


# Stanford

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## Roger Howe

William E. Ayer Professor of Electrical Engineering, Emeritus

 Curriculum Vitae available Online

### Bio

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#### BIO

Design and fabrication of sensors and actuators using micro and nanotechnologies, with applications to information processing and energy conversion.

#### ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Electrical Engineering
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

#### ADMINISTRATIVE APPOINTMENTS

- Acting Faculty Director, Stanford Nanofabrication Facility, (2020-2021)
- Faculty Director, Stanford Nanofabrication Facility, (2009-2017)

#### BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Member, National Academy of Engineering (2005 - present)

#### PROFESSIONAL EDUCATION

- PhD, UC Berkeley (1984)

#### LINKS

- <https://web.stanford.edu/~rthowe/>: <https://web.stanford.edu/~rthowe/>

### Teaching

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#### COURSES

##### 2024-25

- An Intro to Making: What is EE: OSPBER 40M (Aut)
- Introduction to Micro and Nano Electromechanical Systems: ENGR 240 (Win)

##### 2023-24

- An Intro to Making: What is EE: OSPBER 40M (Aut, Win, Spr)
- Introduction to Micro and Nano Electromechanical Systems: ENGR 240 (Win)

##### 2022-23

- An Intro to Making: What is EE: OSPBER 40M (Aut, Win, Spr)

- Integrated Circuit Fabrication Laboratory: EE 312 (Win)
- Introduction to Micro and Nano Electromechanical Systems: ENGR 240 (Win)

## STANFORD ADVISEES

### Doctoral Dissertation Reader (AC)

Jillian Anderson, Kai Chang, Sergio Cordero, Jasmine Cox, Wei Ren

### Doctoral (Program)

Michelle Hedlund, Zahra Heussen, Hannah Lee, Favour Nerrise, Allan Raventos Knohr

## Publications

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### PUBLICATIONS

- **"Deep approaches to learning" in a project-based nanofabrication graduate course** *JOURNAL OF THE SOCIETY FOR INFORMATION DISPLAY*  
Tang, M., Kommera, S., Raghuram, U., Rincon, M., Xu, X., Fan, J., Howe, R. T.  
2022
- **Optimized Deep Reactive-Ion Etching of Nanostructured Black Silicon for High-Contrast Optical Alignment Marks** *ACS APPLIED NANO MATERIALS*  
Yusuf, M., Herring, G. K., Neustock, L., Zaman, M., Raghuram, U., Narasimhan, V. K., Chia, C., Howe, R. T.  
2021; 4 (7): 7047-7061
- **Encapsulated Cell Dynamics in Droplet Microfluidic Devices with Sheath Flow.** *Micromachines*  
Beshay, P. E., Ibrahim, A. M., Jeffrey, S. S., Howe, R. T., Anis, Y. H.  
2021; 12 (7)
- **Interpretable Classification of Bacterial Raman Spectra with Knockoff Wavelets.** *IEEE journal of biomedical and health informatics*  
Chia, C., Sesia, M., Ho, C. S., Jeffrey, S. S., Dionne, J. A., Candes, E., Howe, R. T.  
2021; PP
- **Encapsulated Cell Dynamics in Droplet Microfluidic Devices with Sheath Flow** *MICROMACHINES*  
Beshay, P. E., Ibrahim, A. M., Jeffrey, S. S., Howe, R. T., Anis, Y. H.  
2021; 12 (7)
- **Modeling of Droplet Generation in a Microfluidic Flow-Focusing Junction for Droplet Size Control.** *Micromachines*  
Ibrahim, A. M., Padovani, J. I., Howe, R. T., Anis, Y. H.  
2021; 12 (6)
- **Electropermanent magnet-driven droplet size modulation for two-phase ferromicrofluidics** *MICROFLUIDICS AND NANOFUIDICS*  
Padovani, J., Ibrahim, A. M., Jeffrey, S. S., Anis, Y. H., Howe, R. T.  
2020; 24 (12)
- **A vibrating beam MEMS accelerometer for gravity and seismic measurements.** *Scientific reports*  
Mustafazade, A., Pandit, M., Zhao, C., Sobreviela, G., Du, Z., Steinmann, P., Zou, X., Howe, R. T., Seshia, A. A.  
2020; 10 (1): 10415
- **Neural network-based model of photoresist reflow** *JOURNAL OF VACUUM SCIENCE & TECHNOLOGY B*  
Chia, C., Martis, J., Jeffrey, S. S., Howe, R. T.  
2019; 37 (6)
- **Surface Photovoltage-Induced Ultralow Work Function Material for Thermionic Energy Converters** *ACS ENERGY LETTERS*  
Schindler, P., Riley, D. C., Bargatin, I., Sahasrahuddhe, K., Schwede, J. W., Sun, S., Pianetta, P., Shen, Z., Howe, R. T., Melosh, N. A.  
2019; 4 (10): 2436-43
- **Anomalous hysteresis and current fluctuations in cyclic voltammograms at microelectrodes due to Ag leaching from Ag/AgCl reference electrodes** *ELECTROCHEMISTRY COMMUNICATIONS*  
Chia, C., Jeffrey, S. S., Howe, R. T.

