relationship management with DOE User Facilities and JCAP Industrial Partners

Lawrence Berkeley National Laboratory, Division of Chemical Sciences – Director of Strategic Initiatives

- Responsible for planning and development of new technical programs and alliances for the Division and support of new proposals, played a direct role in 4 successful awards of new funding in 2012

- Named Associate Director and key personnel for Critical Materials Hub bid by the lead Laboratory, co-leader of LBNL proposal team (approx 15 primary participants)
- Appointed member of LBNL Opportunity Board and 2 Laboratory-wide technical strategy groups to shape future initiatives

InVisage Technologies - Manager

- Responsible for key nanoparticle based material in image sensor device at approx. 26 person startup company. Led and actively participated in the following areas
    - Delivery of film composition and scaled-up processes that met integration and imaging performance targets and milestones. 1 invention disclosure.
    - Development of measurement techniques suitable for quality assurance of wafers, solutions and nanoparticle and other films, process diagnostics
- Technical program planning and execution as a team with integration, production and device engineering functions
- People manager for 18 months

IBM - Selected technical team leadership experiences

- Built and led team (3 full-time and 15 part-time members) that developed nanoimprint materials systems joint with 2 external corporate partners. Defect mechanisms and design of new materials to reduce them. 9 patents.
- Co-led multisite 36-member team addressing a critical photomask degradation problem involving nanoscale Cr migration. 1 IBM recognition and 1 patent application.
- Co-led 4-member multidisciplinary team investigating fundamental issues in photoresist extendability. Innovative experimental and modeling techniques created for discovery of factors limiting resolution of chemically amplified photoresists to 50nm. Results have led to new chemically amplified resist design paradigms used throughout the industry. 4 patents. 2 IBM recognitions.

Additional relevant experiences

Failure analysis - IBM

Member, Reticle Growth Defect working group (2005-2008)
Task force on disk drives (2002)
Task force on head-disk interface failure mechanisms (1984)

Business planning - IBM

Member and sub-team co-leader, IBM Academy of Technology study group on eScience (2006)
Study group on Physical Sciences Strategy (2002)
Study group on cross-functional teams (1995)
Assignment to Scientific and Technical Application Software department for product commercialization project (1994-1995)
Task force on Research-Market Management Interface and New Business Opportunities (1994-1995)

External alliances – IBM and InVisage Technologies

Managed relationships with materials and characterization services vendors, Invisage (2009-2011)
Member, Nanoimprint Advisory Group, International SEMATECH (2008-2009)
Technical lead, nanoimprint activities under IBM-JSR joint research agreement (2008-2009)
IBM representative to the Industrial Advisory Board, NSF EUV Engineering Research Center (2007-2009)

Member, International SEMATECH Resist Outgassing Work Group (2004-2006)
Member, IBM team, Resist group, EUV LLC (2001- 2002)

Health and safety – InVisage Technologies

Managed health and safety programs, regulatory documentation, hazardous materials handling and documentation
Responsible for employee training and record keeping

Awards, Honors and Fellowships

John A. Thornton Memorial Award and Lecture, American Vacuum Society, 2009.
IBM Research Division Accomplishment recognition for Mask Defect Root Cause, 2008
IBM Research Division Technical Group Award for Photoresist Limits, 2004
Gomes School Parent-Teachers Association Award (for developing the Science Fair), 2003
IBM Research Division Accomplishment recognition for Photoresist Limits, 2002
AIChE Northern California Section Chemical Engineering Excellence Award: Research Project of the Year (for Chemical Kinetics Simulator), 1999
IBM Corporate Environmental Affairs Excellence Award (for Chemical Kinetics Simulator), 1998
Fellow of the American Vacuum Society, 1996
IBM Supplemental Patent Issue Award for US patent 5446870, 1996
Fellow of the American Physical Society, 1992
IBM Outstanding Innovation Award for Laser Deposition of Metals, 1990
First Prize, IBM Computational Chemistry Challenge, 1990
IBM Invention Achievement Awards, First-Seventh Plateaus, 1985-2010
IBM Postdoctoral Fellowship, UCB/LBL, 1979-80
Herbert Newby McCoy Award for Outstanding Contributions in Chemistry, CIT, 1979
IBM Predoctoral Fellowship, CIT, 1977-78
Dean's Award for Outstanding Senior in Chemistry, UCI, 1974
ACS (Orange County Section) Award, UCI, 1974

