

**BOOK**

R. T. Howe and C. G. Sodini, *Microelectronics: an Integrated Approach*, Prentice Hall, 1997.

**BOOK CHAPTER**

C. W. Low, S. F. Almeida, E. P. Quévy, and R. T. Howe, “Poly-SiGe Surface Micro-machining,” in *3D and IC Integration of MEMS*, M. Esashi, editor, Wiley VCH, 2021.

**REFEREED PUBLICATIONS***Archival Journal Papers*

1. A. Levy, M. Oduoza, A. Balasingam, R. T. Howe, and P. Raina, “3-D coarse grained reconfigurable array using multi-pole NEM relays for programmable routing,” *Integration, the VLSI Journal*, **88**, 249-261 (2023).
2. M. Tang, S. Kommera, M. Rincon, U. Ragharam, X. Xu, J. Fan, and R. T. Howe, “Deep approaches to learning in a project-based nanofabrication graduate course,” *Journal of the Society for Information Display*, **2022**, 1-9 (2022).
3. P. Beshay, A. M. Ibrahim, S. S. Jeffrey, R. T. Howe, and Y. H. Anis, “Encapsulated cell dynamics in droplet microfluidic devices with sheath flow,” *Micromachines*, **12**, 839 <https://doi.org/10.3390/mi12070839> (2021).
4. C. Chia, M. Sesia, C.-S. Ho, S. S. Jeffrey, J. Dionne, E. J. Candès, and R. T. Howe, “Interpretable classification of bacterial Raman spectra with knockoff wavelets,” *IEEE Journal of Biomedical and Health Informatics*, **25**, doi.org/10.1109/JBHI.2021.3094873 (2021).
5. M. Yusuf, G. K. Herring, L. T. Neustock, M. A. Zaman, U. Raghuram, V. K. Narasimhan, C. Chia, and R. T. Howe, “Optimized deep reactive-ion etch of nanostructured black silicon for high-contrast optical alignment marks,” *ACS Applied Nano Materials*, <https://doi.org/10.1021/acsanm.1c01070> (2021).
6. A. M. Ibrahim, J. I. Padovani, R. T. Howe, and Y. H. Anis, “Modeling of droplet generation in a microfluidic flow-focusing junction for droplet size control,” *Micromachines*, **12**, 590 <https://doi.org/10.3390/mi12060590> (2021).
7. J. I. Padovani, A. M. Ibrahim, S. S. Jeffrey, Y. H. Anis, and R. T. Howe, “Electropermanent magnet-driven droplet size modulation for two-phase ferro-microfluidics,” *Microfluidics and Nanofluidics*, doi.org/10.1007/s10404-020-02398-4 (2020).
8. A. Mustafazade, M. Pandit, C. Zhao, G. Sobreviela, Z. Du, P. Steinmann, X. Zou, R. T. Howe, and A. A. Seshia, “A vibrating beam MEMS accelerometer for gravity and seismic measurements,” *Scientific Reports*, **10**, 10415 (2020).
9. P. Schindler, D. C. Riley, I. Bargatin, K. Sahasrabudhe, J. W. Schwede, S. Sun, P. Pianetta, Z.-X. Shen, R. T. Howe, and N. A. Melosh, “Surface photovoltage-induced

- ultralow work function material for thermionic energy converters,” *ACS Energy Letters*, **4**, 2436-2443 (2019).
10. C. Chia, J. Martis, S. S. Jeffrey, and R. T. Howe, “Neural network-based model of photoresist reflow,” *Journal of Vacuum Science and Technology B*, **37**, 061604 (2019).
  11. C. Chia, S. S. Jeffrey, and R. T. Howe, “Anomalous hysteresis and current fluctuations in cyclic voltammograms at microelectrodes due to Ag leaching from Ag/AgCl reference electrodes,” *Electrochemistry Communications*, **105**, 206499 (2019).
  12. C. Chia, S. S. Jeffrey, and R. T. Howe, “Scalable methods for ultra-smooth platinum in nanoscale devices,” *Micro and Nano Engineering*, **3**, 50-58 (2019).
  13. C. Chia, M. M. Shulaker, J. Provine, S. S. Jeffrey, and R. T. Howe, “ALD HfO<sub>2</sub> Films for Defining Microelectrodes for Electrochemical Sensing and Other Applications,” *ACS Applied Materials and Interfaces*, **11**, 26082-26092 (2019).
  14. S. M. Nicaise, C. Lin, Mohsen Azadi, T. Bozorg-Grayeli, P. Adebayo-Ige, D. E. Lilley, Y. Pfitzer, W. Cha, K. Van Houten, N. A. Melosh, R. T. Howe, and J. W. Schwede, “Micron-gap spacers with ultrahigh thermal resistance and mechanical robustness for direct energy conversion,” *Microsystems & Nanoengineering*, **5**:31 (2019).
  15. M. Shulaker, G. Hills, R. S. Park, R. T. Howe, K. Saraswat, H.-S. P. Wong, and S. Mitra, “Three-dimensional integration of nanotechnologies for computing and data storage on a single chip,” *Nature*, **547**, 74-78 (2017).
  16. C. Gupta, R. M. Walker, S. Chang, S. R. Fischer, M. Seal, B. Murmann, and R. T. Howe, “Quantum Tunneling Currents in a Nanoengineered Electrochemical System,” *Journal of Physical Chemistry C*, **121**, 15085–15105 (2017).
  17. H. Yuan, D. C. Riley, Z.-X. Shena, P. A. Pianetta, N. A. Melosh, and R. T. Howe, “Back-gated graphene anode for more efficient thermionic energy converters,” *Nano Energy*, **32**, 67-72 (2017).
  18. C. Gupta, A. Peña Perez, S. R. Fischer, S. B. Weinreich, B. Murmann, and R. T. Howe, “Active control of probability amplitudes in a mesoscale system via feedback-induced suppression of dissipation and noise,” *Journal of Applied Physics*, **120**, 224902 (2016).
  19. T. Wu, C.-E. Chang, S. S. Hamann, A. C. Ceballos, O. Solgaard and R. T. Howe, “Design and fabrication of silicon tessellated structures for monocentric imagers,” *Microsystems & Nanoengineering*, **2**, 16019, (2016).
  20. J. I. Padovani, S. S. Jeffrey, and R. T. Howe, “Electropermanent magnet actuation for droplet ferromicrofluidics,” *Technology*, **04**, 110 (2016).
  21. Z. Guo, U. Aboudi, P. Peumans, R. T. Howe and F.-K. Chang, “A super stretchable organic thin-film diode network that can be embedded into carbon fiber composite materials for sensor network applications,” *IEEE J. Microelectromechanical Systems*, **25**, 524-532 (2016).

22. E. J. Ng, K. L. Harrison, Y. Yang, C. H. Ahn, V. A. Hong, R. T. Howe, and T. W. Kenny, "Stable encapsulated charge-biased resonators," *IEEE J. Microelectromechanical Systems*, **25**, 30-37 (2016).
23. K. L. Harrison, W. A. Clary, J. Provine, J. and R. T. Howe, "Back-end-of-line compatible Poly-SiGe lateral nanoelectromechanical relays with multi-level interconnect," *Microsystem Technologies*, **22**, 1-6 (2016).
24. H. Yuan, S. Chang, I. Bargatin, N. C. Wang, D. C. Riley, H. Wang, J. W. Schwede, J. Provine, E. Pop, Z.-X. Shen, P. A. Pianetta, N. A. Melosh, and R. T. Howe, "Engineering ultra-low workfunction of graphene," *Nano Letters*, **15**, 6475-6480 (2015).
25. A. Arun, C. Gupta, and R. T. Howe, "Polyether Ether Ketone (PEEK) fluidic cell to study electrochemistry of microelectrodes on silicon substrate," *ECS Solid State Letters*, **4**, P67-P71 (2015).
26. S. Dumpala, S. R. Broderick, K. Umedjon, E. C. Neyts, A. C. T. van Duin, J. Provine, R. T. Howe, and K. Rajan, "Integrated atomistic chemical imaging and reactive force field molecular dynamic simulations on silicon oxidation," *Applied Physics Letters*, **106**, 011602 (2015).
27. S. Emaminejad, M. Javanmard, C. Gupta, S. Chang, R. W. Davis, and R. T. Howe, "Tunable Control of Antibody Immobilization using Electric Field," *Proc. Nat. Acad. Sciences*, **112**, 1995-1999 (2015).
28. M. Shavezipur, K. Harrison, W. S. Lee, S. Mitra, H.-S. P. Wong, and R. T. Howe, "Partitioning Electrostatic and Mechanical Domains in Nanoelectromechanical Relays," *IEEE J. Microelectromechanical Systems*, **24**, 592-598 (2014).
29. J.-H. Lee, I. Bargatin, B. K. Vancil, T. O. Gwinn, R. Maboudian, N. A. Melosh, and R. T. Howe, "Microfabricated thermally isolated low work-function emitter," *IEEE J. Microelectromechanical Systems*, **23**, 1182-1187 (2014).
30. S. H. Chou, J. Voss, A. Vojvodic, R. T. Howe, and F. Abild-Pedersen, "DFT Study of Atomically-Modified Alkali-Earth Metal Oxide Films on Tungsten," *J. Physical Chemistry C*, **118**, 11303 – 11309 (2014).
31. J. Voss, A. Vojvodic, S. H. Chou, R. T. Howe, and F. Abild-Pedersen, "Inherent enhancement of electronic emission from hexaboride heterostructure," *Physical Review Applied*, **2**, 024004 (2014).
32. O. Solgaard, A. A. Godil, R. T. Howe, L. P. Lee, Y.-A. Peter, and H. Zappe, "Optical MEMS: From Micromirrors to Complex Systems," *IEEE Journal of Microelectromechanical Systems*, **23**, pp. 517 – 538 (2014).
33. B. Park, I. W. Joong, J. Provine, A. Gellineau, J. Landry, R. T. Howe, and O. Solgaard, "Double-layer silicon photonic crystal fiber-tip temperature sensors," *IEEE Photonics Technology Letters*, **26**, 900 – 903 (2014).

34. W. M. Tang, U. Aboudi, J Provine, R. T. Howe, and H.-S. P. Wong, "Improved performance of bottom-contact organic thin-film transistor using Al doped HfO<sub>2</sub> gate dielectric," *IEEE Transactions on Electron Devices*, **61**, 2378 – 2386 (2014).
35. M. Javanmard, S. Emaminejad, C. Gupta, J Provine, R. W. Davis, and R. T. Howe, "Depletion of cells and abundant proteins from biological samples by enhanced dielectrophoresis," *Sensors and Actuators B: Chemical*, **193**, 918 – 924 (2014).
36. K. A. Littau, K. Saharsrabuddhe, D. Barfield, H. Yuan, Z.-X. Shen, R. T. Howe, and N. A. Melosh, "Microbead-separated thermionic energy converter with enhanced emission current," *Physical Chemistry Chemical Physics*, **15**, 14442 – 14446 (2013).
37. D. Lee, W. S. Lee, C. Chen, F. Fallah, J Provine, S. Chong, J. Watkins, H.-S. P. Wong, R. T. Howe, and S. Mitra, "Combinatorial logic design using six-terminal NEM relays," *IEEE Transactions on Computer-Aided Design*, **32**, 655 – 666 (2013).
38. R. G. Hennessy, M. M. Shulaker, M. Messana, A. B. Graham, N. Klejwa, J. Provine, T. W. Kenny, and R. T. Howe, "Vacuum encapsulated resonators for humidity measurement," *Sensors and Actuators B: Chemical*, **185**, 575-581 (2013).
39. R. Parsa, W. S. Lee, M. Shavezipur, J Provine, R. Maboudian, S. Mitra, H.-S. P. Wong, and R. T. Howe, "Laterally actuated platinum-coated relays," *IEEE Journal of Microelectromechanical Systems*, **22**, 768 – 778 (2013).
40. J. R. Jain, A. Hryciw, T. M. Baer, D. A. B. Miller, M. L. Brongersma, and R. T. Howe, "Light emission from strained germanium," *Nature Photonics*, **7**, 162 – 163 (2013).
41. J. Voss, A. Vojvodic, S. H. Chou, R. T. Howe, I. Bargatin, and F. Abild-Pedersen, "Thermionic current densities from first principles," *Journal of Chemical Physics* **138**, 204701 (2013).
42. J. W. Schwede, T. Sarmiento, V. K. Narasimhan, S. J. Rosenthal, D. C. Riley, F. Schmitt, I Bargatin, K. Saharsrabuddhe, R. T. Howe, J. S. Harris, N. A. Melosh, and Z.-X. Shen, "Photon-enhanced thermionic emission from heterostructures with low interface recombination," *Nature Communications* **4**, DOI: 10.1038/ncomms2577 (2013).
43. S. H. Chou, J. Voss, I. Bargatin, A. Vojvodic, R. T. Howe, and F. Abild-Pedersen, "An orbital-overlap model for minimal work functions of cesiated metals," *J. Physics: Condensed Matter*, **24**, 445007 (2012).
44. K. Saharsrabuddhe, J. W. Schwede, I. Bargatin, J. Jean, R. T. Howe, Z.-X. Shen, and N. A. Melosh, "A model for emission yield from planar photocathodes based on photon-enhanced thermionic emission or negative-electron-affinity photoemission," *J. Applied Physics*, **112**, 094907 (2012).
45. K.-H. Paik, Y. Liu, V. Tabard-Cossa, M. J. Waugh, D. E. Huber, J Provine, R. T. Howe, R. W. Dutton, and R. W. Davis, "Control of DNA capture by nanofluidic transistors," *ACS Nano*, **6**, 6767-6775 (2012).

46. S. Sedky, H. Tawfik, M. Ashour, A. B. Graham, J. Provine, Q. Wang, X. X. Zhang, and R. T. Howe, "Microencapsulation of silicon cavities using a pulsed excimer laser", *J. Micromechanics and Microengineering*, **22**, 075012 (2012).
47. J.-H. Lee, I. Bargatin, N. A. Melosh, and R. T. Howe, "Optimal emitter-collector gap for thermionic energy converters," *Applied Physics Letters*, **100**, 173904 (2012).
48. J.-W. P. Chen, J. Provine, N. Klejwa, and R. T. Howe, "A dry wafer reconstitution process with zero insertion force by embedded alignment guide tabs," *J. Micromechanics and Microengineering*, **22**, 65007 (2012).
49. J.-H. Lee, I. Bargatin, Igor; J. Park, K.M. Milaninia, L. S. Theogarajan, R. Sinclair, R. T. Howe, "Smart-cut layer transfer of single-crystal SiC using spin-on-glass". *J. Vacuum Sci. Tech. B: Microelectronics and Nanometer Structures*, **30**, 042001 (2012).
50. J. R. Jain, A. Hryciw, T. M. Baer, D. A. B. Miller, M. L. Brongersma, and R. T. Howe, "A micromachining-based technology for enhancing germanium light emission via tensile strain," *Nature Photonics*, DOI: 10.1038/NPHOTON.2012.111 (2012).
51. C. S. Roper, A. Gutiérrez, C. Carraro, R. T. Howe, and R. Maboudian, "Single crystal silicon nanopillars, nanoneedles and nanoblades with precise positioning for massively parallel nanoscale device integrations," *Nanotechnology*, **23**, 225303 (2012).
52. S. Chong, B. Lee, S. Mitra, R. T. Howe, and H.-S. P. Wong, "Integration of nanoelectromechanical relays with silicon nMOS," *IEEE Trans. Electron Devices*, **59**, 255-257 (2012).
53. S. Yoneoka, J. Lee, M. Liger, G. Yama, T. Kodama, M. Gunji, J. Provine, R. T. Howe, K. E. Goodsen, and T. W. Kenny, "Electrical and thermal conduction in atomic layer deposition nanobridges down to 7 nm thickness," *Nano Letters*, doi 10.1021/nl203548w, Jan. 2012.
54. S. Basu Mallick, I. W. Jung, A. M. Meisner, J. Provine, R. T. Howe, and O. Solgaard, "Multilayered monolithic silicon photonic crystals," *IEEE Photonics Tech. Lett.*, **23**, 730-732 (2011).
55. K.-L. Chen, S. Wang, J. C. Salvia, R. Melamud, R. T. Howe, and T. W. Kenny, "Wafer-level epitaxial silicon packaging for out-of-plane RF MEMS resonators with integrated actuation electrodes," *IEEE Trans. Components, Packaging, and Manufacturing Technology*, **1**, 310 – 317 (2011).
56. G. Bahl, J. C. Salvia, R. Melamud, B. Kim, R. T. Howe, and T. W. Kenny, "AC polarization for charge-drift elimination in resonant electrostatic MEMS and oscillators," *IEEE/ASME J. Microelectromechanical Systems*, **20**, 355 – 364 (2011).
57. M. Ziaei-Moayyed, D. Elata, E. P. Quévy, and R. T. Howe, "Differential internal dielectric transduction of a Lamé-mode resonator," *J. Micromechanics and Microengineering*, **20**, 115036 (2010).

