RENATA MELAMUD

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EDUCATION

9/03 - Present **Stanford University**, Stanford, CA
Ph.D. Candidate in Mechanical Engineering
Stanford Graduate Fellow

9/99 – 6/03 **Carnegie Mellon University (CMU)**, Pittsburgh, PA
B.S. in Mechanical Engineering with Honors
Minor in Computer Science, Minor in Robotics
Andrew Carnegie Scholar

DISSERTATION

"Temperature Compensated Microelectromechanical Resonators"
Advisor: Dr. Thomas W. Kenny

Developed a novel and practical method to passively reduce the inherent temperature sensitivity of frequency in silicon resonators. Created composite resonators of silicon and silicon dioxide that exhibited a zero temperature coefficient of frequency. The resulting twenty-fold reduction in the frequency-temperature behavior over the industrial temperature range (-40ºC to 85ºC) is comparable to watch-grade quartz crystal resonators. In conjunction with active temperature compensation, this passive technology enables silicon-based high stability frequency references. Technology has been patented under Stanford University Office of Technology Licensing.

PROFESSIONAL EXPERIENCE

01/04 – Present **Micro Structures and Sensors Lab**, Stanford University, Stanford, CA
Research Assistant, Advisor: Dr. Thomas W. Kenny
Designed, fabricated, and characterized silicon microelectromechanical (MEMS) resonators for frequency reference applications.

- Investigated passive temperature compensation methods and role of thermal stresses on frequency-temperature behavior of electrostatically actuated resonators.
- Developed fabrication process to hermetically package composite resonators in a CMOS compatible wafer-level encapsulation process.
- Led a nine mask MEMS fabrication process and opened design access to more than twenty contributors from several interdisciplinary groups. Responsibilities included design rule development and checking, mask layout, fabrication in a class 100 cleanroom, and wafer post-processing.
- Constructed experimental setup for multi-resonator testing of temperature sensitivity and long-term behavior.
- Developed analytical and finite element models to predict resonant behavior.

06/05 – 12/05 **SiTime Inc,** Sunnyvale, CA
MEMS Packaging Engineer
Supported development of a surface mount package for MEMS based programmable oscillator using finite element modeling (FEM) and analysis.

- Optimized packaging of dual die (MEMS and ASIC) in a single plastic package to reduce error of digital temperature compensation.
- Developed nonlinear COMSOL / MATLAB FEM models to aid in selection of packaging materials.
- Evaluated static and dynamic thermal performance of package and its effect on frequency-temperature stability of MEMS resonator.

06/04 – 01/05 **MEMS Laboratory**, Stanford University, Stanford, CA
Research Assistant, Advisor: Dr. Beth Pruitt
Designed, fabricated, and characterized a polymer pressure sensor for *in-vivo* cardiovascular procedures.

- Developed a low cost fabrication process for an SU-8 polymer based Fabry-Perot interferometeric pressure sensor.
- Characterized the sensor in aqueous solutions and demonstrated 2 mmHg sensor resolution over a 0 to 125 mmHg pressure range suitable for medical device applications
- Evaluated the use of SU-8 polymer as a transduction material.

01/02 – 08/03 **Bayer Corporation**, Pittsburgh, PA
Computer Integrated Engineering Laboratory, CMU, Pittsburgh, PA
Software Engineer / Research Assistant, Advisor: Dr. Kenji Shimada
Developed software to aid design of plastic-metal hybrid automobile bumpers.

- Automated the optimization of hybrid structures for material and manufacturing cost reduction using computational methods.
- Reduced FEM modeling time by developing algorithms to automate the computational description of the complex metal-plastic interaction.

AWARDS AND HONORS

2003 Gabilan Stanford Graduate Fellowship
2003 CMU Bennet Prize for Academic Achievement in Mechanical Engineering
2003 CMU Forstall Award for Excellence in Mechanical Engineering
2003 Andrew Carnegie Scholar
1999 Carnegie Mellon University Presidential Scholarship

PATENTS

R. Melamud, B.Kim, M.A. Hopcroft, S. Chandorkar, A. Manu, T.W. Kenny, "Composite Mechanical Transducers and Approaches Therefor," Patent Pending, 2007

INVITED TALKS

2007 Bosch Research and Technology Center, "Composite Resonators: Enabling MEMS Frequency References," Palo Alto, CA.

2007 Stanford Graduate Fellowship Visit Day and Stanford Mechanical Engineering

Department Admit Day, “Choice and Serendipity,” Stanford, CA.