Selected Professional Activities

Current Service:

Member, New Meetings Subcommittee, Materials Research Society (2012- present)
Member-at-large, Executive committee of the Division of Condensed Matter Physics, American Physical Society (2014-2016)
Chair-Elect, Panel on Public Affairs, American Physical Society (Chair line 2015-2018)

Professional Society Memberships -

American Chemical Society, American Physical Society (Fellow), American Vacuum Society (Fellow), Materials Research Society, American Geophysical Union

Past Service:

Editorial -

Co-Editor, "Laser Chemical Processing of Semiconductor Devices", F. A. Houle, T. F. Deutsch and R. M. Osgood, Jr., Materials Research Society, Pittsburgh, 1984.
Associate Editor, Journal of Vacuum Science and Technology A (1989-1993)
Co-Editor, "Surface Chemistry and Beam-Solid Interactions", H. Atwater, F. A. Houle and D. Lowndes, Materials Research Society, Pittsburgh, 1991.
Member of the Editorial Committee, Annual Reviews of Physical Chemistry (2001-2005)
Associate Editor, Journal of Vacuum Science and Technology B (2001-2003)

Professional Society Governance-

Board of Directors, Northern California Chapter, AVS (1982-1986)
AVS Thin Film Division Executive Committee (1988-1989)
AVS Board of Scholarship Trustees (1990-1992)
Vice Chair (1993), Program Chair (1994) and Chair (1995), Electronic Materials and Processing Division, AVS
Selection and Scheduling Committee, Gordon Research Conferences (1996-2002)
Council of the Gordon Research Conferences (1994, 1996-2002)
Nominations Committee, Division of Physical Chemistry, American Chemical Society (1998)
Nanometer-scale Science and Technology Division Executive Committee, AVS (2001-2002)
Nominating Committee, Division of Laser Science, American Physical Society (2001)
General Councilor, American Physical Society (2002-2005)
Chair, American Physical Society Task Force on Professional Ethics, Standards and Practices (2002-2003)
Member of the Executive Board, American Physical Society (2004-2005)
Member, Budget Committee, American Physical Society (2004-2006)
Member, Committee on Committees, American Physical Society (2005)
Member-at-large, Executive committee of the California Section, American Physical Society (2008-2010)
Member, American Physical Society Panel on Public Affairs (2009-2011).
Member, Fellowship Committee, American Physical Society (2010-2012).

Conference Organization -

American Chemical Society National Meeting Program Committee (1983)
Materials Research Society Fall Meeting, Symposium Co-chair (1984, 1990)
Society of Photo -Instrumentation Engineers LA'84 Program Committee (1984)
Conference on Lasers and Electro - Optics Program Subcommittee Chair (1987), member (1988)
American Vacuum Society National Symposium Program Committee (1987, 1990, 1994 – EMPD Program Chair)
Microphysics of Surfaces, Beams and Adsorbates Topical Meeting Organizing Committee (1991,1995)
Chemistry of Electronic Materials Gordon Research Conference, Vice-chair (1992), Chair (1994 – theme of conference was chemical control in nanofabrication)
International Advisory Committee, 2nd International Conference on Laser Advanced Materials Processing, Japan (1992)
International Advisory Committee, First International Symposium on Laser and Optoelectronics Technology and Applications, Singapore (1993)
International Advisory Committee, 10th International Conference in Solid Films and Surfaces, Princeton, NJ (2000)
Advances in Resist Technology and Processing Program Committee, SPIE International Symposium on Microlithography, Santa Clara (2001-2003)
International Advisory Committee, 3rd African Materials Research Society Symposium, Casablanca, Tunisia (2005)
Resist Section, Electron, Ion and Photon Beams and Nanolithography Program Committee (2008)
Alternative Lithographic Technologies Program Committee, SPIE Advanced Lithography Symposium (2008-2009)
International Conference on Nanoimprint and Nanoprint Technology (2009)
Council for Chemical Research Chemical Innovation Forum and Annual Meeting, Washington DC (2013)