2019; 105

- **ALD HfO<sub>2</sub> Films for Defining Microelectrodes for Electrochemical Sensing and Other Applications** *ACS APPLIED MATERIALS & INTERFACES*  
Chia, C., Shulaker, M. M., Provine, J., Jeffrey, S. S., Howe, R. T.  
2019; 11 (29): 26082–92
- **Micron-gap spacers with ultrahigh thermal resistance and mechanical robustness for direct energy conversion.** *Microsystems & nanoengineering*  
Nicaise, S. M., Lin, C., Azadi, M., Bozorg-Grayeli, T., Adebayo-Ige, P., Lilley, D. E., Pfitzer, Y., Cha, W., Van Houten, K., Melosh, N. A., Howe, R. T., Schwede, J. W., Bargatin, et al  
2019; 5: 31
- **Micron-gap spacers with ultrahigh thermal resistance and mechanical robustness for direct energy conversion** *MICROSYSTEMS & NANOENGINEERING*  
Nicaise, S. M., Lin, C., Azadi, M., Bozorg-Grayeli, T., Adebayo-Ige, P., Lilley, D. E., Pfitzer, Y., Cha, W., Van Houten, K., Melosh, N. A., Howe, R. T., Schwede, J. W., Bargatin, et al  
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- **Quantum Tunneling Currents in a Nanoengineered Electrochemical System** *JOURNAL OF PHYSICAL CHEMISTRY C*  
Gupta, C., Walker, R. M., Chang, S., Fischer, S. R., Seal, M., Murmann, B., Howe, R. T.  
2017; 121 (28): 15085–105
- **Three-dimensional integration of nanotechnologies for computing and data storage on a single chip** *NATURE*  
Shulaker, M. M., Hills, G., Park, R. S., Howe, R. T., Saraswat, K., Wong, H., Mitra, S.  
2017; 547 (7661): 74+
- **Back-end-of-line compatible Poly-SiGe lateral nanoelectromechanical relays with multi-level interconnect**  
Harrison, K. L., Clary, W. A., Provine, J., Howe, R. T.  
SPRINGER.2017: 2125–30
- **Back-gated graphene anode for more efficient thermionic energy converters** *NANO ENERGY*  
Yuan, H., Riley, D. C., Shen, Z., Pianetta, P. A., Melosh, N. A., Howe, R. T.  
2017; 32: 67-72
- **Active control of probability amplitudes in a mesoscale system via feedback-induced suppression of dissipation and noise** *JOURNAL OF APPLIED PHYSICS*  
Gupta, C., Perez, A. P., Fischer, S. R., Weinreich, S. B., Murmann, B., Howe, R. T.  
2016; 120 (22)
- **A Super Stretchable Organic Thin-Film Diodes Network That Can Be Embedded Into Carbon Fiber Composite Materials for Sensor Network Applications** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Guo, Z., Aboudi, U., Peumans, P., Howe, R. T., Chang, F.  
2016; 25 (3): 524-532
- **Electropermanent magnet actuation for droplet ferromicrofluidics.** *Technology*  
Padovani, J. I., Jeffrey, S. S., Howe, R. T.  
2016; 4 (2): 110-119
- **Design and fabrication of silicon-tessellated structures for monocentric imagers.** *Microsystems & nanoengineering*  
Wu, T., Hamann, S. S., Ceballos, A. C., Chang, C. E., Solgaard, O., Howe, R. T.  
2016; 2: 16019
- **Design and fabrication of silicon-tessellated structures for monocentric imagers** *MICROSYSTEMS & NANOENGINEERING*  
Wu, T., Hamann, S. S., Ceballos, A. C., Chang, C., Solgaard, O., Howe, R. T.  
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- **Stable Encapsulated Charge-Biased Resonators** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Ng, E. J., Harrison, K. L., Yang, Y., Ahn, C. H., Hong, V. A., Howe, R. T., Kenny, T. W.  
2016; 25 (1): 30-37
- **Engineering Ultra-Low Work Function of Graphene** *NANO LETTERS*  
Yuan, H., Chang, S., Bargatin, I., Wang, N. C., Riley, D. C., Wang, H., Schwede, J. W., Provine, J., Pop, E., Shen, Z., Pianetta, P. A., Melosh, N. A., Howe, et al  