58. J. W. Schwede, I. Bargatin, D. C. Riley, B. E. Hardin, S. J. Rosenthal, Y. Sun, F. Schmitt, P. Pianetta, R. T. Howe, Z.-X. Shen, and N. A. Melosh, "Photon enhanced thermionic emission for solar concentrator systems," *Nature Materials*, **9**, 762-767 (1 August 2010).
59. S. Yoneoka, C. S. Roper, R. N. Candler, S. A. Chandorkar, A. B. Graham, J. Provine, R. Maboudian, R. T. Howe, and T. W. Kenny, "Characterization of encapsulated micromechanical resonators sealed and coated with polycrystalline SiC," *IEEE/ASME J. Microelectromechanical Systems*, **19**, 357 – 366 (2010).
60. G. Bahl, R. Melamud, B. Kim, S. A. Chandorkar, J. C. Salvia, M. A. Hopcroft, D. Elata, R. G. Hennessy, R. N. Candler, R. T. Howe, and T. W. Kenny, "Model and observations of dielectric charge in thermally oxidized silicon resonators," *IEEE/ASME J. Microelectromechanical Systems*, **19**, 162 – 174 (2010).
61. A. B. Graham, M. W. Messana, P. G. Hartwell, J. Provine, S. Yoneoka, R. Melamud, B. Kim, R. T. Howe, and T. W. Kenny, "A method for wafer-scale encapsulation of large lateral deflection MEMS devices," *IEEE/ASME J. Microelectromechanical Systems*, **19**, 28 – 37 (2010).
62. K.-L. Chen, J. Salvia, R. Potter, R. T. Howe, and T. W. Kenny, "Performance evaluation and equivalent model of silicon interconnects for fully encapsulated RF MEMS devices," *IEEE Trans. Advanced Packaging*, **32**, 402-409 (2009).
63. R. Kant, N. Ferralis, J. Provine, R. Maboudian, and R. T. Howe, "Experimental investigation of silicon surface migration in low pressure nonreducing gas environments," *Electrochemical and Solid-State Letters*, **12**, H437-H440 (2009).
64. C. S. Roper, R. T. Howe, and R. Maboudian, "Room temperature wet etching of polycrystalline and nanocrystalline silicon carbide thin films with HF and HNO<sub>3</sub>," *J. Electrochem. Soc.*, **156**, D104 – D107 (2009).
65. C. S. Roper, V. Radmilovic, R. T. Howe, and R. Maboudian, "Characterization of polycrystalline 3C-SiC films deposited from precursors of 1,3-disilabutane and dichlorosilane," *Journal of Applied Physics*, **103**, 084907 (2008).
66. G. K. Fedder, R. T. Howe, T.-J. King Liu, and E. P. Quévy, "Technologies for Co-Fabricating MEMS and Electronics," *Proceedings of the IEEE*, **96**, 306-322 (2008).
67. C. S. Roper, V. Radmilovic, R. T. Howe, and R. Maboudian, "Effects of annealing on residual stress and strain gradient of doped polycrystalline SiC thin films," *Electrochem. Solid-State Letters*, **11**, D35 – D37 (2008).
68. K. Arkarvardar, C. Eggimann, D. Tsamados, Y. S. Chauhan, G. C. Wan, A. M. Ionescu, R. T. Howe, and H.-S. P. Wong, "Analytical modeling of the suspended-gate FET and design insights for low-power logic," *IEEE Transactions on Electron Devices*, **55**, 48-59 (2008).
69. J. Zhang, J. W. Zimmer, R. T. Howe, and R. Maboudian, "Characterization of boron-doped micro- and nanocrystalline diamond films deposited by wafer-scale hot filament

- chemical vapor deposition for MEMS applications,” *Diamond and Related Materials*, **17**, 23-28 (2008).
70. J. Zhang, C. Carraro, R. T. Howe, and R. Maboudian, “Electrical, mechanical and metal contact properties of polycrystalline 3C-SiC films for MEMS in harsh environments,” *Surface & Coatings Tech.*, **201**, 8893-8898 (2007).
71. J. Zhang, R. T. Howe, and R. Maboudian, “Nickel and platinum ohmic contacts to polycrystalline 3C-silicon carbide,” *Materials Science & Engineering B*, **139**, 235-239 (2007).
72. A. San Paulo, N. Arellano, J. A. Plaza, R. He, C. Carraro, R. Maboudian, R. T. Howe, J. Bokor, and P. Yang, “Suspended mechanical structures based on elastic silicon nanowire arrays,” *Nano Letters*, **7**, 1100-1104 (2007).
73. A. San Paulo, E. Quevy, J. Black, R. T. Howe, R. White, and J. Bokor, “Mode shape imaging of out-of-plane and in-plane vibrating RF micromechanical resonators by atomic force microscopy,” *Microelectronic Engineering*, **84**, 1354-1357 (2007).
74. C. W. Low, T.-J. King Liu, and R. T. Howe, “Characterization of polycrystalline silicon-germanium film deposition for modularly integrated MEMS applications,” *IEEE/ASME J. Microelectromechanical Systems*, **16**, 68-77 (2007).
75. C. S. Roper, R. T. Howe, and R. Maboudian, “Stress control of polycrystalline 3C-SiC films in a large-scale LPCVD reactor using 1,3-disilabutane and dichlorosilane as precursors,” *J. Micromechanics and Microengineering*, **16**, 2736-2739 (2006).
76. C. S. Roper, V. Radmilovic, R. T. Howe, and R. Maboudian, “Single-source chemical vapor deposition of SiC films in a large-scale low-pressure mechanical characterization reactor,” *J. Electrochem. Soc.*, **153**, C562-566 (2006).
77. J. C. Zhang, R. T. Howe, and R. Maboudian, “Control of strain gradient in doped polycrystalline silicon carbide films through tailored doping,” *J. Micromechanics and Microengineering*, **16**, L1-L5 (2006).
78. J. C. Zhang, R. T. Howe, and R. Maboudian, “Electrical characterization of n-type polycrystalline 3C-silicon carbide thin films deposited by 1,3-disilabutane,” *J. Electrochem. Soc.*, **153**, G548-G551 (2006).
79. D. Gao, C. Carraro, R. T. Howe, and R. Maboudian, “Polycrystalline silicon carbide as a substrate material for reducing adhesion in MEMS,” *Tribology Lett.*, **21**, 226-232 (2006).
80. A. S. Phani, A. A. Seshia, M. Palaniapan, R. T. Howe, and J. Yasaitis, “Modal coupling in micromechanical vibratory rate gyroscopes,” *IEEE Sensors Journal*, **6**, 1144-52 (2006).
81. A. San Paulo, J. Bokor, R. T. Howe, R. He, P. Yang, D. Gao, C. Carraro, and R. Maboudian, “Mechanical elasticity of single and double clamped silicon nanobeams fabricated by the vapor-liquid-solid method,” *Applied Physics Letters*, **87**, 53111-13, (2005).

82. D. Gao, R. He, C. Carraro, R. T. Howe, P. Yang, and R. Maboudian, "Selective growth of Si nanowire arrays via galvanic displacement processes in water-in-oil microemulsions," *Journal of the American Chemical Society*, **127**, 4574-4575 (2005).
83. H. Takeuchi, A. Wun, Xin Sun, R. T. Howe, and T.-J. King, "Thermal budget limits of quarter-micrometer foundry CMOS for post-processing MEMS devices," *IEEE Trans. Electron Devices*, **52**, 2081-2086, (2005).
84. S. Sedky, J. Schroeder, T.-J. King, and R. T. Howe, "Effect of eximer laser annealing on the structural properties of silicon germanium films," *J. Materials Research*, **19**, 3503-3511 (2004).
85. H. Takeuchi, E. Quevy, S. Bhave, T.-J. King, and R. T. Howe, "Ge-blade damascene process for post-CMOS integration of nano-mechanical resonators," *IEEE Electron Device Lett.*, **25**, 529-531, (2004).
86. D. Gao, C. Carraro, V. Radmilovic, R. T. Howe, and R. Maboudian, "Fracture of polycrystalline 3C-SiC films in microelectromechanical systems," *IEEE/ASME J. of Microelectromechanical Systems*, **13**, 972-976 (2004).
87. S. Sedky, R. T. Howe, and T.-J. King, "Pulsed Laser Annealing, a Low Thermal Budget Technique for Eliminating Stress Gradient in Poly-SiGe MEMS Structures," *IEEE/ASME J. of Microelectromechanical Systems*, **13**, 669-675 (2004).
88. D. Gao, R. T. Howe, and R. Maboudian, "Transformer coupled plasma etching of 3C-SiC films using fluorinated chemistry for MEMS applications," *J. Vac. Sci. Tech. B*, **22**, 513-518 (2004).
89. D. Gao, M. B. J. Wijesundara, C. Carraro, R. T. Howe, and R. Maboudian, "Recent progress toward a manufacturable polycrystalline SiC surface micromachining technology," *IEEE Sensors Journal*, **4**, 441-448 (2004).
90. K. L. Scott, T. Hirano, H. Yang, H. Singh, R. T. Howe, and A. M. Niknejad, "High performance inductors using capillary based fluidic self-assembly," *IEEE/ASME J. of Microelectromechanical Systems*, **13**, 300-309 (2004).
91. C. L. Muhlstein, R. T. Howe, and R. O. Ritchie, "Fatigue of Polycrystalline Silicon for Microelectromechanical Systems: Crack Growth and Stability under Resonant Loading Conditions," *Mechanics of Materials*, **36**, 13-33 (2004).
92. M. B. J. Wijesundara, G. Valente, R. T. Howe, A. P. Pisano, C. Carraro, and R. Maboudian, "Single-source chemical vapor deposition of 3C-SiC films in a LPCVD reactor, part I: Growth, Structure, and Chemical Characterization," *Journal of the Electrochemical Society*, **151**, 210-214 (2004).
93. M. M. Maharbiz, W. J. Holtz, R. T. Howe, and J. D. Keasling, "Microbioreactor arrays with parametric control for high-throughput experimentation," *Biotechnology and Bioengineering*, **85**, 376-381 (2004).



94. M. B. J. Wijesundara, D. Gao, C. Carraro, R. T. Howe, and R. Maboudian, "Nitrogen doping of polycrystalline 3C-SiC films using 1,3-disilabutane in a conventional LPCVD reactor," *J. Crystal Growth*, **259**, 18-25 (2003).
95. D. Gao, M. B. J. Wijesundara, C. Carraro, R. T. Howe, and R. Maboudian, "Characterization of residual strain in SiC films deposited using 1,3-disilabutane for MEMS applications," *J. Microlith., Microfab., Microsyst.*, **2**, 259-264 (2003).
96. P. S. Riehl, K. L. Scott, R. S. Muller, R. T. Howe, and J. A. Yasaitis, "Electrostatic charge and field sensors based on micromechanical resonators," *IEEE/ASME J. of Microelectromechanical Systems*, **12**, 577-589 (2003).
97. M. M. Maharbiz, W. J. Holtz, S. Sharifzadeh, J. D. Keasling, and R. T. Howe, "A microfabricated electrochemical oxygen generator for high-density cell culture arrays," *IEEE/ASME J. of Microelectromechanical Systems*, **12**, 590-599 (2003).
98. D. Gao, R. T. Howe, and R. Maboudian, "High-selectivity etching of polycrystalline 3C-SiC films using HBr-based transformer coupled plasma," *Applied Physics Letters*, **82**, 1742-1744 (2003).
99. Y.-C. Jeon, T.-J. King, and R. T. Howe, "Properties of phosphorus-doped poly-SiGe films for MEMS applications," *Journal of the Electrochemical Society*, **150**, H1-H6 (2003).
100. A. E. Franke, J. M. Heck, T.-J. King, and R. T. Howe, "Polycrystalline silicon germanium films for integrated microsystems," *IEEE/ASME Journal of Microelectromechanical Systems*, **12**, 160-171 (2003).
101. M. B. J. Wijesundara, C. R. Stoldt, C. Carraro, R. T. Howe, and R. Maboudian, "Nitrogen doping of 3C-SiC films grown by single-source chemical vapor deposition," *Thin Solid Films*, **419**, 69-75 (2002).
102. A. A. Seshia, M. Palaniapan, T. A. Roessig, R.T. Howe, R.W. Gooch, T. R. Schimert, and S. Montague, "A vacuum packaged surface micromachined resonant accelerometer," *IEEE/ASME Journal of Microelectromechanical Systems*, **11**, 784-793 (2002).
103. C. R. Stoldt, C. Carraro, W. R. Ashurst, D. Gao, R. T. Howe, and R. Maboudian, "A low-temperature CVD process for silicon carbide MEMS," *Sensors and Actuators A*, **97-98**, 410-415 (2002).
104. U. Srinivasan, M. A. Helmbrecht, C. Rembe, R. S. Muller, and R. T. Howe, "Fluidic self-assembly of micromirrors onto microactuators using capillary forces (invited)," *IEEE Journal on Selected Topics in Quantum Electronics*, **8**, 4-11 (2002).
105. L. Muller, A. P. Pisano, and R. T. Howe, "Microgimbal torsion beam design using open, thin-walled cross sections," *IEEE/ASME J. of Microelectromechanical Systems*, **10**, 550-560 (2001).