Committees -

Student Awards Judge, Materials Research Society Spring Meeting (1994)
Scientific Advisory Panel, Alice in Wonderland Project, an NSF-funded project at the Children's Discovery Museum, San Jose, California (1998-1999)
Industrial Advisory Board, Graduate Training Program in Optical Sciences and Engineering, University of Colorado, Boulder (1998-1999)
Discussion Leader, Advanced and Emerging Materials Group, US-Africa Materials Workshop (Pretoria, South Africa, 2000)
Advisory Committee, African Materials Science Gateway project, Northwestern University and University of Witwatersrand (2001)
Organizing committee, 75th Anniversary of the Gordon Research Conferences (2002-2006)
ACS awards committee (2003 – 2005)
ACS awards committee (2006 – 2008)
Industrial Advisory Board, NSF Engineering Research Center for Extreme Ultraviolet Science and Technology, Colorado State University, University of Colorado, UC Berkeley and Lawrence Berkeley National Laboratory (2007- 2009).
American Institute of Physics Statistics Advisory Committee (2007-2009).
APS Ethics Education Web Site committee (2007- present)
National Academies committee to revise *On being a scientist* (booklet on scientific ethics) (2007-2008)
APS Panel on Public Affairs - MRS study on Energy – Critical Elements (2010-2011)
APS Physics Policy Committee - POPA study on innovation (2011-2012)

Review panels -

Review Panel for the Proposed Department of Energy Combustion Dynamics Facility (1989)
Review Panel, Materials Synthesis and Processing Initiative, National Science Foundation (1992)
NRC Board of Assessment for NIST, Subpanel for JILA (1996 - 1998)
NSF Panel for Materials Research Science and Engineering Centers (1996)
NSF Site Review Committee, Science and Technology Center (1996)
Committee of Visitors, Physics Division, National Science Foundation (1997)
NSF Site Review Committee, Proposed Science and Technology Center (1999)
Chair, NRC Board of Assessment for NIST, Subpanel for JILA (1999-2002)
NSF Site Review Committee, Materials Research Science and Engineering Center (2000)
NSF Review Panel for LIGO, Caltech/MIT (2001)
NSF Site Review Committee, Materials Research Science and Engineering Center (2005)
DOE Review Panel (2014) – two programs

Funding History

ONR grant for the 1994 Chemistry of Electronic Materials Gordon Research Conference, $6000.
NSF grant for the 1994 Chemistry of Electronic Materials Gordon Research Conference, DMR-9321393, $6000.
NATO grant CRG 951452, "Stochastic Simulation of Chemical Vapor Deposition of Amorphous Hydrogenated Silicon" with Prof. Dr. Peter Hess, Heidelberg University, Germany (1996-1998)
NIST ATP grant 70NANB7H7025 subaward from Anasys (2008-2009), support for a postdoc to provide nanoimprint materials for nanoscale IR characterization
Joint Center for Artificial Photosynthesis, DOE Energy Innovation Hub Renewal Proposal (2013-2015), Principal Investigator for LBNL, $24M/year

Joint Center for Artificial Photosynthesis, DOE Energy Innovation Hub Renewal Proposal (2015-2020), Principal Investigator for LBNL, $15M/year
California Energy Commission contract for solar fuels research, Principal Investigator for LBNL, $5M
LBNL Laboratory Research And Development Grant, PI, $200K/year (2014-2016)
LBNL Laboratory Research And Development Grant, co-PI, $200K/year (2016-2017)