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- **Thermionic and photon-enhanced emission energy conversion**  
Melosh, N., Riley, D., Sahasrabudde, K., Shen, Z. X., Schwede, J., Howe, R.  
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- **Partitioning Electrostatic and Mechanical Domains in Nanoelectromechanical Relays** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Shavezipur, M., Harrison, K., Lee, W. S., Mitra, S., Wong, H. P., Howe, R. T.  
2015; 24 (3): 592-598
- **Tunable control of antibody immobilization using electric field.** *Proceedings of the National Academy of Sciences of the United States of America*  
Emaminejad, S., Javanmard, M., Gupta, C., Chang, S., Davis, R. W., Howe, R. T.  
2015; 112 (7): 1995-1999
- **Integrated atomistic chemical imaging and reactive force field molecular dynamic simulations on silicon oxidation** *APPLIED PHYSICS LETTERS*  
Dumpala, S., Broderick, S. R., Khalilov, U., Neyts, E. C., van Duin, A. C., Provine, J., Howe, R. T., Rajan, K.  
2015; 106 (1)
- **Polyether Ether Ketone (PEEK) Fluidic Cell to Study Electrochemistry of Microelectrodes on Silicon Substrate** *ECS SOLID STATE LETTERS*  
Arun, A., Gupta, C., Howe, R.  
2015; 4 (10): P67-P71
- **Microfabricated Thermally Isolated Low Work-Function Emitter** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Lee, J., Bargatin, I., Vancil, B. K., Gwinn, T. O., Maboudian, R., Melosh, N. A., Howe, R. T.  
2014; 23 (5): 1182-1187
- **Inherent Enhancement of Electronic Emission from Hexaboride Heterostructure** *PHYSICAL REVIEW APPLIED*  
Voss, J., Vojvodic, A., Chou, S. H., Howe, R. T., Abild-Pedersen, F.  
2014; 2 (2)
- **Improved Performance of Bottom-Contact Organic Thin-Film Transistor Using Al Doped HfO<sub>2</sub> Gate Dielectric** *IEEE TRANSACTIONS ON ELECTRON DEVICES*  
Tang, W. M., Aboudi, U., Provine, J., Howe, R. T., Wong, H. P.  
2014; 61 (7): 2398-2403
- **Optical MEMS: From Micromirrors to Complex Systems** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Solgaard, O., Godil, A. A., Howe, R. T., Lee, L. P., Peter, Y., Zappe, H.  
2014; 23 (3): 517-538
- **DFT Study of Atomically-Modified Alkali-Earth Metal Oxide Films on Tungsten** *JOURNAL OF PHYSICAL CHEMISTRY C*  
Chou, S. H., Voss, J., Vojvodic, A., Howe, R. T., Abild-Pedersen, F.  
2014; 118 (21): 11303-11309
- **Double-Layer Silicon Photonic Crystal Fiber-Tip Temperature Sensors** *IEEE PHOTONICS TECHNOLOGY LETTERS*  
Park, B., Jung, I. W., Provine, J., Gellineau, A., Landry, J., Howe, R. T., Solgaard, O.  
2014; 26 (9): 900-903
- **Depletion of cells and abundant proteins from biological samples by enhanced dielectrophoresis** *17th International Conference on Solid-State Sensors, Actuators and Microsystems*  
Javanmard, M., Emaminejad, S., Gupta, C., Provine, J., Davis, R. W., Howe, R. T.  
ELSEVIER SCIENCE SA.2014: 918-24
- **Analysis of Asperity Dominated Contacts in Nanoelectromechanical Relays Using Thin Films**  
Harrison, K. L., Dalvi, C., Asheghi, M., Howe, R. T., IEEE  
IEEE.2014: 1256-60
- **STABLE CHARGE-BIASED CAPACITIVE RESONATORS WITH ENCAPSULATED SWITCHES**  
Ng, E. J., Harrison, K. L., Everhart, C. L., Hong, V. A., Yang, Y., Ahn, C., Heinz, D. B., Howe, R. T., Kenny, T. W., IEEE  
IEEE.2014: 1277-80
- **Vacuum encapsulated resonators for humidity measurement** *SENSORS AND ACTUATORS B-CHEMICAL*  
Hennessy, R. G., Shulaker, M. M., Messana, M., Graham, A. B., Klejwa, N., Provine, J., Kenny, T. W., Howe, R. T.