106. W. R. Ashurst, C. Yau, C. Carraro, C. Lee, G. J. Kluth, R. T. Howe, and R. Maboudian, "Alkene based monolayer films as anti-stiction coatings for polysilicon MEMS," *Sensors and Actuators A*, **91**, 239-248 (2001).
107. L. Muller, R. T. Howe, and A. P. Pisano, "High-aspect-ratio, molded microstructures with electrical isolation and embedded interconnects," *Microsystem Technologies*, **7**, 47-54, (2001).
108. U. Srinivasan, D. Liepmann, and R. T. Howe, "Microstructure to substrate self-assembly using capillary forces," *IEEE/ASME J. of Microelectromechanical Systems*, **10**, 17-24 (2001).
109. C. T.-C. Nguyen and R. T. Howe, "An integrated CMOS micromechanical resonator high-Q oscillator," *IEEE J. Solid-State Circuits*, **34**, 440-455 (1999).
110. L. Lin, R. T. Howe, and A. P. Pisano, "Microelectromechanical filters for signal processing," *IEEE/ASME J. of Microelectromechanical Systems*, **7**, 286-294 (1998).
111. J. M. Bustillo, R. T. Howe, and R. S. Muller, "Surface micromachining for micro-electro-mechanical systems," (invited), *Proc. of the IEEE*, **86**, 1552-1574 (1998).
112. U. Srinivasan, M. R. Houston, R. T. Howe, and R. Maboudian, "Alkyltrichlorosilane-based self-assembled monolayer films for stiction reduction," *IEEE/ASME J. of Microelectromechanical Systems*, **7**, 252-260 (1998).
113. L. Lin, A. P. Pisano, and R. T. Howe, "A micro strain gauge with mechanical amplifier," *IEEE/ASME J. of Microelectromechanical Systems*, **6**, 313-321 (1997).
114. R. Maboudian and R. T. Howe, "Stiction reduction processes for surface micromachines," *Tribology Letters*, **3**, 215-221 (1997).
115. R. Maboudian and R. T. Howe, "Critical review: stiction in surface micromechanical structures," (invited), *J. Vacuum Science and Technology B*, **B15**, 1-19, (1997).
116. M. R. Houston, R. T. Howe, and R. Maboudian, "Effect of hydrogen termination on the work of adhesion between rough polycrystalline silicon surfaces," *J. of Applied Physics*, **81**, 3474-3483 (1997).
117. G. K. Fedder and R. T. Howe, "Multi-mode digital control of suspended polysilicon microstructures," *IEEE/ASME J. of Microelectromechanical Systems*, **5**, 283-297 (1996).
118. R. T. Howe, B. E. Boser, and A. P. Pisano, "Polysilicon integrated microsystems: technologies and applications," (invited) *Sensors and Actuators A*, **56**, 167-177 (1996).
119. B. E. Boser and R. T. Howe, "Surface micromachined accelerometers," *IEEE J. of Solid-State Circuits*, **31**, 366-375, (1996).

120. P. Cheung, R. Horowitz, and R. T. Howe, "Design, fabrication, position sensing, and control of an electrostatically driven polysilicon microactuator," *IEEE Trans. on Magnetism*, **32**, 122-128 (1996).
121. J. M. Bustillo, G. K. Fedder, C. T.-C. Nguyen, and R. T. Howe, "Process Technology for the Modular Integration of CMOS and Microstructures," (invited) *Microsystem Technology*, **1**, 30-41 (1994).
122. R. L. Alley, K. Komvopoulos, and R. T. Howe, "Self-assembled monolayer film for enhanced imaging of rough surfaces with atomic force microscopy," *J. of Applied Physics*, **76**, 5731-5737, (1994).
123. Y.-H. Cho, B. M. Kwak, A. P. Pisano, and R. T. Howe, "Slide film damping in laterally driven microstructures," *Sensors and Actuators A*, **40**, 31-39 (1994).
124. D. J. Monk, D. S. Soane, and R. T. Howe, "Silicon dioxide sacrificial layer hydrofluoric acid etching: Part I - experimental observations," *J. of the Electrochemical Society*, **141**, 264-269 (1994).
125. D. J. Monk, D. S. Soane, and R. T. Howe, "Silicon dioxide sacrificial layer hydrofluoric acid etching: Part II -- modeling," *J. of the Electrochemical Society*, **141**, 271-274 (1994).
126. Y.-H. Cho, B. M. Kwak, A. P. Pisano, and R. T. Howe, "Viscous damping model for laterally oscillating microstructures," *IEEE/ASME J. of Microelectromechanical Systems*, **3**, 81-87 (1994).
127. D. J. Monk, D. S. Soane, and R. T. Howe, "A Chemical Reaction Mechanism and Kinetics for Hydrofluoric Acid Etching of Silicon Dioxide Thin Films," (invited review) *Thin Solid Films*, **232**, 1, 1-12 (1993).
128. D. J. Monk, D. S. Soane, and R. T. Howe, "Determination of the etching kinetics for the hydrofluoric acid/silicon dioxide system," *J. of the Electrochemical Society*, **140**, 2339-2346, (1993).
129. W. C. Tang, M. G. Lim, and R. T. Howe, "Electrostatic comb drive levitation and control method," *IEEE/ASME Journal of Microelectromechanical Systems*, **1**, 4, 170-178 (1992).
130. R. M. Moroney, R. M. White, and R. T. Howe, "Microtransport induced by ultrasonic Lamb waves," *Applied Physics Letters*, **59**, 7, 774-776, (1991).
131. R. S. Muller and R. T. Howe, "Technologies for microdynamic devices," *Nanotechnology*, **1**, 8-12, (1990).
132. K. S. Udell, A. P. Pisano, R. T. Howe, R. M. White, and R. S. Muller, "Microsensors for heat transfer and fluid flow measurements," *Experimental Thermal and Fluid Science*, **3**, 52-59 (1990).

133. S. C. Chang, M. W. Putty, D. B. Hicks, C. H. Li, and R. T. Howe, "Resonant-Bridge Two-Axis Microaccelerometer," *Sensors and Actuators*, **A21-A23**, 342-345, (1990).
134. L.-S. Fan, R. T. Howe, and R. S. Muller, "Fracture-Toughness Characterization of Brittle Thin Films," *Sensors and Actuators*, **A21-A23**, 872-874, (1990).
135. W. C. Tang, T.-C. H. Nguyen, M. W. Judy, and R. T. Howe, "Electrostatic-Comb Drive of Lateral Polysilicon Resonators," *Sensors and Actuators A*, **A21-A23**, 328-331, (1990).
136. H. R. Wenk, M. Sintubin, J. Huang, G. C. Johnson, and R. T. Howe, *J. of Applied Physics*, **67**, 572-574, (1990).
137. R. T. Howe, "Microsensor and microactuator applications of thin films," *Thin Solid Films*, **181**, 235-243, (1989).
138. J. Huang, R. T. Howe, and H.-S. Lee, "Vacuum-insulated field-effect transistor," *Electronics Letters*, **25**, 1571-1573, (1989).
139. W. C. Tang, T.-C. H. Nguyen, and R. T. Howe, "Laterally driven polysilicon resonant microstructures," *Sensors and Actuators*, **20**, 25-32 (1989).
140. M. W. Putty, S.-C. Chang, R. T. Howe, A. L. Robinson, and K. D. Wise, "Process integration for active polysilicon resonant microstructures," *Sensors and Actuators*, **20**, 143-151, (1989).
141. R. T. Howe, "Surface micromachining for microsensors and microactuators," *J. of Vacuum Science and Technology, Part B*, **6**, 1809-1813, (1988).
142. J. T. Kung, H.-S. Lee, and R. T. Howe, "A digital readout technique for capacitive sensor applications," *IEEE J. of Solid-State Circuits*, **23**, 972-977, (1988).
143. M. A. Schmidt, R. T. Howe, S. D. Senturia, and J. H. Haritonidis, "Design and calibration of a microfabricated floating-element shear-stress sensor," *IEEE Trans. on Electron Devices*, **35**, 750-757, (1988).
144. S. F. Bart, T. A. Lober, J. H. Lang, R. T. Howe, and M. F. Schlecht, "Design considerations for microfabricated electric actuators," *Sensors and Actuators*, **14**, 269-292, (1988).
145. M. Mehregany, R. T. Howe, and S. D. Senturia, "Novel microstructures for the in-situ measurement of mechanical properties of thin films," *J. of Applied Physics*, **62**, 3579-3584, (1987).
146. M. G. Allen, M. Mehregany, R. T. Howe, and S. D. Senturia, "Microfabricated structures for the in-situ measurement of residual stress, Young's modulus, and ultimate strain in polyimide films," *Applied Physics Letters*, **51**, 241-243, (1987).
147. R. T. Howe, "Polycrystalline silicon micromachining: a new technology for integrated sensors," *Annals of Biomedical Engineering*, **14**, 187-197, (1986).

148. R. T. Howe and R. S. Muller, "Resonant-microbridge vapor sensor," *IEEE Trans. on Electron Devices*, **ED-33**, 499-506, (1986).
149. R. T. Howe and R. S. Muller, "Polycrystalline and amorphous silicon micromechanical beams: annealing and mechanical properties," *Sensors and Actuators*, **4**, 447-454, (1983).
150. R. T. Howe and R. S. Muller, "Stress in polycrystalline and amorphous silicon thin films," *J. of Applied Physics*, **54**, 4674-4675, (1983).
151. R. T. Howe and R. S. Muller, "Polycrystalline silicon micromechanical beams," *J. of the Electrochemical Society*, **130**, 1420-1423, (1983).

#### *Refereed Conference and Symposium Proceedings*

1. A. Levy, M. Oduoza, A. V. Balasingham, R. T. Howe, and P. Raina, "Efficient routing in coarse-grained reconfigurable arrays using multi-pole NEM relays," *27<sup>th</sup> Asia South Pacific Design Automation Conference (ASP-DAC)*, (virtual), January 17-20, 2022.
2. S. Nicaise, C. Lin, M. Azadi, T. Bozorg-Grayeli, P. Adebayo-Ige, K. Van Houten, F. Schmitt, D.E. Lilly, Y. Pfitzer, W. Cha, J. W. Schwede, N. Melosh, R. T. Howe, J. W. Schwede, I. Bargatin, "Thermionic energy converter based on micron-gap nanostructured spacers: Achieving record-high short-circuit current," *Micro and Nanotechnology for Power Generation and Energy Conversion Applications, PowerMEMS 2018*, Daytona Beach, Florida, December 4 - 7, 2018.
3. T. Wu, S. S. Hamman, A. Ceballos, O. Solgaard, and R. T. Howe, "Design and fabrication of curved silicon image planes for miniature monocentric imagers," *18<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '15)*, Anchorage, Alaska, June 21-25, 2015.
4. C.-E. Chang, J. D. Siegel, A. J. Roodman, C. J. Kenney, and R. T. Howe, "Experimental demonstration of a stacked SOI multi-band charged-coupled device," *IEEE International Electron Devices Meeting*, San Francisco, Calif., December 15-17, 2014, pp. 4.5.1-4.5.4.
5. K. L. Harrison, C. Dalvi, M. Aseghi, and R. T. Howe, "Analysis of asperity dominated contacts in nanoelectromechanical relays using thin films," *IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems*, May 27-30, 2014, pp. 1256-1260.
6. E. J. Ng, K. L. Harrison, C. L. Everhart, V. A. Hong, Y. Yang, C. H. Ahn, D. B. Heinz, R. T. Howe, and T. W. Kenny, "Stable charge-biased capacitive resonators with encapsulated switches," *27<sup>th</sup> IEEE International Conference on Micro Electro Mechanical Systems*, San Francisco, Calif., January 26-30, 2014, pp. 1277-1280.
7. M. Javanmard, S. Emaminejad, R. W. Davis, C. Gupta, and R. T. Howe, "Three stage sample preparation for purification of proteins from complex biological samples," *IEEE Sensors 2013*, Baltimore, Maryland, November 3 - 6, 2013, pp. 1-4.

8. S. Emaminejad, M. Javanmard, C. Gupta, R. W. Davis, and R. T. Howe, "Ultra dielectrophoresis: electrothermal analysis and its applications in microfluidic sample preparation and proteomics," *17<sup>th</sup> Int. Conf. on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS 2013)*, Freiburg, Germany, Oct. 27-31, 2013.
9. M. Javanmard, S. Emaminejad, C. Gupta, S. Chang, R. W. Davis, and R. T. Howe, "Immobilization of antibodies on solid-state surfaces with controlled orientation using electric field," *17<sup>th</sup> Int. Conf. on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS 2013)*, Freiburg, Germany, Oct. 27-31, 2013.
10. C. Gupta, S. Chang, and R. T. Howe, "Engineering an electrochemical sensor for the characterization of bond vibration frequencies of a chemical analyte." *224<sup>th</sup> Electrochemical Society Meeting*, San Francisco, California, October 27 – November 1, 2013, Abstract 2656.
11. S. Emaminejad, M. Javanmard, C. Gupta, R. W. Dutton, R. W. Davis, and R. T. Howe, "Applications of nanonewton dielectrophoresis forces using atomic layer deposited oxides for microfluidic sample preparation and proteomics," *17<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '13)*, Barcelona, Spain, June 16 – 20, 2013, pp. 2345-2348.
12. A. J. Haemmerli, J. C. Doll, J. Provine, R. T. Howe, D. Goldhaber-Gordon, and B. L. Pruitt, "Ultra-thin atomic layer deposition films for corrosion resistance," *17<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '13)*, Barcelona, Spain, June 16 – 20, 2013, pp. 1931-1934.
13. F. Purkl, T. S. English, G. Yama, J. Provine, A. Samarao, A. Feyh, B. Kim, G. O'Brien, O. Ambacher, R. T. Howe, and T. W. Kenny, "Serpentine geometry for enhanced performance of nanometer-thin platinum bolometers," *17<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '13)*, Barcelona, Spain, June 16 – 20, 2013, pp. 1507-1510.
14. K. L. Harrison, W. S. Lee, K. Shavezipur, J. Provine, S. Mitra, H.-S. P. Wong, and R. T. Howe, "Dual-beam six-terminal nanoelectromechanical relays," *17<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '13)*, Barcelona, Spain, June 16 – 20, 2013, pp. 1436-1439.
15. A. A. Gellineau, A. J. Rastegar, and R. T. Howe, "Capacitive accelerometer laboratory using polymer-film rapid prototyping technology," *3<sup>rd</sup> Interdisciplinary Engineering Design Education Conference*, Santa Clara, Calif., March 4-5, 2013, pp. 79-82.
16. C.-E. Chang, J. D. Siegel, C. J. Kenney, A. J. Roodman, and R. T. Howe, "Multiband charge-coupled device," *IEEE Nuclear Science Symposium, Medical Imaging Conference*, Anaheim, Calif., October 29 – November 3, 2012.
17. J. P. Snapp, J.-H. Lee, J. Provine, I. Bargatin, R. Maboudian, T. H. Lee, and R. T. Howe, "Sidewall silicon carbide emitters for terahertz vacuum electronics", *15<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, S.C., June 4-7, 2012, pp. 336-33