Refereed publications

1. The Nature of the Bonding of Li^+ to H_2O and NH_3; Ab Initio Studies
   R. L. Woodin, F. A. Houle and W. A. Goddard, III
   Chem. Phys. **14**, 461 (1976).
2. The First Ionization Potential of Ethyl Radical by Photoelectron Spectroscopy
   F. A. Houle and J. L. Beauchamp
   Chem. Phys. Lett. **48**, 457 (1977).
3. Detection and Investigation of Allyl and Benzyl Radicals by Photoelectron Spectroscopy
   F. A. Houle and J. L. Beauchamp
   J. Am. Chem. Soc. **100**, 3290 (1978).
4. On Exit Channel Coupling Effects in the Unimolecular Decomposition of Triatomics
   D. L. Bunker, K. R. Wright, W. L. Hase and F. A. Houle
   J. Phys. Chem. **83**, 933 (1979).
5. Photoelectron Spectroscopy of Methyl, Ethyl, Isopropyl and tert-Butyl Radicals. Implications for the Thermochemistry and Structures of the Radicals and their Corresponding Carbonium Ions
   F. A. Houle and J. L. Beauchamp
   J. Am. Chem. Soc. **101**, 4067 (1979).
6. Effects of Molecular Structure and Basicity. The Gas Phase Proton Affinities of Cyclic Phosphites
   R. V. Hodges, F. A. Houle, J. L. Beauchamp, R. A. Montag and J. G. Verkade
   J. Am. Chem. Soc. **102**, 932 (1980).
7. Simulation Methods in Kinetics Courses
   F. A. Houle and D. L. Bunker
   J. Chem. Educ. **58**, 405 (1981).
8. The Effect of Vibrational and Translational Energy on the Reaction Dynamics of the $H_2^+ + H_2$ System
   S. L. Anderson, F. A. Houle, D. Gerlich and Y. T. Lee
   J. Chem. Phys. **75**, 2153 (1981).
9. Vibrational Effects in Proton and Charge Transfer in the $H_2^+ + Ar$ System
   F. A. Houle, S. L. Anderson, D. Gerlich, T. Turner and Y. T. Lee
   Chem. Phys. Lett. **82**, 392 (1981).
10. Thermal Decomposition Pathways of Alkyl Radicals by Photoelectron Spectroscopy. Application to Cyclopentyl and Cyclohexyl Radicals
    F. A. Houle and J. L. Beauchamp
    J. Phys. Chem. **85**, 3456 (1981).
11. Nonadiabaticity in Ion-Molecule Reactions: Coupling of Proton and Charge Transfer in the H_2^+ and $D_2^+ + Ar$ System
    F. A. Houle, S. L. Anderson, D. Gerlich, T. Turner and Y. T. Lee
    J. Chem. Phys. **77**, 748 (1982).
12. Laser-Induced Chemical Etching of Metals and Semiconductors
    F. A. Houle and T. J. Chuang
    J. Vac. Sci. Technol. **20**, 790 (1982).
13. Gaseous Products from the Reaction of XeF_2 with Silicon
    H. F. Winters and F. A. Houle
    J. Appl. Phys. **54**, 1218 (1983).
14. Nonthermal Effects in Laser-Enhanced Etching of Silicon by XeF_2
    F. A. Houle
    Chem. Phys. Lett. **95**, 5 (1983).

15. Photoeffects on the Fluorination of Silicon. I. Influence of Doping on Steady-State Phenomena
F. A. Houle
J. Chem. Phys. **79**, 4237 (1983).
16. Photoeffects on the Fluorination of Silicon. II. Kinetics of the Initial Response to Light
F. A. Houle
J. Chem. Phys. **80**, 4851 (1984).
17. Photoelectron Spectroscopy of 1-Propyl, 1-Butyl, Isobutyl, Neopentyl and 2-Butyl Radicals: Free Radical Precursors to High Energy Carbonium Ions
J. C. Schultz, F. A. Houle and J. L. Beauchamp
J. Am. Chem. Soc **106**, 3917 (1984).
18. Photoelectron Spectroscopy of Isomeric $C_4.H_7$ Radicals. Implications for the Thermochemistry and Structures of the Radicals and their Corresponding Carbonium Ions
J. C. Schultz, F. A. Houle and J. L. Beauchamp
J. Am. Chem. Soc. **106**, 7336 (1984).
19. Mechanism of Laser-Enhanced Etching of Silicon
F. A. Houle
MRS Symp. Proc. **29**, 203 (1984).
20. Photochemical Generation and Deposition of Copper from the Gas Phase
C. R. Jones, F. A. Houle, C. A. Kovac and T. H. Baum
Appl. Phys. Lett. **46**, 97 (1985).
21. Laser Chemical Vapor Deposition of Copper
F. A. Houle, C. R. Jones, T. H. Baum, C. Pico and C. A. Kovac
Appl. Phys. Lett. **46**, 204 (1985).
22. Composition, Structure and Electric Field Variations in Photodeposition
R. J. Wilson and F. A. Houle
Phys. Rev. Lett. **55**, 2184 (1985).
23. Surface Processes Leading to Carbon Contamination of Photochemically Deposited Copper Films
F. A. Houle, R. J. Wilson and T. H. Baum
J. Vac. Sci. Technol. A **4**, 2452 (1986).
24. A Reinvestigation of the Etch Products of Silicon and XeF_2: Doping and Pressure Effects
F. A. Houle
J. Appl. Phys. **60**, 3018 (1986).
25. Basic Mechanisms in Laser Etching and Deposition
F. A. Houle
Appl. Phys. A **41**, 315 (1986) *(invited).*
26. Fundamental Aspects of Photon Assisted Processing
F. A. Houle
"Reduced Temperature Processing for VLSI", Electrochemical Society Symposium Proceedings **86-5**, 32 (1986).
27. Heat and Light in Laser-Materials Interactions
F. A. Houle
J. Vac. Sci. Technol. A **4**, 665 (1986).
28. Optical Self-Regulation during Laser-Induced Oxidation of Copper
L. Baufay, F. A. Houle and R. J. Wilson
J. Appl. Phys. **61**, 4640 (1987).
29. Dynamics of Desorption of SiF_4 During Etching of Silicon by XeF_2
F. A. Houle
J. Chem. Phys. **87**, 1866 (1987).