2013; 185: 575-581

- **Laterally Actuated Platinum-Coated Polysilicon NEM Relays** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Parsa, R., Lee, W. S., Shavezipur, M., Provine, J., Maboudian, R., Mitra, S., Wong, H. P., Howe, R. T.  
2013; 22 (3): 768-778
- **Thermionic current densities from first principles.** *journal of chemical physics*  
Voss, J., Vojvodic, A., Chou, S. H., Howe, R. T., Bargatin, I., Abild-Pedersen, F.  
2013; 138 (20): 204701-?
- **Thermionic current densities from first principles.** *journal of chemical physics*  
Voss, J., Vojvodic, A., Chou, S. H., Howe, R. T., Bargatin, I., Abild-Pedersen, F.  
2013; 138 (20): 204701-?
- **Combinational Logic Design Using Six-Terminal NEM Relays** *IEEE TRANSACTIONS ON COMPUTER-AIDED DESIGN OF INTEGRATED CIRCUITS AND SYSTEMS*  
Lee, D., Lee, W. S., Chen, C., Fallah, F., Provine, J., Chong, S., Watkins, J., Howe, R. T., Wong, H. P., Mitra, S.  
2013; 32 (5): 653-666
- **Photon-enhanced thermionic emission from heterostructures with low interface recombination.** *Nature communications*  
Schwede, J. W., Sarmiento, T., NARASIMHAN, V. K., Rosenthal, S. J., Riley, D. C., Schmitt, F., Bargatin, I., Sahasrabudhe, K., Howe, R. T., Harris, J. S., Melosh, N. A., Shen, Z.  
2013; 4: 1576-?
- **Applications of nanonewton dielectrophoresis forces using atomic layer deposited oxides for microfluidic sample preparation and proteomics**  
Emaminejad, S., Javanmard, M., Gupta, C., Dutton, R., W., Davis, R., W., Howe, R., T.  
2013
- **Ultra dielectrophoresis: electrothermal analysis and its applications in microfluidic sample preparation and proteomics**  
Emaminejad, S., Javanmard, M., Gupta, C., Davis, R., W., Howe, R., T.  
2013
- **Capacitive Accelerometer Laboratory Using Polymer-Film Rapid Prototyping Technology** *3rd Interdisciplinary Engineering Design Education Conference (IEDEC)*  
Gellineau, A. A., Rastegar, A. J., Howe, R. T.  
IEEE.2013: 79-82
- **Microbead-separated thermionic energy converter with enhanced emission current** *PHYSICAL CHEMISTRY CHEMICAL PHYSICS*  
Littau, K. A., Sahasrabudhe, K., Barfield, D., Yuan, H., Shen, Z., Howe, R. T., Melosh, N. A.  
2013; 15 (34): 14442-14446
- **LATERALLY ACTUATED NANO-ELECTROMECHANICAL RELAYS WITH COMPLIANT, LOW RESISTANCE CONTACT** *26th IEEE International Conference on Micro Electro Mechanical Systems (MEMS)*  
Shavezipur, M., Lee, W. S., Harrison, K. L., Provine, J., Mitra, S., Wong, H. P., Howe, R. T.  
IEEE.2013: 520-523
- **Ultra-thin atomic layer deposition films for corrosion resistance**  
Haemmerli, A., J., Doll, J., C., Provine, J., Howe, R., T., Goldhaber-Gordon, D., Pruitt, B., L.  
2013
- **Immobilization of antibodies on solid-state surfaces with controlled orientation using electric field**  
Javanmard, M., Emaminejad, S., Gupta, C., Chang, S., Davis, R., W., Howe, R., T.  
2013
- **Three stage sample preparation for purification of proteins from complex biological samples** *IEEE Sensors 2013, Baltimore, Maryland*  
Javanmard, M., Emaminejad, S., Davis, R., W., Gupta, C., Howe, R., T.  
2013: 1-4
- **Applications of nanonewton dielectrophoresis forces using atomic layer deposited oxides for microfluidic sample preparation and proteomics**  
Emaminejad, S., Javanmard, M., Gupta, C., Dutton, R., W., Davis, R., W., Howe, R., T.  
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- **Ultra dielectrophoresis: electrothermal analysis and its applications in microfluidic sample preparation and proteomics**  