18. W. S. Lee, A.N. Cloud, J. Provine, N. Tayebi, R. Parsa, S. Mitra, H.-S. P. Wong, J. R. Abelson, and R.T. Howe, "CVD hafnium diboride as a contact material for nano-electromechanical switches", *15<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, S.C., June 4-7, 2012, pp. 437-440
19. J.-H. Lee, I. Bargatin, K. Iwami, K.A. Littau, M. Vincent, R. Maboudian, Z.-X. Shen, N. A. Melosh, and R. T. Howe, "Encapsulated thermionic energy converter with stiffened suspension", *15<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, S.C., June 4-7, 2012, pp. 493-496
20. C. Gupta, R. M. Walker, R. Gharpuray, M. M. Shulaker, Z. Zhang, M. Javanmard, R. W. Davis, B. Murmann, and R. T. Howe, "Electrochemical quantum tunneling for electronic detection and characterization of biological toxins," *SPIE Defense, Security, and Sensing 2012*, Baltimore, Md., April 23-27, 2012, *Proc. SPIE*, **8373**, 837303.
21. Chen Chen, W.S. Lee, R. Parsa, S. Chong, J. Provine, J. Watt, R.T. Howe, H.-S.P. Wong, S. Mitra, "Nano-electro-mechanical relays for FPGA routing: experimental demonstration and a design technique", *Proc. Design, Automation & Test in Europe Conference & Exhibition (DATE 2012)*, Dresden, Germany, 12-16 March 2012, pp. 1361 – 1366.
22. J.-H. Lee, I. Bargatin, T. O. Gwinn, M. Vincent, K. A. Littau, R. Maboudian, Z.-X. Shen, N. A. Melosh, and R. T. Howe, "Microfabricated silicon carbide thermionic energy converter for solar electricity generation," *25<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Paris, France, Jan. 29 – Feb. 2, 2012.
23. S. Chong, B. Lee, K. B. Parizi, J. Provine, S. Mitra, R. T. Howe, and H.-S. P. Wong, "Integration of nanoelectromechanical (NEM) relays with silicon (CMOS) with functional CMOS-NEM circuit," *IEEE Int. Electron Devices Meeting*, Washington, DC, Dec. 5-7, 2011, paper 30.5.
24. K.-H. Paik, Y. Liu, V. Tabard-Cossa, D. E. Huber, J. Provine, R. T. Howe, and R. W. Dutton, "Experimental demonstration and analysis of DNA passage in nanopore-based nanofluidic transistors," *IEEE Int. Electron Devices Meeting*, Washington, DC, Dec. 5-7, 2011, paper 30.6.
25. B. Park, I. W. Jung, J. Provine, R. T. Howe, and O. Solgaard, "Double-layered monolithic silicon photonic crystal fiber tip sensor," *IEEE Int. Conf. on Optical MEMS & Nanophotonics*, Istanbul, Turkey, August 8 – 11, 2011.
26. R. T. Howe, "Vacuum microsystems for energy conversion and other applications," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, (plenary talk), Beijing, China, June 5 – 9, 2011, pp. 7 – 11.
27. N. Klejwa, R. G. Hennessy, J.-W. P. Chen, and R. T. Howe, "A reel-to-reel printed accelerometer," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 699 – 702.

28. R. G. Hennessy, M. M. Shulaker, M. W. Messana, A. B. Graham, N. Klejwa, J Provine, T. W. Kenny, and R. T. Howe, "Temperature dependence of vacuum encapsulated resonators for humidity measurement," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 1950 – 1953.
29. I. Laboriante, N. Klejwa, A. Suwandi, C. Carraro, R. T. Howe, and R. Maboudian, "Suppression of wear in cyclically loaded polycrystalline silicon via a thin silicon carbide coating," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 2319 – 2322.
30. D. Lee, S. Mitra, R. T. Howe, and H.-S. P. Wong, "Spacer technique for low-voltage, high-aspect-ratio lateral electrostatic actuators," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 2602 – 2605.
31. W. S. Lee, S. Chong, R. Parsa, J Provine, D. Lee, S. Mitra, H.-S. P. Wong, and R. T. Howe, "Dual sidewall lateral nanoelectromechanical relays with beam isolation," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 2606 – 2609.
32. J.-H. Lee, I. Bargatin, J Provine, F. Liu, M.-K. Seo, R. Maboudian, M. L. Brongersma, N. A. Melosh, Z. X. Shen, and R. T. Howe, "Effect of illumination on thermionic emission of microfabricated silicon carbide structures," *16<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators, and Microsystems (Transducers '11)*, Beijing, China, June 5 – 9, 2011, pp. 2658 – 2661.
33. M. M. Shulaker, J Provine, R. T. Howe, and S. Mitra, Atomic layer deposition of Al<sub>2</sub>O<sub>3</sub> to protect carbon nanotubes for integration with top-down fabrication," *55<sup>th</sup> Int. Conf. on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN 2011)*, Las Vegas, Nevada, May 31 – June 3, 2011.
34. S. Sedky, H. Tawfik, A. Abdel Aziz, S. ElSaegh, A. B. Graham, J Provine, and R. T. Howe, "Low thermal-budget silicon sealed-cavity microencapsulation process," *24<sup>rd</sup> IEEE Micro Electro Mechanical Systems Conference*, Cancun, Mexico, Jan. 23 – 27, 2011, pp. 276-279.
35. S. Yoneoka, M. Liger, G. Yama, R. Schuster, F. Purkl, J Provine, F. B. Prinz, R. T. Howe, and T. W. Kenny, "ALD-metal uncooled bolometer," *24<sup>rd</sup> IEEE Micro Electro Mechanical Systems Conference*, Cancun, Mexico, Jan. 23 – 27, 2011, pp. 676-679.
36. R. Parsa, M. Shavezipur, W. S. Lee, S. Chong, D. Lee, H.-S. P. Wong, R. Maboudian, and R. T. Howe, "Nanomechanical relays with decoupled electrode and suspension," *24<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Cancun, Mexico, Jan. 23 – 27, 2011, pp. 1361-1364.
37. B. Park, J Provine, R. T. Howe, O. Solgaard, and I. W. Jung, "High temperature photonic crystal fiber tip sensor," *9<sup>th</sup> IEEE Conference on Sensors*, Waikoloa, Hawaii, November 1-4, 2010.



38. N. Klejwa, J Provine, and R. T. Howe, "pH sensor demonstrating a layout programmable squeeze pumped microfluidic platform," *9<sup>th</sup> IEEE Conference on Sensors*, Waikoloa, Hawaii, November 1-4, 2010.
39. C. Gupta, R. T. Howe, and M. A. Shannon, "Non-adiabatic electronic relaxation events at monolayer-modified electrode-electrolyte interfaces: physics and applications," *218<sup>th</sup> Electrochemical Society Meeting*, Las Vegas, Nevada, October 10 – 15, 2010, abs. 2097.
40. X. Shen, S. Chong, D. Lee, R. Parsa, R. T. Howe, and H.-S. P. Wong, "2D analytical model for the study of NEM relay device scaling," *Int. Conf. on the Simulation of Semiconductor Processes and Devices (SISPAD 2011)*, Osaka, Japan, Sept. 8-10, 2010.
41. D. Lee, W. S. Lee, S. Mitra, R. T. Howe, and H.-S. P. Wong, "Four-mask process based on spacer technology for scaled-down electrostatic actuators," *International Conference on Optical MEMS and Nanophotonics*, Sapporo, Japan, August 9-12, 2010.
42. R. Parsa, K. Akarvardar, J Provine, D. Lee, D. Elata, S. Mitra, H.-S. P. Wong, and R. T. Howe, "Composite polysilicon-platinum lateral nanoelectromechanical relays," *14<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Carolina, June 6 – 10, 2010, pp. 7 – 10.
43. M. W. Messana, A. B. Graham, S. Yoneoka, R. T. Howe, and T. W. Kenny, "Packaging of large lateral deflection MEMS using a combination of fusion bonding and epitaxial reactor sealing," *14<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Carolina, June 6 – 10, 2010, pp. 336 – 339.
44. J Provine, N. Ferralis, A. B. Graham, M. W. Messana, R. Kang, R. Maboudian, T. W. Kenny, and R. T. Howe, "Time evolution of released hole arrays into membranes via vacuum silicon migration," *14<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Carolina, June 6 – 10, 2010, pp. 344 – 347.
45. G. Bahl, J. Salvia, H. K. Lee, R. Melamud, B. Kim, R. T. Howe, and T. W. Kenny, "Heterodyned electrostatic transduction oscillators evade low frequency noise aliasing," *14<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Carolina, June 6 – 10, 2010, pp. 384 – 385.
46. R. G. Hennessy, M. M. Shulaker, R. Melamud, N. Klejwa, S. Chandorkar, B. Kim, J Provine, T. W. Kenny, and R. T. Howe, "Vacuum encapsulated resonators for humidity measurement," *14<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Carolina, June 6 – 10, 2010, pp. 487 – 490.
47. R. Kant, H. Choo, and R. T. Howe, "Single-step, wafer-scale, hermetic sealing using silicon migration, to be presented at the *54<sup>th</sup> Int. Conf. on Electron, Ion, and Photon Beam Technology and Nanofabrication*, Anchorage, Alaska, June 1 – 4, 2010.
48. M. Ziaei-Moayyed and R. T. Howe, "Higher-order dielectrically transduced bulk-mode ring resonator with low motional resistance," *64<sup>th</sup> IEEE Frequency Control Symposium*, Newport Beach, Calif., June 1-4, 2010, pp. 19-24.

49. C. Chen, R. Parsa, N. Patil, S. Chong, K. Arkarvdar, J. Provine, D. Lewis, J. Watt, R. T. Howe, H.-S. P. Wong, and S. Mitra, "Efficient FPGAs using nanoelectromechanical relays," *18<sup>th</sup> ACM/SIGDA Int. Symp. on Field Programmable Gate Arrays*, Monterey, California, February 21-23, 2010, pp. 273-282.
50. S. Hadzialic, I. W. Jung, O. Kilic, S. Kim, J. Provine, R. T. Howe, and O. Solgaard, "Photonic crystal mirrors for free-space communication and fiber-optic sensors," *Applications of Lasers for Sensing and Free Space Communications*, OSA Technical Digest Series, paper LSWD2.
51. D. Lee, W. S. Lee, J. Provine, J.-O. Lee, J.-B. Yoon, R. T. Howe, S. Mitra, and H.-S. P. Wong, "Titanium nitride sidewall stringer process for lateral nanoelectromechanical relays," *23<sup>rd</sup> IEEE Micro Electro Mechanical Systems Conference*, Hong Kong, Jan. 24 – 28, 2010.
52. M. Ziaei-Moayyed, E. P. Quévy, J. Hsieh, and R. T. Howe, "Efficient internal electrostatic transduction of the 41<sup>st</sup> radial mode of a ring resonator," *23<sup>rd</sup> IEEE Micro Electro Mechanical Systems Conference*, Hong Kong, Jan. 24 – 28, 2010.
53. G. Bahl, J. Salvia, I. Bargatin, S. Yoneoka, R. Melamud, B. Kim, S. Chandorkar, M. A. Hopcroft, R. Bahl, R. T. Howe, and T. W. Kenny, "Charge-drift elimination in resonant electrostatic MEMS," *23<sup>rd</sup> IEEE Micro Electro Mechanical Systems Conference*, Hong Kong, Jan. 24 – 28, 2010.
54. J.-H. Lee, I. Bargatin, J. Provine, R. T. Howe, W. A. Clay, N. A. Melosh, Z.-X. Shen, F. Liu, and R. Maboudian, "Thermionic emission from microfabricated silicon carbide filaments," to be presented at the *9<sup>th</sup> Int. Conf. on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (Power MEMS 2009)*, Washington, D.C., Dec. 1-4, 2009.
55. S. Chong, K. Arkarvdar, R. Parsa, J.-B. Yoon, R. T. Howe, S. Mitra, and H.-S. P. Wong, "Nanoelectromechanical (NEM) relays integrated with SRAM for improved stability and low leakage," *IEEE/ACM Int. Conf. on Computer-Aided Design*, San Jose, California, Nov. 2-5, 2009.
56. T. A. Zangle, R. Kant, R. T. Howe, and J. G. Santiago, "Microfluidic device with integrated nanopores for protein detection," *13<sup>th</sup> Int. Conf. on Miniaturized Systems for Chemistry and Life Sciences ( $\mu$ TAS 2009)*, Jeju, Korea, Nov. 1-5, 2009.
57. I.W. Jung, B. Park, J. Provine, R.T. Howe, O. Solgaard, "Photonic Crystal Fiber Tip Sensor for Precision Temperature Sensing," *22<sup>nd</sup> IEEE Photonics Society Annual Meeting*, Antalya, Turkey, October 4-8, 2009.
58. I.W. Jung, B. Park, J. Provine, R.T. Howe, and O. Solgaard, "Monolithic Silicon Photonic Crystal Slab Fiber Tip Sensor," *IEEE Optical MEMS and Nanophotonics Conference*, Clearwater Beach, Florida, August 17-20, 2009.
59. J.-W. P. Chen and R. T. Howe, "Wafer reconstitution with precision dry front-to-front registration," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver,

Colorado, June 21-25, 2009.

60. M. Ziaei-Moayyed, J. Hsieh, J.-W. P. Chen, E. P. Quévy, D. Elata, and R. T. Howe, "Higher-order mode internal electrostatic transduction of a bulk-mode ring resonator on a quartz substrate," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
61. K. L. Tsai, D. Pickard, J. Kao, X. Yin, B. Leen, K. Knutson, R. Kant, and R. T. Howe, "Magnetic nanoparticle-driven pumping in microchannels," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
62. K.-L. Chen, S. Wang, J. Salvia, R. T. Howe, and T. W. Kenny, "Encapsulated out-of-plane differential square-plate resonators with integrated actuation electrodes," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
63. C. S. Roper, R. Candler, S. Yoneoka, T. Kenny, R. T. Howe, and R. Maboudian, "Simultaneous wafer-scale vacuum encapsulation and microstructure cladding with LPCVD polycrystalline 3C-SiC," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
64. R. Kant, M. Ziaei-Moayyed, and R. T. Howe, "Suspended microstructures made using silicon microstructures," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
65. N. Klejwa, R. Misra, J. Provine, S. J. Klejwa, M. Zhang, S.-X. Wang, and R. T. Howe, "Laser-printed magnetic-polymer microstructures," *15<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Denver, Colorado, June 21-25, 2009.
66. J. Provine, N. Ferralis, N. Klejwa, C. Carraro, R. Maboudian, and R. T. Howe, "Epitaxial growth of graphene on high topology SiC structures patterned by focused ion beam," *53<sup>rd</sup> International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication*, Marco Island, Florida, May 26-29, 2009.
67. N. Klejwa, R. Misra, S. J. Klejwa, and R. T. Howe, "Laser print patterning of planar spiral inductors," *53<sup>rd</sup> International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication*, Marco Island, Florida, May 26-29, 2009.
68. G. Thareja, R. Kant, R. Howe, and Y. Nishi, "Structural transformation of silicon due to hydrogen ambient during germanium epitaxy on silicon nano-pillars," *Materials Research Society Spring Meeting*, San Francisco, California, April 13-17, 2009.
69. A. B. Graham, M. Messana, P. Hartwell, J. Provine, S. Yoneoka, B. Kim, R. Melamud, R. T. Howe, and T. W. Kenny, "Wafer scale encapsulation of large lateral deflection MEMS structures," *22<sup>nd</sup> IEEE Micro Electro Mechanical Systems Conference*, Sorrento, Italy, January 25-29, 2009.
70. K.-L. Chen, H. Chandralim, A. B. Graham, S. A. Bhave, R. T. Howe, and T. W. Kenny, "Epitaxial silicon microshell vacuum-encapsulated CMOS-compatible 200 MHz