2005 SiTime, “Package and Temperature Dependent Frequency Stability,” Sunnyvale, CA.

SELECT PUBLICATIONS

First Author Journal Publications

1. R. Melamud, B. Kim, S.A. Chandorkar, M.A. Hopcroft, M. Agarwal, C.M. Jha and T.W. Kenny, “Temperature Compensated High-Stability Silicon Resonators,” App. Phys. Lett. 90 (24), 2007.

2. G.C. Hill*, R. Melamud*, F.E. Declercq, A.A. Davenport, I.H. Chan, P.G. Hartwell, B.L. Pruitt, “SU-8 MEMS Fabry-Perot Pressure Sensor”, Sen. Act. A., 138 (1), pp. 52-62, 2007. * Shared first authorship.

First Author Conference Publications

1. R. Melamud, B. Kim, M.A. Hopcroft, S.Chandorkar, M.Agarwal, C.M. Jha, and T.W. Kenny, "Composite Flexural-Mode Resonator with Controllable Turnover Temperature", Poster Presentation, Proc. of IEEE Intern. Conf. on MEMS, 2007.

2. R Melamud, B. Kim, M.A. Hopcroft, S. Chandorkar, M. Agarwal, C. Jha, S. Bhat, K.K. Park, and T.W. Kenny, "Composite Flexural Mode Resonators with Reduced Temperature Coefficient of Frequency," Oral Presentation, Proc. of the 2006 Hilton Head Workshop in Solid State Sensors, Actuators, and Microsystems, 2006.

3. R. Melamud, M. Hopcroft, C. Jha, B. Kim, S. Chandorkar, R. Candler, T.W. Kenny, "Effects of Stress on the Temperature Coefficient of Frequency in Double-Clamped Resonators," Oral Presentation, Proc. of Transducers, 2005.

4. R. Melamud, A.A. Davenport, G.C. Hill, I.H. Chan, F. Declercq, P.G. Hartwell, B.L. Pruitt, “Development of an SU-8 Fabry-Perot Blood Pressure Sensor,” Poster Presentation, Proc. of IEEE Intern. Conf. On MEMS, 2005.

Coauthor Journal Publications

1. M. A. Hopcroft, B. Kim, S. Chandorkar, R. Melamud, M. Agarwal, C. M. Jha, G. Bahl, J. Salvia, H. Mehta, H. K. Lee, R. N. Candler and T. W. Kenny, “Using the Temperature Dependence of Resonator Quality Factor as a Thermometer,” Appl. Phys. Lett. 91 (1), 2007.

2. C. M. Jha, G. Bahl, R. Melamud, S. A. Chandorkar, M. A. Hopcroft, B. Kim, M. Agarwal, J. Salvia, H. Mehta and T. W. Kenny, “High Resolution Microresonator-Based Digital Temperature Sensor,” Appl. Phys. Lett. 91 (7), 2007.

3. M. Agarwal, S.A. Chandorkar, R.N. Candler, B.Kim, M.A. Hopcroft, R. Melamud, C. M. Jha, T. W. Kenny, B. Murmann, “Optimal Drive Condition for Nonlinearity Reduction in Electrostatic MEMS resonators,” Appl. Phys. Lett. 89 (21), 2006.

4. M. Agarwal, H. Mehta, R.N. Candler, S.A. Chandorkar, B. Kim, M.A. Hopcroft, R. Melamud, G. Bahl, G. Yama, T.W. Kenny, B. Murmann. “Scaling of amplitude-frequency-dependence nonlinearities in electrostatically transduced microresonators.” Jour. App. Phys. v.102, no.7, 2007.

5. M. Agarwal, K.K. Park, S.A. Chandorkar, R.N. Candler, B. Kim, M.A. Hopcroft, R. Melamud, T.W. Kenny, B. Murmann. “Acceleration sensitivity in beam-type

electrostatic microresonators." App. Phys. Lett. vol.90, no.1, 2007

6. R. N. Candler, M. Hopcroft, B. Kim, W.-T. Park, R. Melamud, M. Agarwal, G. Yama, A. Partridge, M. Lutz, T. W. Kenny, "Long-Term and Accelerated Life Testing of a Novel Single-Wafer Vacuum Encapsulation for MEMS Resonators," Journal of Microelectromechanical Systems, Vol. 15, pp. 1446-1456, 2006.

REFERENCES

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Additional references available upon request