Emaminejad, S., Javanmard, M., Gupta, C., Davis, R., W., Howe, R., T.  
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- **Capacitive Accelerometer Laboratory Using Polymer-Film Rapid Prototyping Technology** *3rd Interdisciplinary Engineering Design Education Conference (IEDEC)*  
Gellineau, A. A., Rastegar, A. J., Howe, R. T.  
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- **Microbead-separated thermionic energy converter with enhanced emission current** *PHYSICAL CHEMISTRY CHEMICAL PHYSICS*  
Littau, K. A., Sahasrabudhe, K., Barfield, D., Yuan, H., Shen, Z., Howe, R. T., Melosh, N. A.  
2013; 15 (34): 14442-14446
- **LATERALLY ACTUATED NANOELECTROMECHANICAL RELAYS WITH COMPLIANT, LOW RESISTANCE CONTACT** *26th IEEE International Conference on Micro Electro Mechanical Systems (MEMS)*  
Shavezipur, M., Lee, W. S., Harrison, K. L., Provine, J., Mitra, S., Wong, H. P., Howe, R. T.  
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- **An orbital-overlap model for minimal work functions of cesiated metal surfaces** *JOURNAL OF PHYSICS-CONDENSED MATTER*  
Chou, S. H., Voss, J., Bargatin, I., Vojvodic, A., Howe, R. T., Abild-Pedersen, F.  
2012; 24 (44)
- **A model for emission yield from planar photocathodes based on photon-enhanced thermionic emission or negative-electron-affinity photoemission** *JOURNAL OF APPLIED PHYSICS*  
Sahasrabudhe, K., Schwede, J. W., Bargatin, I., Jean, J., Howe, R. T., Shen, Z., Melosh, N. A.  
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- **Control of DNA Capture by Nanofluidic Transistors** *ACS NANO*  
Paik, K., Liu, Y., Tabard-Cossa, V., Waugh, M. J., Huber, D. E., Provine, J., Howe, R. T., Dutton, R. W., Davis, R. W.  
2012; 6 (8): 6767-6775
- **Microencapsulation of silicon cavities using a pulsed excimer laser** *JOURNAL OF MICROMECHANICS AND MICROENGINEERING*  
Sedky, S., Tawfik, H., Ashour, M., Graham, A. B., Provine, J., Wang, Q., Zhang, X. X., Howe, R. T.  
2012; 22 (7)
- **Smart-cut layer transfer of single-crystal SiC using spin-on-glass** *JOURNAL OF VACUUM SCIENCE & TECHNOLOGY B*  
Lee, J., Bargatin, I., Park, J., Milaninia, K. M., Theogarajan, L. S., Sinclair, R., Howe, R. T.  
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- **Single crystal silicon nanopillars, nanoneedles and nanoblades with precise positioning for massively parallel nanoscale device integration** *NANOTECHNOLOGY*  
Roper, C. S., Gutes, A., Carraro, C., Howe, R. T., Maboudian, R.  
2012; 23 (22)
- **A dry wafer-reconstitution process with zero insertion force by embedded alignment guide tabs** *JOURNAL OF MICROMECHANICS AND MICROENGINEERING*  
Chen, J. P., Provine, J., Klejwa, N., Howe, R. T.  
2012; 22 (6)
- **A micromachining-based technology for enhancing germanium light emission via tensile strain** *NATURE PHOTONICS*  
Jain, J. R., Hryciw, A., Baer, T. M., Miller, D. A., Brongersma, M. L., Howe, R. T.  
2012; 6 (6): 398-405
- **Optimal emitter-collector gap for thermionic energy converters** *APPLIED PHYSICS LETTERS*  
Lee, J., Bargatin, I., Melosh, N. A., Howe, R. T.  
2012; 100 (17)
- **Application of principal component analysis to a full profile correlative analysis of FTIR spectra** *SURFACE AND INTERFACE ANALYSIS*  
Broderick, S. R., Suh, C., Provine, J., Roper, C. S., Maboudian, R., Howe, R. T., Rajan, K.  
2012; 44 (3): 365-371