- bulk-mode resonator,” ,” *22<sup>nd</sup> IEEE Micro Electro Mechanical Systems Conference*, Sorrento, Italy, January 25-29, 2009.
71. M. Ziaei-Moayyed, D. Elata, J. Hsieh, J.-W. Chen, E. P. Quévy, and R. T. Howe, “Fully differential interal electrostatic transduction of a Lamé-mode resonator,” *22<sup>nd</sup> IEEE Micro Electro Mechanical Systems Conference*, Sorrento, Italy, January 25-29, 2009.
  72. J. Provine, C. Roper, J. Schuller, M. Brongersma, R. Maboudian, R.T. Howe, “The Dependence of Poly-Crystalline SiC Mid-Infrared Optical Properties on Deposition Conditions,” *IEEE/LEOS International Conference on Optical MEMS and Nanophotonics*, Freiburg, Germany, August 11-14, 2008.
  73. K. Arkarvardar, D. Elata, R. T. Howe, H.-S. P. Wong, “Energy-reversible complementary NEM logic gates,” *66<sup>th</sup> IEEE Device Research Conference*, Santa Barbara, California, June 25-28, 2008.
  74. G. Bahl, R. Melamud, B. Kim, S. Chandorkar, J. Salvia, M. A. Hopcroft, R. A. Hennessey, S. Yoneoka, C. M. Jha, G. Yama, D. Elata, R. N. Candler, R. T. Howe, and T. W. Kenny, “Observations of fixed and mobile charge in composite MEMS resonators,” *13<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Caroline, June 1-5, 2008, pp. 102-105.
  75. D. Elata, R. Hennessey, V. Leus, N. Klejwa, A. Hirshberg, J. Provine, and R. T. Howe, “Measuring charge and charge-decay in floating electrode electrostatic MEMS actuators,” *13<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Caroline, June 1-5, 2008, pp. 178-181.
  76. K. L. Tsai, M. Ziaei-Moayyed, N. Klejwa, R. N. Candler, W. Hu, S. X. Wang, and R. T. Howe, “Characterization of magnetic nanoparticle-embedded SU8 for microactuation,” *13<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head, South Caroline, June 1-5, 2008, pp. 162-165.
  77. S. Kim, R. Kant, S. Hadzialic, R. T. Howe, O. Solgaard, “Interface quality control of monolithic photonic crystals by hydrogen annealing,” *Conference on Lasers and Electro-Optics (CLEO) 2008*, San Jose, California, May 6-8 2008.
  78. N. Arellano, E. P. Quévy, J. Provine, R. Maboudian, and R. T. Howe, “Nanowire coupled micro-resonators,” *21<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Tucson, Arizona, January 13-16, 2008.
  79. K. Akarvardar, D. Elata, R. Parsa, G. C. Wan, K. Yoo, J. Provine, P. Peumans, R. T. Howe, and H.-S. P. Wong, “Design considerations for complementary nanoelectromechanical logic gates,” *IEEE Int. Electron Devices Meeting*, Washington, D.C., December 10-12, 2007.
  80. J. Provine, P. B. Catrysse, C. Roper, R. Maboudian. S. Fan, and R. T. Howe, “Phonon polariton reflectance spectra in a silicon carbide membrane hole array,” *Annual Meeting of the IEEE Laser and Electro-Optics Society*, Lake Buena Vista, Florida, October 21-25, 2007.

81. J. Provine, P. B. Catrysse, C. Roper, R. Maboundian, S. Fan, and R. T. Howe, "Extraordinary transmission through a poly-SiC membrane with subwavelength hole arrays," *IEEE Optical MEMS and Nanophotonics Workshop*, Hualien, Taiwan, Aug. 12-16, 2007.
82. H. Chandralalim, S. A. Bhave, E. P. Quévy, and R. T. Howe, "Aqueous transduction of poly-SiGe disk resonators," *14<sup>th</sup> Int. Conf. on Solid-State Sensors, Actuators and Microsystems*, Lyon France, June 10-14, 2007.
83. F. J. Zendejas, U. Srinivasan, W. J. Holtz, J. D. Keasling, and R. T. Howe, "Microfluidic generation of tunable monodisperse double emulsions for templated silica particles," *10<sup>th</sup> Int. Conf. on Miniaturized Systems for Chemistry and Life Sciences*, Tokyo, Japan, Nov. 5-9, 2006.
84. E. P. Quévy, R. T. Howe, and T.-J. King, "Reconstituted wafer technology for heterogeneous integration," *19<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Istanbul, Turkey, January 22-26, 2006, pp. 302-305.
85. E. P. Quévy, A. San Paulo, E. Basol, R. T. Howe, T.-J. King, and J. Bokor, "Back-end-of-line poly-SiGe disk resonators," *19<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Istanbul, Turkey, January 22-26, 2006, pp. 234-237.
86. H. Kam, R. T. Howe, and T.-J. King, "A new nano-electro-mechanical field effect transistor (NEMFET) for low-power electronics," *IEEE Int. Electron Devices Meeting*, December 5-7, 2005, Washington, DC.
87. T. Koyama, D. S. Bindel, W. He, E. P. Quévy, S. Govindjee, J. W. Demmel, and R. T. Howe, "Simulation tools for damping in high frequency resonators," *IEEE Sensors Conference*, Irvine, California, October 31 – November 2, 2005.
88. E. P. Quévy and R. T. Howe, "Redundant MEMS resonators for precise reference oscillators," (invited), *IEEE Radio Frequency Integrated Circuits Symposium*, Long Beach, California, June 12-14, 2005, pp. 113-116.
89. S. A. Bhave and R. T. Howe, "Silicon nitride-on-silicon bar resonator using internal electrostatic transduction," *13<sup>th</sup> International Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '05)*, Seoul, Korea, June 5-9, 2005.
90. F. J. Zendejas, U. Srinivasan, W. J. Holtz, J. D. Keasling, and R. T. Howe, "Microfluidic generation of tunable emulsions for templated monodisperse silica," *13<sup>th</sup> International Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '05)*, Seoul, Korea, June 5-9, 2005.
91. S. A. Bhave, D. Gao, R. Maboudian, and R. T. Howe, "Fully differential poly-SiC Lamé-mode resonator and checkerboard filter," *18<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference (MEMS-05)*, Miami, Florida, January 30 – February 3, 2005.
92. D. S. Bindel, E. Quévy, S. Govinjee, J. W. Demmel, and R. T. Howe, "Anchor loss simulation in resonators," *18<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference (MEMS-05)*, Miami, Florida, January 30 – February 3, 2005.

93. C. W. Low, B. L. Bircumshaw, T. Dorofeeva, G. Solomon, T. -J. King and R. T. Howe, "Stress Stability of Poly-SiGe and Various Oxide Films in Humid Environments," *Stability of Thin Films and Nanostructures Symposium*, Materials Research Society, Boston, Mass., Nov. 29 - Dec. 3, 2004
94. C. W. Low, M. L. Wasilik, H. Takeuchi, T.-J. King, and R. T. Howe, "In-situ doped poly-SiGe LPCVD process using  $\text{BCl}_3$  for post-CMOS integration of MEMS devices," *SiGe Materials, Processing, and Device Symposium*, Electrochemical Society Fall Meeting, Honolulu, Hawaii, October 3-8, 2004. P. 1384.
95. S. A. Bhave and R. T. Howe, "Internal electrostatic transduction for bulk-mode MEMS resonators," (late news paper) *11<sup>th</sup> Solid-State Sensor, Actuator, and Microsystems Workshop*, Hilton Head Island, South Carolina, June 6-10, 2004, pp. 59-60.
96. D. Gao, W. R. Ashurst, C. Carraro, R. T. Howe, and R. Maboudian, "Silicon carbide for enhanced MEMS reliability," *11<sup>th</sup> Solid-State Sensor, Actuator, and Microsystems Workshop*, Hilton Head Island, South Carolina, June 6-10, 2004, pp. 192-195.
97. M.-A. N. Eyoum, Y. R. Su, B. L. Bircumshaw, D. Kouzimov, H. Takeuchi, R. T. Howe, and T.-J. King, "Effects of boron concentration on  $\text{Si}_{1-x}\text{Ge}_x$  properties for integrated MEMS technology," *11<sup>th</sup> Solid-State Sensor, Actuator, and Microsystems Workshop*, Hilton Head Island, South Carolina, June 6-10, 2004, pp. 246-249.
98. E. P. Quévy, S. A. Bhave, H. Takeuchi, T.-J. King, and R. T. Howe, "Poly-SiGe high frequency resonators based on lithographic definition of nano-gap lateral transducers," *11<sup>th</sup> Solid-State Sensor, Actuator, and Microsystems Workshop*, Hilton Head Island, South Carolina, June 6-10, 2004, pp. 360-363.
99. A. S. Phani, A. A. Seshia, M. Palaniapan, and R. T. Howe, "Coupling of resonant modes in micromechanical vibratory rate gyroscopes," *Modeling and Simulation of MEMS (MSM-04)*, Boston, Mass., March 7-11, 2004, pp. 343-346.
100. B. L. Bircumshaw, M. L. Wasilik, E. B. Kim, Y. R. Su, H. Takeuchi, C. W. Low, A. P. Pisano, T.-J. King, and R. T. Howe, "Hydrogen peroxide etching and stability of p-type poly-SiGe films," *17<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference (MEMS-04)*, Maastricht, The Netherlands, January 25-29, 2004, pp. 514-519.
101. B. C. Y. Lin, T.-J. King, and R. T. Howe, "Optimization of poly-SiGe deposition processes for modular MEMS integration," *Micro- and Nanosystems Symposium*, December 1-3, 2003, Boston, Mass., pp. 43-48.
102. B. Bircumshaw, G. Liu, H. Takeuchi, T.-J. King, R. Howe, O. O'Reilly, and A. Pisano, "The radial bulk annular resonator: towards a 50 $\Omega$  RF MEMS filter," *12<sup>th</sup> Int. Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '03)*, Boston, Mass., June 8-12, 2003, pp. 875-878.
103. S. A. Bhave, J. I. Seeger, X. Jiang, B. E. Boser, R. T. Howe, and J. Yasaitis, "An integrated, vertical drive, in-plane-sense microgyroscope," *12<sup>th</sup> Int. Conference on Solid-*

- State Sensors, Actuators, and Microsystems (Transducers '03)*, Boston, Mass., June 8-12, 2003, pp. 171-174.
104. D. Gao, B. J. Wijesundara, C. Carraro, C. W. Low, R. T. Howe, and R. Maboudian, "High modulus polycrystalline 3C-SiC technology for RF MEMS," *12<sup>th</sup> Int. Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '03)*, Boston, Mass., June 8-12, 2003, pp. 1160-1163.
  105. K. L. Scott, R. T. Howe, and C. J. Radke, "Model for micropart planarization in capillary-based microassembly," *12<sup>th</sup> Int. Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers '03)*, Boston, Mass., June 8-12, 2003, pp. 1319-1322.
  106. M. Palaniapan, R. T. Howe, and J. Yasaitis, "Integrated Z-axis frame microgyroscope with ISOD design," *16<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference*, Kyoto, Japan, January 2003, pp. 482-485.
  107. J. Yasaitis, M. Judy, T. Brosnihan, P. Garone, N. Pokrovskiy, D. Sniderman, S. Limb, R. Howe, B. Boser, M. Palaniapan, X. Jiang, and S. Bhave, "A modular process for integrating thick polysilicon MEMS devices with sub-micron CMOS," *Proceedings of SPIE, 4979, Micromachining and Microfabrication Process Technology VII*, edited by John A. Yasaitis, Mary Ann Perez-Maher, Jean Michel Karam, (SPIE, Bellingham, WA, 2003).
  108. T.-J. King, R. T. Howe, S. Sedky, G. Liu, B. C.-Y. Lin, M. Wasilik, and C. Dünn (invited), "Recent progress in modularly integrated MEMS technologies," *IEEE International Electron Devices Meeting*, San Francisco, Calif., December 9-11, 2002, pp. 199-202.
  109. M. Palaniapan, R. T. Howe, and J. Yasaitis, "Integrated surface-micromachined Z-axis frame microgyroscope," *IEEE International Electron Devices Meeting*, San Francisco, Calif., December 9-11, 2002, pp. 203-206.
  110. S. Sedky, J. Schroeder, T. Sands, R. Howe, and T.-J. King, "Pulsed laser annealing of silicon germanium films," *MRS Proceedings*, **741**, Boston, Mass., December 2002, pp. J4.2.1-J4.2.6.
  111. T.-J. King, R. T. Howe, M.-A. Eyoun, and S. A. Bhave, "Interconnect issues for integrated MEMS technologies," (invited) *Advanced Metallization Conference*, San Diego, Calif., October 2002.
  112. X. Jiang, S. A. Bhave, J. I. Seeger, R. T. Howe, B. E. Boser, and J. Yasaitis, " $\Sigma\Delta$  Capacitive Interface for a Vertically Driven X&Y-Axis Rate Gyroscope," *European Solid-State Circuits Conference*, Bologna, Italy, September 2002, 639-642
  113. S. A. Bhave, B. L. Bircumshaw, Y.-S. Kim, W. Z. Low, T.-J. King, and R. T. Howe, "Poly-SiGe: a high-Q structural material for integrated RF MEMS," *10<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head Island, S.C., June 2-6, 2002, pp. 34-37.

114. M. M. Maharbiz, W. J. Holtz, J. D. Keasling, and R. T. Howe, "A microfabricated electrochemical oxygen generator for high-density cell culture arrays," *10<sup>th</sup> Solid-State Sensors, Actuators, and Microsystems Workshop*, Hilton Head Island, S.C., June 2-6, 2002, pp. 259-263.
115. P. Riehl, K. Scott, R. S. Muller, and R. T. Howe, "High-resolution electrometer with micromechanical variable capacitor," *10<sup>th</sup> Solid-State Sensors and Actuators Workshop*, Hilton Head Island, S.C., June 2-6, 2002, pp. 305-308.
116. A. A. Seshia, W. Z. Low, S. A. Bhave, and R. T. Howe, "Micromechanical Pierce oscillator for resonator sensor applications," *Modeling and Simulation of Microsystems Workshop*, San Juan, Puerto Rico, April 22-25, 2002, pp. 162-165.
117. R. T. Howe and T.-J. King, "Low-temperature LPCVD MEMS technologies," MRS Symposium on BioMEMS and Bionanotechnologies, *MRS Proceedings*, **729**, San Francisco, Calif., April 1-4, 2002, paper U5.1, 205-213.
118. A. A. Seshia, R. T. Howe, and S. Montague, "An integrated microelectromechanical resonant-output gyroscope," *15<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference (MEMS 2002)*, Las Vegas, Nevada, January 2002, pp. 722-726.
119. M. A. Helmbrecht, U. Srinivasan, C. Rembe, R. T. Howe, and R. S. Muller, "Micromirrors for adaptive optics," *11<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 01)*, Munich, Germany, June 10-14, 2001, pp. 1290-1293.
120. C. Rembe, L. Muller, R. S. Muller, A. P. Pisano, and R. T. Howe, "Full three-dimensional motion characterization of a gimbaled electrostatic microactuator," *IEEE Int. Reliability Physics Symposium*, Orlando, Florida, April 30-May 3, 2001, pp. 91-98.
121. K. F. Böhringer, U. Srinivasan, and R. T. Howe, "Modeling of capillary forces and binding sites for fluidic self-assembly," *14<sup>th</sup> IEEE Micro Electro Mechanical Systems Conference (MEMS 2001)*, Interlaken, Switzerland, Jan. 21-25, 2001, pp. 369-374.
122. M. Maharbiz, R. T. Howe, and J. D. Keasling, "Silicon microbial bioreactor arrays," *1<sup>st</sup> Int. IEEE-EMBS Conf. on Microtechnologies in Medicine & Biology*, Lyon, France, Oct. 12-14, 2000, pp. 165-170.
123. U. Srinivasan, M. Helmbrecht, C. Rembe, R. S. Muller, and R. T. Howe, "Fluidic self-assembly of micromirrors onto surface micromachined actuators," *IEEE/LEOS Int. Conf. on Optical MEMS*, Kawai, Hawaii, August 21-24, 2000, pp. 59-60.
124. C. Rembe, M. Hart, M. A. Helmbrecht, U. Srinivasan, R. S. Muller, K. Y. Lau, and R. T. Howe, "Stroboscopic interferometer with variable magnification to measure dynamics in an adaptive-optics micromirror," *IEEE/LEOS Int. Conf. on Optical MEMS*, Kawai, Hawaii, August 21-24, 2000, pp. 73-74.
125. A. E. Franke, Y. Jiao, M. T. Wu, T.-J. King, and R. T. Howe, "Post-CMOS modular integration of poly-SiGe microstructures using poly-Ge sacrificial layers," *9<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, South Carolina, June 4-8, 2000, pp. 18-21.