30. On the Relative Importance of Physical and Chemical Sputtering in Ion-Enhanced Etching of Silicon by XeF_2
    F. A. Houle
    Appl. Phys. Lett. **50**, 1838 (1987).
31. Real-Time Studies of Laser-Oxidation of Copper: Characteristics of an Optical Heat Source
    L. Baufay, F. A. Houle and R. J. Wilson
    MRS Symp. Proc. **75**, 281 (1987).
32. Interdependence of Optical Excitation and Surface Chemistry in Laser Induced Deposition and Etching
    F. A. Houle
    Laser Chemistry **9**, 107 (1988) *(invited)*.
33. Origin of Contaminants in Photochemically Deposited Chromium Films
    K. A. Singmaster, F. A. Houle and R. J. Wilson
    Appl. Phys. Lett. **53**, 1048 (1988).
34. Photostimulated Desorption in Laser-Assisted Etching of Silicon
    F. A. Houle
    Phys. Rev. Lett. **61**, 1871 (1988).
35. Desorption Dynamics of SiF_4 Etch Product
    F. A. Houle
    J. Vac. Sci. Technol. A**6**, 840 (1988).
36. Laser Deposition of Films from Acetylacetonate Complexes
    F. A. Houle, T. H. Baum and C. R. Moylan
    "Laser Chemical Processing for Microelectronics", K. Ibbs and R. M. Osgood, Jr., Editors, Cambridge University Press, Cambridge (1989), Chapter 2 *(invited).*
37. Photochemical Etching of Silicon: the Influence of Photogenerated Charge Carriers
    F. A. Houle
    Phys. Rev. B**39**, 10 120 (1989).
38. Surface Reactions Leading to Contamination of Metal Films Photochemically Deposited from the Hexacarbonyls
    K. A. Singmaster, F. A. Houle and R. J. Wilson
    MRS Symp. Proc. **131**, 469 (1989).
39. Surface Photoprocesses in Laser Assisted Etching and Film Growth
    F. A. Houle
    J. Vac. Sci. Technol. B**7**, 1149 (1989).
40. Photochemical Deposition of Thin Films from the Metal Hexacarbonyls
    K. A. Singmaster, F. A. Houle and R. J. Wilson
    J. Phys. Chem. **94**, 6864 (1990).
41. Effect of Laser Heating on Compositions of Films Deposited from the Metal Hexacarbonyls
    K. A. Singmaster and F. A. Houle
    MRS Symp. Proc. **201**, 159 (1991).
42. Doping Effects on the Etching Chemistry of GaAs and Si
    F. A. Houle
    MRS Symp. Proc. **204**, 25 (1991).
43. Fundamental Aspects of Laser Deposition of Thin Metal Films: Chemistry of Contamination
    K. A. Singmaster and F. A. Houle
    "Symposia on Reliability of Semiconductor Devices/Interconnections and Dielectric Breakdown and Laser Processes for Microelectronic Applications", Electrochemical Society Proceedings 92-4, 265 (1992).