- **Electrical and Thermal Conduction in Atomic Layer Deposition Nanobridges Down to 7 nm Thickness** *NANO LETTERS*  
Yoneoka, S., Lee, J., Liger, M., Yama, G., Kodama, T., Gunji, M., Provine, J., Howe, R. T., Goodson, K. E., Kennyt, T. W.  
2012; 12 (2): 683-686
- **Integration of Nanoelectromechanical Relays With Silicon nMOS** *IEEE TRANSACTIONS ON ELECTRON DEVICES*  
Chong, S., Lee, B., Mitra, S., Howe, R. T., Wong, H. P.  
2012; 59 (1): 255-258
- **Nano-Electro-Mechanical Relays for FPGA Routing: Experimental Demonstration and a Design Technique**  
Chen, C., Lee, W., Parsa, R., Chong, S., Provine, J., Watt, J., Howe, R. T., Wong, H., Mitra, S., IEEE  
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- **CVD hafnium diboride as a contact material for nano-electromechanical switches**  
Lee, W., S., Cloud, A., N., Provine, J., Tayebi, N., Parsa, R., Mitra, S., Howe, R. T.  
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- **Nano-electro-mechanical relays for FPGA routing: experimental demonstration and a design technique**  
Chen, C., Lee, W., S., Parsa, R., Chong, S., Provine, J., Watt, J., Howe, R. T.  
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- **Encapsulated thermionic energy converter with stiffened suspension**  
Lee, J., H., Bargatin, I., Iwami, K., Littau, K., A., Vincent, M., Maboudian, R., Howe, R. T.  
2012
- **Sidewall silicon carbide emitters for terahertz vacuum electronics**  
Snapp, J., P., Lee, J., H., Provine, J., Bargatin, I., Maboudian, R., Lee, T., H., Howe, R. T.  
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- **Electrochemical quantum tunneling for electronic detection and characterization of biological toxins**  
Gupta, C., Walker, R., M., Gharpuray, R., Shulaker, M., M., Zhang, Z., Javanmard, M., Howe, R. T.  
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- **Multiband charge-coupled device**  
Chang, C., E., Siegel, J., D., Kenney, C., J., Roodman, A., J., Howe, R., T.  
2012
- **Smart-cut layer transfer of single-crystal SiC using spin-on-glass** *J. Vacuum Sci. Tech. B: Microelectronics and Nanometer Structures*  
Lee, J., H., Bargatin, Igor, I., Park, J., Milaninia, K., M., Theogarajan, L., S., Sinclair, R., Howe, R. T.  
2012; 30: 42001
- **Multiband Charge-Coupled Device** *IEEE Nuclear Science Symposium / Medical Imaging Conference Record (NSS/MIC) / 19th Room-Temperature Semiconductor X-ray and Gamma-ray Detector Workshop*  
Chang, C., Segal, J. D., Roodman, A. J., Howe, R. T., Kenney, C. J.  
IEEE.2012: 743-746
- **Electrochemical quantum tunneling for electronic detection and characterization of biological toxins** *Conference on Micro- and Nanotechnology Sensors, Systems, and Applications IV*  
Gupta, C., Walker, R. M., Gharpuray, R., Shulaker, M. M., Zhang, Z., Javanmard, M., Davis, R. W., Murmann, B., Howe, R. T.  
SPIE-INT SOC OPTICAL ENGINEERING.2012
- **Nano-Electro-Mechanical (NEM) Relays and their Application to FPGA Routing** *17th Asia and South Pacific Design Automation Conference (ASP-DAC)*  
Chen, C., Lee, S., Provine, J., Chong, S., Parsa, R., Lee, D., Howe, R. T., Wong, H. P., Mitra, S.  
IEEE.2012: 639-639
- **MICROFABRICATED SILICON CARBIDE THERMIONIC ENERGY CONVERTER FOR SOLAR ELECTRICITY GENERATION** *25th IEEE International Conference on Micro Electro Mechanical Systems (MEMS)*  
Lee, J. H., Bargatin, I., Gwinn, T. O., Vincent, M., Littau, K. A., Maboudian, R., Shen, Z., Melosh, N. A., Howe, R. T.  
IEEE.2012
- **Electrical Properties of CuPc-based OTFTs with Atomic Layer Deposited HfAlO Gate Dielectric** *8th IEEE International Conference on Electron Devices and Solid State Circuit (EDSSC)*