126. W. R. Ashurst, C. Yao, C. Carraro, R. T. Howe, and R. Maboudian, "Alkene based monolayer films as anti-stiction coatings for polysilicon MEMS," *9<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, South Carolina, June 4-8, 2000, pp. 320-333.
127. E. E. Hui, R. T. Howe, and M. S. Rodgers, "Single-step assembly of complex 3-D microstructures," *13<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 2000)*, Miyazaki, Japan, Jan. 2000, pp. 602-607.
128. L. Muller, J. M. Heck, R. T. Howe, and A. P. Pisano, "Electrical isolation process for molded, high-aspect-ratio polysilicon microstructures," *13<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 2000)*, Miyazaki, Japan, Jan. 2000, pp. 590-595.
129. P. T. Jones, G. C. Johnson, and R. T. Howe, "Materials characterization for MEMS - a comparison of uniaxial and bending tests," *SPIE Micromachining and Microfabrication Symposium*, Santa Clara, Calif., Sept. 1999.
130. P. T. Jones, G. C. Johnson, and R. T. Howe, "Statistical characterization of fracture of brittle MEMS materials," *SPIE Micromachining and Microfabrication Symposium*, Santa Clara, Calif., Sept. 1999.
131. A. Singh, D. Bilic, and R. T. Howe, "Performance evaluation of batch-transferred surface micromachined resonators," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1158-1161.
132. O. Tabata, T. Yamamoto, A. A. Seshia, and R. T. Howe, "Integrated resonant accelerometer based on rigidity change," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1538-1541.
133. D. Bilic, R. T. Howe, W. A. Clark, and T. A. Roessig, "Third harmonic double-ended tuning fork resonator," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1824-1825.
134. A. E. Franke, D. Bilic, D. T. Chang, P. T. Jones, T.-J. King, R. T. Howe, and G. C. Johnson, "Optimization of poly-silicon-germanium as a microstructural material," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 530-533.
135. J. M. Heck, C. G. Keller, A. E. Franke, L. Muller, T.-J. King, and R. T. Howe, "High aspect ratio poly-silicon-germanium microstructures," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 328-331.
136. L. Muller, J. M. Noworolski, R. T. Howe, and A. P. Pisano, "Mechanical performance of an integrated microgimbal / microactuators for disk drives," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1002-1005.
137. U. Srinivasan, R. T. Howe, and D. Liepmann, "Fluidic microassembly using patterned self-assembled monolayers and shape matching," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1170-1173.

138. M. Maharbiz, R. T. Howe, and K. S. J. Pister, "Batch transfer assembly of micro-components onto surface and SOI MEMS," *10<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 99)*, Sendai, Japan, June 7-11, 1999, pp. 1478-1481.
139. A. M. Shkel, R. Horowitz, A. A. Seshia, S. Park, and R. T. Howe, "Dynamics and control of micromachined gyroscopes," *Proceedings, American Control Conference*, San Diego, Calif., June 2-4, 1999.
140. A. M. Shkel, R. T. Howe, and R. Horowitz, "Modeling and simulation of micromachined gyroscopes in the presence of imperfections," *Int. Conf. On Modeling and Simulation of Microsystems (MSM 99)*, San Juan, Puerto Rico, April 1999.
141. A. E. Franke, D. Bilic, D. T. Chang, P. T. Jones, T.-J. King, R. T. Howe, and G. C. Johnson, "Post-CMOS integration of germanium microstructures," *12<sup>th</sup> IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 99)*, Orlando, Florida, Jan. 17-21, 1999, pp. 630-637.
142. K. S. Leboutz, A. Mazaheri, R. T. Howe, and A. P. Pisano, "Vacuum encapsulation of resonant devices using permeable polysilicon," *12<sup>th</sup> IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 99)*, Orlando, Florida, Jan. 17-21, 1999, pp. 470-475.
143. M. M. Maharbiz, M. B. Cohn, R. T. Howe, R. Horowitz, and A. P. Pisano, "Batch micropackaging by compression-bonded wafer-wafer transfer," *12<sup>th</sup> IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 99)*, Orlando, Florida, Jan. 17-21, 1999, pp. 482-489.
144. M. B. Cohn, K. F. Bohringer, J. M. Noworolski, A. Singh, C. G. Keller, K. Y. Goldberg, and R. T. Howe, "Microassembly technologies for MEMS," (invited plenary paper), *SPIE Micromachining and Microfabrication Symposium*, Santa Clara, Calif., Sept. 20-22, 1998, SPIE Proc. **3511**, pp. 2-16.
145. E. E. Hui, C. G. Keller, and R. T. Howe, "Carbonized parylene as a conformal sacrificial layer for high aspect ratio molded polysilicon," *8<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, S.C., June 7-11, 1998, pp. 256-260.
146. T. A. Roessig, R. T. Howe, A. P. Pisano, and J. H. Smith, "Surface-micromachined 1 MHz oscillator with low-noise Pierce configuration," *8<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, S.C., June 7-11, 1998, pp. 328-332.
147. U. Srinivasan, J. D. Foster, R. Maboudian, R. T. Howe, D. C. Senft, and M. D. Dugger, "Lubrication of polysilicon micromechanisms with self-assembled monolayers," *8<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, S.C., June 7-11, 1998, pp. 156-161.
148. K.-F. Bohringer, K. Goldberg, M. Cohn, R. Howe, and A. Pisano, "Parallel microassembly with electrostatic force fields," *Int. Conference on Robotics and Automation*, Leuven, Belgium, May 1998.
149. P. T. Jones, G. C. Johnson, and R. T. Howe, "Fracture strength of polycrystalline silicon," MRS, San Francisco, Calif., April 1998.

150. J. T. Feddema, C. G. Keller, and R. T. Howe, "Experiments in micromanipulation and CAD-driven microassembly," *SPIE Symposium on Microrobotics and Microsystem Fabrication*, **3202**, Pittsburgh, Pa., Oct. 16-17, 1997, pp. 98-107.
151. A. Singh, D. A. Horsley, M. B. Cohn, A. P. Pisano, and R. T. Howe, "Batch transfer of microstructures using flip-chip solder bump bonding," *9<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 97)*, Chicago, Ill., June 16-19, 1997, pp. 265-268.
152. T. J. Brosnihan, J. M. Bustillo, A. P. Pisano, and R. T. Howe, "Embedded interconnect and electrical isolation for high-aspect-ratio, SOI inertial instruments," *9<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 97)*, Chicago, Ill., June 16-19, 1997, pp. 637-641.
153. T. A. Roessig, R. T. Howe, and A. P. Pisano, "Surface-micromachined resonant accelerometer," *9<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 97)*, Chicago, Ill., June 16-19, 1997, pp. 859-862.
154. U. Srinivasan, M. R. Houston, R. T. Howe, and R. Maboudian, "Self-assembled fluorocarbon films for enhanced stiction reduction," *9<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 97)*, Chicago, Ill., June 16-19, 1997, pp. 1399-1402.
155. T. A. Roessig, R. T. Howe, and A. P. Pisano, "Nonlinear mixing in surface-micromachined tuning fork oscillators," *IEEE Frequency Control Symposium*, Orlando, Florida, May 27-29, 1997.
156. C. G. Keller and R. T. Howe, "Hexsil tweezers for teleoperated micro-assembly," *IEEE 10<sup>th</sup> Int. Workshop on Micro Electromechanical Systems (MEMS 97)*, Nagoya, Japan, Jan. 26-30, 1997, pp. 72-77.
157. W. A. Clark, R. T. Howe, and R. Horowitz, "Z-axis vibratory rate gyroscope," *AVS Micromachining Workshop III - Technology and Applications*, Anaheim, Calif., Sept. 24-26, 1996.
158. P. T. Jones, G. C. Johnson, and R. T. Howe, "Micromechanical structures for fracture testing of brittle thin films," *Symp. on Microelectromechanical Systems (MEMS)*, vol. **DSC-59**, ASME Int. Conf. and Exp., Atlanta, Georgia, Nov. 1996, pp. 325-330.
159. C. G. Keller and R. T. Howe, "Hexsil tweezers with polysilicon piezoresistive strain gauges," *Late News Digest, 7<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S. C., June 2-6, 1996, pp. 31-32.
160. W. A. Clark, R. T. Howe, and R. Horowitz, "Surface micromachined Z-axis vibratory rate gyroscope," *7<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S. C., June 2-6, 1996, pp. 299-302.

161. M. R. Houston, R. Maboudian, and R. T. Howe, "Self-assembled monolayers as permanent anti-stiction coatings for polysilicon microstructures," *7<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S. C., June 2-6, 1996, pp. 42-47.
162. M. B. Cohn, Y. Liang, R. T. Howe, and A. P. Pisano, "Wafer-to-wafer microstructure transfer for vacuum packaging," *7<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S. C., June 2-6, 1996, pp. 32-35.
163. T. A. Roessig, A. P. Pisano, and R. T. Howe, "Surface micromachined resonant force sensors," *ASME Int. Congress and Exposition, Symposium on Micromechanical Systems*, San Francisco, Calif., vol. **DSC 57-2**, Nov. 12-17, 1995, pp. 871-876.
164. M. B. Cohn, R. T. Howe, and A. P. Pisano, "Self-assembly of microsystems using non-contact electrostatic traps," *ASME Int. Congress and Exposition, Symposium on Micromechanical Systems*, San Francisco, Calif., Nov. 12-17, 1995, pp. 893-900.
165. T. J. Brosnihan, A. P. Pisano, and R. T. Howe, "Surface micromachined angular accelerometer with force feedback," *ASME Int. Congress and Exposition, Symposium on Micromechanical Systems*, San Francisco, Calif., vol. **DSC 57-2**, Nov. 12-17, 1995, pp. 941-947.
166. C. G. Keller and R. T. Howe, "High aspect ratio molded CVD silicon MEMS," *AVS Micromachining Workshop II -Technology and Applications*, Anaheim, Calif., Sept. 27-28, 1995.
167. R. T. Howe, "Polysilicon Integrated Microsystems: Technologies and Applications," (invited plenary talk), *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **1**, pp. 43-46.
168. M. Biebl, G. Brandl, and R. T. Howe, "Young's Modulus of *in-situ* Phosphorus-Doped Polysilicon," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **2**, pp. 80-83.
169. M. Biebl, G. T. Mulhern, and R. T. Howe, "*In Situ* Phosphorus Doped Polysilicon for Integrated MEMS," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **1**, pp. 198-201.
170. K. H.-L. Chau, S. R. Lewis, Y. Zhao, R. T. Howe, S. F. Bart, and R. G. Marcheselli, "An integrated force-balanced capacitive accelerometer for low-G applications," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **1**, pp. 593-596.
171. C. G. Keller and R. T. Howe, "Hexsil bimorphs for vertical actuation," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **1**, pp. 99-102.
172. C. G. Keller and R. T. Howe, "Nickel-filled thermally actuated hexsil tweezers," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers '95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. **2**, pp. 376-379.

173. K. S. Leboutitz, R. T. Howe, and A. P. Pisano, "Permeable Polysilicon Microshell Etch-Access Windows," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. 1, pp. 224-227.
174. M. R. Houston, R. T. Howe, and R. Maboudian, "Ammonium Fluoride Surface Treatments for Reducing In-Use Stiction in Polysilicon Microstructures," *8<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 95) and Eurosensors IX*, Stockholm, Sweden, June 25-29, 1995, vol. 1, pp. 210-213.
175. R. T. Howe, "Recent Advances in Surface Micromachining," *13<sup>th</sup> Sensor Symposium*, (invited plenary talk), IEE Japan, Tokyo, Japan, June 7-9, 1995, pp. 1-8.
176. B. E. Boser and R. T. Howe, "Surface Micromachined Accelerometers," (invited) *IEEE Custom Integrated Circuits Conference*, Santa Clara, Calif., May 1-4, 1995, pp. 337-344.
177. M. R. Houston, R. T. Howe, K. Komvopoulos, and R. Maboudian, "Diamond-like carbon for silicon passivation in micromechanical devices," *Materials Research Society Spring Meeting, Symposium I: Mechanical Behavior of Diamond and other Forms of Carbon*, San Francisco, Calif., April. 17-21, 1995, MRS Symposium Proceedings, **383**, *Behavior of Diamond and Other Forms of Carbon*, M. D. Drory, D. B. Bogy, M. S. Donley, and J. E. Field, eds., 1995, pp. 391-402.
178. R. S. Payne, S. Sherman, S. Lewis, and R. T. Howe, "Surface Micromachining: from Vision to Reality to Vision," (invited) *IEEE Int. Solid-State Circuits Conference*, San Francisco, Calif., February 14-16, 1995, 160-161.
179. R. T. Howe and C. T.-C. Nguyen, "Micromechanical Resonators for Frequency References and Signal Processing," (invited), *IEEE Int. Electron Devices Meeting*, San Francisco, Calif., December 12-14, 1994.
180. C. T.-C. Nguyen and R. T. Howe, "Polysilicon microresonators for signal processing," (invited), *Government Microcircuits Applications Conference (GOMAC)*, San Diego, Calif., **20**, November 7-10, 1994, pp. 195-198.
181. M. R. Houston, R. Maboudian, and R. T. Howe, "Silicon Surface Treatments for Stiction Reduction in Silicon Micromachining : A Surface Science Approach," American Institute of Chemical Engineers, San Francisco, Calif., November 1994.
182. R. T. Howe, "Polysilicon Integrated Mechatronics: Applications and Recent Developments," (invited keynote talk), *5<sup>th</sup> Symposium on Micro Machine and Human Science*, Nagoya, Japan, October 2-4, 1994.
183. G. K. Fedder and R. T. Howe, "Integrated Testbed for Multi-Mode Digital Control of Suspended Microstructures," *6<sup>th</sup> Solid-State Sensor and Actuator Workshop*, Hilton Head, South Carolina, June 13-15, 1994, pp. 145-150.
184. R. T. Howe, "Silicon Micromachining for Resonator Fabrication," (invited plenary talk), *IEEE Frequency Control Symposium*, Boston, Mass., June 1-3, 1994, pp. 2-7.