44. Continuous Wave Visible Laser-Assisted Decomposition of $Cr(CO)_6$ on a Growing Film: In Situ Observations
    F. A. Houle and L. I. Yeh
    J. Phys. Chem. **96**, 2691 (1992).
45. Chemical Changes Accompanying Facet Degradation of AlGaAs Quantum Well Lasers
    F. A. Houle, D. L. Neiman, W. C. Tang and H. J. Rosen
    J. Appl. Phys. **72**, 3884-3896 (1992).
46. Visible Laser Induced Nucleation and Growth of Cr, Mo and W Films from the Hexacarbonyls. Reactivity of CO on Film Surfaces
    F. A. Houle and K. A. Singmaster
    J. Phys. Chem. **96**, 10425-10439 (1992).
47. Electron Impact Fragmentation of Gases by Molecular Beam Mass Spectrometry. Application to $AsCl_3$ and a $GaCl_3/Ga_2Cl_6$ Mixture
    F. A. Houle
    Int. J. Mass. Spec. Ion Proc. **123**, 243-252 (1993).
48. Laser Assisted Chemical Vapor Deposition from the Metal Hexacarbonyls
    K. A. Singmaster and F. A. Houle
    Laser Chemistry of Organometallics, J. Chaiken, Ed. ACS Symposium Series **530**, Chapter 21 (1993).
49. Thermal and Acid-Catalyzed Deprotection Kinetics in Deep UV Resist Materials
    G. Wallraff, J. Hutchinson, W. Hinsberg, F. A. Houle, P. Seidel, R. Johnson, and W. Oldham
    J. Vac. Sci. Technol. B**12**, 3857-3862 (1994).
50. Kinetics of Thermal and Acid-Catalyzed Deprotection in Deep UV Resist Materials
    J. Hutchinson, G. Wallraff, W. Hinsberg, F. Houle and P. Seidel
    Microelectronic Engineering, **27**, 397-400 (1995).
51. Stochastic Simulations of Temperature Programmed Desorption Kinetics
    F. A. Houle and W. D. Hinsberg
    Surface Science, **338**, 329-346 (1995).
52. Simulations of Thermal Decomposition and Film Growth from the Group VI Metal Hexacarbonyls
    F. A. Houle and W. D. Hinsberg
    J. Phys. Chem. **99**, 14477-14485 (1995).
53. Stochastic Simulation of Heat Flow with Application to Laser-Solid Interactions
    F. A. Houle and W. D. Hinsberg
    Appl. Phys. A **66**, 143-151 (1998).
54. In Situ FTIR Spectroscopy and Stochastic Modelling of Surface Chemistry of Amorphous Silicon Growth
    U. Wetterauer, J. Knobloch, P. Hess and F. A. Houle
    J. Appl. Phys. **83**, 6096-6105 (1998).
55. Mechanistic Studies of Chemically Amplified Photoresists
    W. D. Hinsberg, G. Wallraff, F. A. Houle, M. Morrison, J. Frommer, R. Beyers and J.Hutchinson
    Organic Thin Films, ACS Symposium Series, C. Frank, ed., Amer. Chem. Soc., Washington DC, vol **695**, 344-359 (1998).
56. Deep UV Interferometric Lithography as a Tool for Assessment of Chemically Amplified Resist Performance
    W. D. Hinsberg, F. A. Houle, J. Hoffnagle, M. Sanchez, G. Wallraff, M. Morrison and S. Frank
    J. Vac. Sci. Technol. B **16**, 3689-3694 (1998).