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- Tang, W. M., Aboudi, U., Provine, J., Howe, R. T., Wong, H. P.  
IEEE.2012
- **Double-Layer Silicon Photonic Crystal Fiber Tip Temperature Sensor** *25th IEEE Photonics Conference (IPC)*  
Park, B., Jung, I. W., Provine, J., Howe, R. T., Solgaard, O.  
IEEE.2012: 550–551
  - **Photonic Crystal Fiber Tip Sensor for High-Temperature Measurement** *IEEE SENSORS JOURNAL*  
Park, B., Provine, J., Jung, I. W., Howe, R. T., Solgaard, O.  
2011; 11 (11): 2643-2648
  - **Tensile-strained germanium-on-insulator substrate fabrication for silicon-compatible optoelectronics** *OPTICAL MATERIALS EXPRESS*  
Jain, J. R., Ly-Gagnon, D., Balram, K. C., White, J. S., Brongersma, M. L., Miller, D. A., Howe, R. T.  
2011; 1 (6): 1121-1126
  - **Multilayered Monolithic Silicon Photonic Crystals** *IEEE PHOTONICS TECHNOLOGY LETTERS*  
Mallick, S. B., Jung, I. W., Meisner, A. M., Provine, J., Howe, R. T., Solgaard, O.  
2011; 23 (11): 730-732
  - **Highly Sensitive Monolithic Silicon Photonic Crystal Fiber Tip Sensor for Simultaneous Measurement of Refractive Index and Temperature** *JOURNAL OF LIGHTWAVE TECHNOLOGY*  
Jung, I. W., Park, B., Provine, J., Howe, R. T., Solgaard, O.  
2011; 29 (9): 1367-1374
  - **AC Polarization for Charge-Drift Elimination in Resonant Electrostatic MEMS and Oscillators** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
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