185. C. T.-C. Nguyen and R. T. Howe, "Design and Performance of CMOS Micromechanical Resonator Oscillators," *IEEE Frequency Control Symposium*, Boston, Mass., June 1-3, 1994, pp. 127-134.
186. C. T.-C. Nguyen and R. T. Howe, "CMOS Micromechanical Resonator Oscillator," *IEEE Int. Electron Devices Meeting*, Washington, D.C., December 1993, pp. 199-202.
187. R. L. Alley, P. Mai, K. Komvopoulos, and R. T. Howe, "Surface roughness modification of interfacial contacts in polysilicon microstructures," *7<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 288-291.
188. M. W. Judy and R. T. Howe, "Highly compliant lateral suspensions using sidewall beams," *7<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 54-57.
189. L. Lin, K. M. McNair, R. T. Howe, and A. P. Pisano, "Vacuum encapsulated lateral microresonators," *7<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 270-273.
190. D. J. Monk, D. S. Soane, R. T. Howe, "Enhanced removal of sacrificial layers for silicon surface micromachining," *7<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 280-283.
191. G. T. Mulhern, D. S. Soane, and R. T. Howe, "Supercritical carbon dioxide drying of microstructures," *7<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 296-299.
192. C. T. Nguyen and R. T. Howe, "Microresonator frequency control using an integrated micro oven," *7<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 93)*, Yokohama, Japan, June 7-10, 1993, pp. 1040-1043.
193. D. J. Monk, P. Krulevitch, R. T. Howe, and G. C. Johnson, "Stress-corrosion cracking and blistering of thin polycrystalline silicon films in hydrofluoric acid," *Symposium on Thin Films: Stresses and Mechanical Properties IV*, Materials Research Society Spring Meeting, San Francisco, Calif., May 1993, MRS Symposium Proceedings, vol. **308**, pp. 641-646, 1993.
194. Y.-H. Cho, B. M. Kwak, A. P. Pisano, and R. T. Howe, "Viscous energy dissipation in laterally oscillating planar microstructures: a theoretical and experimental study," *6<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 93)*, Ft. Lauderdale, Florida, February 7-10, 1993, pp. 93-98.
195. M. W. Judy and R. T. Howe, "Polysilicon hollow beam lateral resonators," *6<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 93)*, Ft. Lauderdale, Florida, February 7-10, 1993, pp. 265-271.
196. L. Lin, R. T. Howe, A. P. Pisano, "A novel micro *in situ* strain gauge," *6<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 93)*, Ft. Lauderdale, Florida, February 7-10, 1993, pp. 201-206.

197. C. T.-C. Nguyen and R. T. Howe, "Quality factor control for micromechanical resonators," *IEEE Int. Electron Devices Meeting*, San Francisco, Calif., December 14-16, 1992, pp. 505-508.
198. D. J. Monk, D. S. Soane, and R. T. Howe, "Sacrificial layer etching model for surface micromachining applications," *5<sup>th</sup> IEEE Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S.C., June 21-25, 1992, pp. 46-49.
199. G. K. Fedder, J. C. Chang, and R. T. Howe, "Thermal microassembly of narrow-gap electrostatic comb-drive structures," *5<sup>th</sup> IEEE Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S.C., June 21-25, 1992, pp. 63-68.
200. W. Yun, R. T. Howe, and P. R. Gray, "Surface micromachined, digitally force-balanced accelerometer with integrated CMOS detection circuitry," *5<sup>th</sup> IEEE Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S.C., June 21-25, 1992, pp. 126-131.
201. R. L. Alley, R. T. Howe, and K. Komvopoulos, "The effect of release-etch processing on surface microstructure stiction," *5<sup>th</sup> IEEE Solid-State Sensor and Actuator Workshop*, Hilton Head Island, S.C., June 21-25, 1992, pp. 202-207.
202. P. Krulevitch, G. C. Johnson, and R. T. Howe, "Stress and microstructure in phosphorus doped polycrystalline silicon," *Symposium on "Smart" Materials Fabrication/Materials for Micro-Electro-Mechanical Systems*, Materials Research Society Spring Meeting, San Francisco, Calif., April 27 - May 1, 1992, MRS Symposium Proceedings, vol. **276**, pp. 79-84, 1992.
203. R. I. Pratt, G. C. Johnson, R. T. Howe, and D. J. Nikkel, Jr., "Characterization of thin films using micromechanical structures," *Symposium on "Smart" Materials Fabrication/Materials for Micro-Electro-Mechanical Systems*, Materials Research Society Spring Meeting, San Francisco, Calif., April 27 - May 1, 1992, MRS Symposium Proceedings, vol. **276**, 1992.
204. D. J. Monk, D. S. Soane, and R. T. Howe, "Sacrificial layer SiO<sub>2</sub> wet etching for micromachining applications," *Symposium on "Smart" Materials Fabrication/Materials for Micro-Electro-Mechanical Systems*, Materials Research Society Spring Meeting, San Francisco, Calif., April 27 - May 1, 1992, MRS Symposium Proceedings, vol. **276**, pp. 303-310, 1992.
205. L. Lin, C. T.-C. Nguyen, R. T. Howe, and A. P. Pisano, "Micro Electromechanical Filters," *5<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 92)*, Travemuende, Germany, February 4-7, 1992, pp. 226-231.
206. P. Krulevitch, G. C. Johnson, and R. T. Howe, "Stress and microstructure in LPCVD polysilicon films: experimental results and closed form modeling of stresses," *Symposium on Thin Films: Stresses and Mechanical Properties III*, Materials Research Society Fall 1991 Meeting, Boston, Mass., December 1991, MRS Symposium Proceedings, vol. **239**, 1992.

207. R. M. Moroney, R. M. White, and R. T. Howe, "Ultrasonically Induced Microtransport with Cylindrical Geometry," *Micromechanical Sensors, Actuators, and Systems Symposium*, vol. **DSC-32**, ASME Winter Annual Meeting, Atlanta, Georgia, December 1-6, 1991, pp. 181-190.
208. P. Cheung, R. Horowitz, and R. Howe, "Modeling and Position-Detection of a Polysilicon Linear Microactuator," *Micromechanical Sensors, Actuators and Systems*, ASME Winter Annual Meeting, vol. **DSC-32**, Atlanta, Georgia, December 1-6, 1991, pp. 269-278.
209. R. I. Pratt, G. C. Johnson, and R. T. Howe, "Micromechanical Structures for Thin Film Characterization," *6<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 91)*, San Francisco, California, June 24-28, 1991, pp. 205-208.
210. P. Krulevitch, G. C. Johnson, and R. T. Howe, "Stress in Undoped LPCVD Polycrystalline Silicon," *6<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 91)*, San Francisco, California, June 24-28, 1991, pp. 949-952.
211. D. J. Monk, D. S. Soane, and R. T. Howe, "Sacrificial Silicon Dioxide Wet Etching for Micromachining Applications," *6<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 91)*, San Francisco, California, June 24-28, 1991, pp. 647-650.
212. P. Cheung, R. Horowitz, and R. Howe, "Design and Modeling of a Linear Microactuator" (invited), *6<sup>th</sup> Int. Precision Engineering Seminar and the 2<sup>nd</sup> Int. Conf. on Ultra Precision in Manufacturing Engineering*, Braunschweig, Germany, May 27-31, 1991.
213. M. W. Judy, Y.-H. Cho, R. T. Howe, and A. P. Pisano, "Self-Adjusting Microstructures," *4<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 91)*, Nara, Japan, January 30 - February 2, 1991, pp. 51-56.
214. G. K. Fedder and R. T. Howe, "Thermal Assembly of Polysilicon Microstructures," *4<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 91)*, Nara, Japan, January 30 - February 2, 1991, pp. 57-62.
215. R. M. Moroney, R. M. White, and R. T. Howe, "Ultrasonically Induced Microtransport," *4<sup>th</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 91)*, Nara, Japan, January 30 - February 2, 1991, 277-282.
216. R. M. Moroney, R. M. White, and R. T. Howe, "Fluid Motion Produced by Ultrasonic Lamb waves," *IEEE Ultrasonics Symposium*, Honolulu, Hawaii, December 4-7, 1990, pp. 355-358.
217. P. A. Krulevitch, T. D. Nguyen, G. C. Johnson, R. T. Howe, H. R. Wenk, R. Gronsky, "LPCVD Polysilicon Thin Films: The Evolution of Structure, Texture, and Stress," Materials Research Society Fall Meeting, Boston, Mass., November 26 - December 1, 1990, *Polysilicon Thin Films and Interfaces*, Materials Research Society Symposium Proceedings, vol. **202**, 167-172, 1991.



218. R. M. White, S. W. Wenzel, B. A. Martin, R. M. Moroney, B. J. Costello, M. A. Straub, and R. T. Howe, "Lamb-Wave Interactions with the Chemical, Biological and Physical Environment," *Electrochemical Society Fall Meeting*, Seattle, Washington, October 14-19, 1990.
219. W. C. Tang, M. G. Lim, and R. T. Howe, "Electrostatically Balanced Comb Drive for Controlled Levitation," *4<sup>th</sup> IEEE Solid-State Sensor and Actuator Workshop*, Hilton Head Island, South Carolina, June 4-7, 1990, pp. 23-27.
220. J. Huang, P. Krulevitch, G. C. Johnson, R. T. Howe, and H. R. Wenk, "Investigation of texture and stress in undoped polysilicon films," Materials Research Society Spring Meeting, San Francisco, Calif., April 16-20, 1990, *Polysilicon Thin Films and Interfaces*, edited by T. Kamins, C. V. Thompson, and B. Raicu, Materials Research Society Symposium Proceedings, vol. **182**, 201-206, 1990.
221. L.-S. Fan, W. Yun, R. S. Muller, R. T. Howe, and J. Huang, "Spiral Microstructures for the Measurement of Average Strain Gradients in Thin Films," *3<sup>rd</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 90)*, Napa Valley, California, February 12-14, 1990, pp. 177-181.
222. M. G. Lim, J. Chang, D. P. Schultz, R. T. Howe, and R. M. White, "Polysilicon Microstructures to Characterize Static Friction," *3<sup>rd</sup> IEEE Micro Electro Mechanical Systems Workshop*, Napa Valley, California, February 12-14, 1990, pp. 82-88.
223. R. M. Moroney, R. M. White, and R. T. Howe, "Ultrasonic Micromotors: Physics and Applications," *3<sup>rd</sup> IEEE Micro Electro Mechanical Systems Workshop*, Napa Valley, California, February 12-14, 1990, pp. 182-187.
224. K. S. J. Pister, R. S. Fearing, and R. T. Howe, "A Planar Air-Levitated Electrostatic Actuator System," *3<sup>rd</sup> IEEE Micro Electro Mechanical Systems Workshop*, Napa Valley, California, February 12-14, 1990, pp. 67-71.
225. W. Yun, W. C. Tang, and R. T. Howe, "Fabrication Technologies for Integrated Microdynamic Systems," (invited paper), *Integrated Micro-Motion Systems Micromachining*, Control and Applications, edited by F. Harashima. Amsterdam: Elsevier Science Publishers, 1990 pp. 297-312.
226. R. M. Moroney, R. M. White, and R. T. Howe, "Ultrasonic micromotor," *IEEE Ultrasonics Symposium*, Montreal, Quebec, Canada, October 3-6, 1989, pp. 745-748.
227. J. Huang, K. K. Lin, J. Lau, D. A. Hodges, C. Spanos, G. C. Johnson, and R. T. Howe, "Texture of Undoped LPCVD Polycrystalline Silicon Films," *Textures in Non-Metallic Materials*, ASM International, Indianapolis, Indiana, October 2-3, 1989.
228. S. C. Chang, M. W. Putty, D. B. Hicks, C. H. Li, and R. T. Howe, "Resonant-Bridge Two-Axis Microaccelerometer," *5<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 89)*, Montreux, Switzerland, June 25-30, 1989, pp. 142-143.

229. L.-S. Fan, R. T. Howe, and R. S. Muller, "Fracture-Toughness Characterization of Brittle Thin Films," *5<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers '89)*, Montreux, Switzerland, June 25-30, 1989, pp. 249-250.
230. W. C. Tang, T.-C. H. Nguyen, and R. T. Howe, "Electrostatic-Comb Drive of Lateral Polysilicon Resonators," *5<sup>th</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 89)*, Montreux, Switzerland, June 25-30, 1989, pp. 138-140.
231. R. T. Howe, "Microsensor and Microactuator Applications of Thin Films," (invited paper), *Symposium on Thin-Film Materials for Integrated Sensors*, International Conference on Metallurgical Coatings, San Diego, California, April 17-21, 1989.
232. L. S. Fan, R. T. Howe, and R. S. Muller, "Microstructures for Fracture Toughness Characterization of Brittle Thin Films," *2<sup>nd</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 89)*, Salt Lake City, Utah, February 20-22, 1989, pp. 40-41.
233. W. C. Tang, T.-C. H. Nguyen, and R. T. Howe, "Laterally Driven Polysilicon Resonant Microstructures," *2<sup>nd</sup> IEEE Micro Electro Mechanical Systems Workshop (MEMS 89)*, Salt Lake City, Utah, February 20-22, 1989, pp. 53-59.
234. M. W. Putty, S. C. Chang, R. T. Howe, A. L. Robinson, and K. D. Wise, "One-Port Active Polysilicon Resonant Microstructures," *2<sup>nd</sup> IEEE Micro Electro Mechanical Systems Workshop*, Salt Lake City, Utah, February 20-22, 1989, pp. 60-65.
235. K. S. Udell, A. P. Pisano, R. T. Howe, R. M. White, and R. S. Muller, "Microsensors for heat transfer and fluid flow measurements," *First World Conference on Experimental Heat Transfer, Fluid Mechanics, and Thermodynamics*, Dubrovnik, Yugoslavia, September 4-9, 1988.
236. M. A. Huff, S. D. Senturia, and R. T. Howe, "A Thermally Isolated Microstructure Suitable for Gas Sensing Applications," *3<sup>rd</sup> IEEE Solid-State Sensors and Actuators Workshop*, Hilton Head, S.C., June 6-9, 1988, pp. 47-50.
237. T. A. Lober and R. T. Howe, "Surface Micromachining Processes for Electrostatic Motor Fabrication," *3<sup>rd</sup> IEEE Solid-State Sensors and Actuators Workshop*, Hilton Head, S.C., June 6-9, 1988, pp. 59-62.
238. R. T. Howe, "Surface Micromachining for Microsensors and Microactuators," (invited plenary paper), *32<sup>nd</sup> Int. Symp. on Electron, Photon, and Ion Beams*, Fort Lauderdale, Florida, May 31 - June 3, 1988, abstract A-2.
239. M. A. Schmidt, R. T. Howe, S. D. Senturia, and J. H. Haritonidis, "Fabrication and testing of a micromachined shear sensor," *IEEE Int. Electron Devices Meeting*, Washington, D.C., December 6-9, 1987, pp. 282-285.
240. R. T. Howe, "Applications of polysilicon films in microsensors and microactuators," (invited), *Polysilicon Films and Interfaces*, edited by C. Y. Wong, C. V. Thompson, and K. N. Tu, Materials Research Society Proceedings, vol. **106**, pp. 213-224, Boston, Mass., November 30 - December 5, 1987.