57. Factors Controlling Pattern Formation in Chemically Amplified Resists at Sub-100 nm Dimensions.
W. Hinsberg, F. Houle, G. Wallraff, M. Sanchez, M. Morrison, J. Hoffnagle, H. Ito, C. Nguyen, C. Larson, P. Brock and G. Breyta
J. Photopolym. Sci. Tech., **12**, 649-662 (1999).
58. Liquid Immersion Deep-UV Interferometric Lithography
J. Hoffnagle, W. D. Hinsberg, M. Sanchez and F. A. Houle
J. Vac. Sci. Technol. B **17**, 3306 (1999).
59. Determination of Coupled Acid Catalysis-Diffusion Processes in a Positive Tone Chemically Amplified Photoresist
F. A. Houle, W. D. Hinsberg, M. Morrison, G. Wallraff, C. Larson, M. Sanchez and J. Hoffnagle
J. Vac. Sci. Technol. B **18**, 1874-1885 (2000).
60. Chemistry and Physics of the Post-expose Bake Process in Chemically Amplified Resists
W. Hinsberg, F. Houle, M. Sanchez and G. Wallraff
IBM Journal of Research and Development, **45**, 667 (2001) *(invited*).
62. The influence of resist components on image blur in a patterned positive-tone chemically amplified photoresist
F. A. Houle, W. D. Hinsberg, M. I. Sanchez and J. A. Hoffnagle
J. Vac. Sci. Technol. B **20**, 924-931 (2002).
63. Product volatilization as a probe of the physics and chemistry of latent image formation in chemically amplified resists
W. D. Hinsberg, F. A. Houle, G. M. Poliskie, D. Pearson, M. I. Sanchez, and H. Ito
J. Phys. Chem. A **106**, 9776-9787 (2002), *invited*
64. High NA lithography imagery at Brewster's angle
T. A. Brunner, J.A. Hoffnagle, W. D. Hinsberg, F. A. Houle, M. I. Sanchez
J. Microlith. Microfab. Microsys. **1**, 188 (2002).
65. A method to measure the spatial resolution of a photoresist
J. A. Hoffnagle, W. D. Hinsberg, M. I. Sanchez and F. A. Houle
Optics Lett. **27**, 1776-1778 (2002).
66. Kinetic model of positive-tone resist dissolution and roughening
F. A. Houle, W. D. Hinsberg and M. I. Sanchez
Macromolecules **35** 3591-3600 (2002).
67. Use of interferometric lithography to characterize the spatial resolution of a photoresist film
J. A. Hoffnagle, W. D. Hinsberg, F. A. Houle and M. I. Sanchez
J. Photopolymer Sci. Technol. **16**, 373 (2003).
68. Statistical limitations of printing 50 and 80 nm contact holes by EUV lithography
G. M. Gallatin, F. A. Houle, and J. L. Cobb
J. Vac. Sci. Technol.B **21**, 3172-3176 (2003).
69. Acid-base reactions in a positive tone chemically amplified photoresist and their effect on imaging
F. A. Houle, W. D. Hinsberg and M. I. Sanchez
J. Vac. Sci. Technol.B **22**, 747-757 (2004).
70. Ethics and the Welfare of the Physics Profession
K. Kirby and F. A. Houle
Physics Today, November, 2004, pages 42-46.
71. Sub-50nm half-pitch imaging with a low activation energy chemically amplified photoresist
G. M. Wallraff, D. R. Medeiros, M. Sanchez, K. Petrillo, W.-S. Huang, C. Rettner, B. Davis, C. E. Larson, L. Sundberg, P. J. Brock, W. D. Hinsberg, F. A. Houle, J. A. Hoffnagle, D. Goldfarb, K. Temple, S. Wind and J. Bucchingnano
J. Vac. Sci. Technol. B **22**, 3479-3484 (2004).

72. Characterization of polymer reactive dissolution and swelling using a quartz crystal microbalance and reflectance interferometry
W. Hinsberg, F. Houle, S-W. Lee, H. Ito and K. Kanazawa
Macromolecules **38**, 1882-1989 (2005).
73. Numeric analysis of the role of liquid phase UV photochemistry in 193nm immersion lithography
W. D. Hinsberg and F. A. Houle
J. Vac. Sci. Technol. B **23**, 2427-2435 (2005).
74. Real-world kinetics via simulations
F. A. Houle and W. D. Hinsberg
Annual Reports in Computational Chemistry **2**, 3 (2006) *Invited.*
75. Numerical analyses of the roles of gas phase and liquid phase UV photochemistry in conventional and immersion 193 nm lithography
William Hinsberg and Frances A. Houle
Journal of Photopolymer Science and Technology **19**, 623 (2006).
76. Adhesion between template materials and UV-cured nanoimprint resists
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