241. J. H. Lang, M. F. Schlecht, and R. T. Howe, "Electric micromotors: electromechanical characteristics," (invited), *IEEE Micro Robots and Teleoperators Workshop*, Hyannis, Mass., November 8-11, 1987.
242. M. A. Schmidt, R. T. Howe, S. D. Senturia, and J. H. Haritonidis, "Surface micromachining of polyimide/metal composites for a shear-stress sensor," *IEEE Micro Robots and Teleoperators Workshop*, Hyannis, Mass., November 8-11, 1987.
243. M. A. Schmidt and R. T. Howe, "Silicon resonant microsensors," (invited), *Ceramic Engineering and Science Proceedings*, **8**, 1019-1034, (1987).
244. R. T. Howe, "Resonant microsensors," (invited), *4<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers '87)*, Tokyo, Japan, June 2-5, 1987, pp. 843-848.
245. M. A. Schmidt, R. T. Howe, and S. D. Senturia, and J. H. Haritonidis, "A micromachined floating-element shear sensor," *4<sup>th</sup> International Conference on Solid-State Sensors and Actuators (Transducers 87)*, Tokyo, Japan, June 2-5, 1987, pp. 383-386.
246. M. A. Schmidt and R. T. Howe, "Resonant structures for integrated sensors," (invited), *2<sup>nd</sup> IEEE Solid-State Sensor Workshop*, Hilton Head, South Carolina, June 2-5, 1986.
247. R. T. Howe, "Polycrystalline silicon microstructures," (invited), *Micromachining and Micropackaging of Transducers*, edited by C. F. Fung, P. W. Cheung, W. H. Ko, and D. G. Fleming. Amsterdam: Elsevier Science Publishers, 169-187, (1985).
248. R. T. Howe and R. S. Muller, "Frequency response of polycrystalline silicon microbridges," *3<sup>rd</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers 85)*, Philadelphia, Pa., June 11-14, 1985, pp. 101-104.
249. Y.-C. Tai, R. S. Muller, and R. T. Howe, "Polysilicon bridges for anemometer applications," *3<sup>rd</sup> Int. Conf. on Solid-State Sensors and Actuators (Transducers '85)*, Philadelphia, Pa., June 11-14, 1985, pp. 354-357.
250. R. T. Howe and R. S. Muller, "Integrated resonant-microbridge vapor sensor," *IEEE Int. Electron Devices Meeting*, San Francisco, California, December 10-12, 1984, pp. 213-216.
251. R. T. Howe and R. S. Muller, "Resonant polysilicon microbridge with integrated NMOS detection circuitry," *Electrochemical Society Fall Meeting*, vol. **84-2**, New Orleans, Louisiana, October 7-12, 1984, pp. 892-893.
252. R. T. Howe and R. S. Muller, "Polycrystalline Silicon Micromechanical Beams," *Electrochemical Society Spring Meeting*, vol. **82-1**, Montreal, Québec, Canada, May 9-14, 1982, pp. 184-185.

**NONREFEREED PUBLICATIONS**

1. R. Howe, M. Allen, A. Berlin, E. Hui, D. Monk, K. Najafi, and M. Yamakawa, "Microsystems Research in Japan," WTEC, Baltimore, Maryland, October 2002.
2. U. Srinivasan, M. A. Helmbrecht, R. S. Muller, and R. T. Howe, "MEMS: Some Self-Assembly Required," *Optics & Photonics News*, November 2002, pp. 26-30.
3. A. E. Franke, T.-J. King, and R. T. Howe, "Integrated MEMS technologies," (invited) *MRS Bulletin*, **26**, 291-295 (2001).
4. T. N. Juneau, M. A. Lemkin, T. A. Roessig, W. A. Clark, R. T. Howe, J. M. Bustillo, T. J. Brosnihan, and A. P. Pisano, "Commercialization of precision inertial sensors with integrated signal conditioning," *Sensors Expo West*, San Jose, California, May 1998.
5. W. Yun and R. T. Howe, "S-D Modulator interfacing with silicon microsensors," *Sensors*, **10**, May 1993, pp. 11-18.
6. W. Yun and R. T. Howe, "Sigma-Delta modulator interfacing with microsensors," (invited paper), *Sensors Expo West*, San Jose, California, March 2-4, 1993, pp. 159-164.
7. W. Yun and R. T. Howe, "Recent developments in silicon microaccelerometers," *Sensors*, **9**, October 1992, pp. 31-41.
8. W. Yun and R. T. Howe, "Silicon microfabricated accelerometers: a perspective on recent developments" (invited paper), *Sensors Expo*, Chicago, Ill., October 1-3, 1991, pp. 204A-1 - 204A-8.
9. R. T. Howe, R. S. Muller, K. J. Gabriel, and W. S. N. Trimmer, "Silicon micromechanics: sensors and actuators on a chip," *IEEE Spectrum*, **27**, July 1990, pp. 29-35.
10. R. T. Howe, "Silicon Microdynamic Systems: Recent Developments in Microactuators and Micromachinery," (invited paper), *IEEE WESCON*, San Francisco, California, November 14-16, 1989, pp. 202-204.

**PATENTS**

1. R. S. Muller and R. T. Howe, "Integrated circuit sensor," U.S. #4,674,319, June 23, 1987.
2. R. T. Howe and S.-C. Chang, "Resonant accelerometer," U.S. #4,805,456, February 21, 1989 and U.S. #4,851,080, July 25, 1989.
3. R. T. Howe, M. Mehregany, and S. D. Senturia, "Released film structures and method of measuring film properties," U.S. #4,823,607, April 25, 1989.
4. H.-S. Lee, J. T. Kung, and R. T. Howe, "A digital technique for precise measurement of variable capacitance," U.S. #4,860,232, August 22, 1989.

5. J. H. Haritonidis, R. T. Howe, M. A. Schmidt, and S. D. Senturia, "Turbulent shear force sensor," U.S. #4,896,098, January 23, 1990.
6. R. T. Howe, J. H. Lang, M. F. Schlecht, M. A. Schmidt, and S. D. Senturia, "Electrostatic micromotor," U. S. #4,943,750, July 24, 1990.
7. R. T. Howe, J. H. Lang, M. F. Schlecht, M. A. Schmidt, and S. D. Senturia, "Electrostatic micromotor," U. S. #4,997,521, March 5, 1991.
8. W. C. Tang and R. T. Howe, "Laterally Driven Resonant Microstructures," U. S. #5,025,346, June 18, 1991.
9. R. T. Howe, J. H. Lang, M. F. Schlecht, M. A. Schmidt, S. D. Senturia, M. Mehregany, and L. S. Tavrow, "Method for Side Drive Electrostatic Micromotor," U. S. #5,043,043, August 27, 1991.
10. T. A. Core and R. T. Howe, "Method for fabricating microstructures," U.S. #5,314,572, May 24, 1994.
11. R. L. Alley, R. T. Howe, and K. Komvopoulos, "Method of applying a monolayer lubricant to micromachines," U.S. #5,403,665, April 4, 1995.
12. L. Lin, C. T.-C. Nguyen, R. T. Howe, and A. P. Pisano, "Micromechanical signal processors," U.S. #5,455,547, October 3, 1995.
13. C. T.-C. Nguyen and R. T. Howe, "Q-Controlled microresonators and tunable electronic filters using such resonators," U.S. #5,491,604, February 13, 1996.
14. L. Lin, C. T.-C. Nguyen, R. T. Howe, and A. P. Pisano, "Micromechanical signal processors," U.S. #5,537,083, July 16, 1996.
15. R. T. Howe, H. J. Barber, and M. Judy, "Apparatus to minimize stiction in micromachined structures," U.S. #5,542,295, August 6, 1996.
16. R. T. Howe and S. Bart, "Sensor with separate actuator and sense fingers," U.S. #5,565,625, October 15, 1996.
17. L. Lin, C. T. Nguyen, R. T. Howe, and A. P. Pisano, "Microelectromechanical signal processor fabrication," U.S. #5,589,082, Dec. 31, 1996.
18. R. T. Howe, R. S. Payne, and S. F. Bart, "Sub-ground plane for micromachined device," U.S. #5,639,542, June 17, 1997.
19. K. H.-L. Chau, R. T. Howe, R. S. Payne, Y. Zhao, T. A. Core, and S. J. Sherman, "Conductive plane beneath suspended structure," U.S. #5,640,039, June 17, 1997.
20. C. T.-C. Nguyen, V. Gutnik, and R. T. Howe, "Mixing, Modulation and Demodulation via Electromechanical Resonators," U. S. #5,839,062, November 17, 1998.

21. K. S. Leboutitz, R. T. Howe, and A. P. Pisano, "Microfabricated filter and shell constructed with a permeable membrane," U.S. #5,919,364, July 6, 1999.
22. C. T.-C. Nguyen and R. T. Howe, "Q-controlled microresonators and tunable electric filters using such resonators," U.S. #5,955,932, September 21, 1999.
23. T. A. Roessig, A. P. Pisano, and R. T. Howe, "Resonant accelerometer with flexural leverage system," U.S. #5,969,249, October 19, 1999.
24. W. A. Clark, T. Juneau, and R. T. Howe, "Micromachined vibratory rate gyroscope," U.S. #6,067,858, May 30, 2000.
25. M. R. Houston, R. Maboudian, R. T. Howe, and U. Srinivasan, "Method of drying micromachines by dewetting from a liquid-based process," U. S. #6,114,044, September 5, 2000.
26. M. B. Cohn and R. T. Howe, "Wafer-to-wafer transfer of microstructures using break-away tethers," U.S. #6,142,358, November 7, 2000.
27. A. E. Franke, T. J. King, and R. T. Howe, "Silicon germanium films for forming microelectromechanical systems," U.S. #6,210,988 B1, April 3, 2001.
28. C. T.-C. Nguyen and R. T. Howe, "Q-controlled microresonators and tunable electronic filters using such resonators," U.S. #6,236,281 B1.
29. A. A. Seshia and R. T. Howe, "Dual-mass micromachined vibratory rate gyroscope," U.S. #6,250,156 B1, June 26, 2001.
30. W. A. Clark, T. Juneau, and R. T. Howe, "Method of fabricating a sensor," U.S. #6,296,779, October 2, 2001.
31. A. Franke, R. T. Howe, and T.-J. King, "Polycrystalline silicon germanium films for microelectromechanical systems," U.S. #6,448,622 B1, September 10, 2002.
32. K. S. Leboutitz, R. T. Howe, and A. P. Pisano, "Microfabricated filter and shell constructed with a permeable polysilicon membrane," U.S. #6,478,974 B1, November 12, 2002.
33. A. Shkel and R. T. Howe, "Micro-machined angle-measuring gyroscope," U.S. #6,481,285 B1, November 19, 2002.
34. D. Gao, R. T. Howe, and R. Maboudian, "Selective etching of silicon carbide films," U.S. #7,151,277, Dec. 19, 2006.
35. E. P. Quévy and R. T. Howe, "Temperature compensated oscillator including MEMS resonator for frequency control," U.S. #7,211,926, May 1, 2007.
36. H. Takeuchi, E. P. Quévy, T.-J. King, and R. T. Howe, "Damascene process for use in fabricating semiconductor structures having micro/nano gaps," U.S. #7,256,107, August 14, 2007.

37. R. T. Howe, E. P. Quévy, and D. H. Bernstein, "MEMS structure having a stress inverter temperature-compensating resonating member," U.S. #7,514,853, April 7, 2009.
38. S. A. Bhave and R. T. Howe, "Internal electrostatic transduction structures for bulk-mode micromechanical resonators," U.S. #7,522,019, April 21, 2009.
39. D. H. Bernstein, R. T. Howe, and E. P. Quévy, "MEMS structure having a compensated resonating member," U.S. Patent #7,591,201, September 22, 2009.
40. P. Monadgemi, E. P. Quévy, and R. T. Howe, "Low stress thin film microshells," U.S. #7,595,209, September 29, 2009.
41. P. Monadgemi, R. T. Howe, and E. P. Quévy, "Microshells for multi-level vacuum cavities," U.S. #7,659,150, February 9, 2010.
42. A. E. Franke, R. T. Howe, and T.-J. King, "Polycrystalline Silicon Germanium Films for Forming Micro-Electromechanical Systems," Japanese Patent #4,511,739, May 14, 2010.
43. P. Monadgemi, R. T. Howe, and E. P. Quévy, "Thin film microshells incorporating a getter layer," U.S. #7,736,929, June 15, 2010.
44. R. T. Howe, P. Monadjemi, and E. P. Quevy, "Planar microshells for vacuum encapsulated devices and damascene method of manufacture," U.S. Patent #8,273,594, Sept. 25, 2012.
45. H. Takeuchi, E. P. Quevy, T.-J. King, and R. T. Howe, "Damascene process for use in fabricating semiconductor structures having micro/nano gaps," U.S. Patent #8,329,559, Dec. 11, 2012.
46. E. P. Quevy and R. T. Howe, "Temperature compensated oscillator including MEMS resonator for frequency control," U.S. Patent #8,427,251 B2, April 23, 2013.
47. J. R. Jain and R. T. Howe, "Strained semiconductor materials, devices, and methods therefore," U.S. Patent #8,633,573 B2, January 21, 2014.
48. E. P. Quevy and R. T. Howe, "MEMS coupler and method to form the same," U.S. Patent #8,716,815, May 6, 2014.
49. R. Kant and R. T. Howe, "Deposition-free sealing for micro- and nano-fabrication," U.S. Patent 8,735,286, May 27, 2014.
50. Y. Liu, R. W. Dutton, and R. T. Howe, "Electro-diffusive enhanced bio-molecule charge detection using electrostatic interaction," U.S. Patent #8,864,969, October 21, 2014.
51. R. T. Howe, E. P. Quevy, and Z. Gu, "Gas diffusion barriers for MEMS encapsulation," U.S. Patent 9,018,715 B2, April 28, 2015.
52. Y. Liu, R. W. Dutton, R. T. Howe, K. G. Knapp, and J. D. Morton, "Electro-diffusive enhanced bio-molecule charge detection using electrostatic interaction," U.S. Patent

- #9,188,560, November 17, 2015.
53. Y. Liu, R. W. Dutton, and R. T. Howe, "Electro-diffusive enhanced bio-molecule charge detection using electrostatic interaction," U.S. Patent #9,470,651, October 18, 2016.
  54. I. Bargatin and R. T. Howe, "MEMS-based integrated inverter for wafer-scale thermionic energy converter," U.S. Patent 9,590,535, March 7, 2017.
  55. J.-H. Lee, I. Bargatin, B. K. Vancil, and R. T. Howe, "Low work-function, mechanically and thermally robust emitter for thermionic energy converters," U.S. Patent 9,607,815, March 28, 2017.
  56. Y. Liu, R. W. Dutton, and R. T. Howe, "Electro-diffusion enhanced bio-molecule charge detection using electrostatic interaction," U.S. Patent 9,989,516, June 5, 2018.
  57. J. I. Padovani Blanco, A. M. Ibrahim, Y. H. Anis, S. S. Jeffrey, and R. T. Howe, "Electropermanent magnet activated microfluidic droplet size modulation," U.S. Patent 10,385,893, August 20, 2019.
  58. S. Emaminejad, M. Javanmard, C. Gupta, and R. T. Howe, "Methods and systems for orienting nanomaterials," U.S. Patent 10,585,096, March 10, 2020.
  59. C. Gupta, R. Walker, B. Murmann, and R. T. Howe, "Mesoscale system feedback-induced dissipation and noise suppression," U.S. Patent 11,035,810, June 15, 2021.