

# CHANDRA MOHAN JHA

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## EDUCATION

**M.S. + Ph.D.** in Mechanical Engineering (CGPA: 3.78/4.0) 2004 - 2008  
Stanford University, Stanford, CA, USA  
Thesis: Thermal and mechanical isolation of MEMS resonator  
Advisor: Professor Thomas W. Kenny  
**B.S.** in Mechanical Engineering (CGPA: 3.66/4, top 3%) 1992 - 1996  
Birla Institute of Technology, Ranchi, India

## SUMMARY

Chandra Mohan Jha is a Senior Process Technology Development Engineer in Intel Corporation (**Sept 2008 – present**). He was a research assistant in Stanford University (**2004 – 2008**) and his work on MEMS Resonator was crucial in meeting phase II target and getting phase III funding from the sponsor DARPA, and new projects from AUDI (MEMS Energy Scavenging) and Draper Lab (Shape Optimization). During this period, he also developed a technique to treat Glaucoma using MEMS device in a two-quarter class project. His work in Bhabha Atomic Research Centre (**1997 – 2004**) helped the organization become self-reliant in certain mechanical equipments and systems which had to be earlier imported, thereby saving huge foreign exchange of India govt. All these achievements were the result of a team work and he was one of the prominent members of the team.

## PUBLICATIONS & PATENTS

Journal / conference: Authored and co-authored 11 journal and 16 conference publications.  
Patents: Three provisional patents filed: two in 2007 for techniques in Glaucoma and Hydrocephalus and one in 2008 for treating human diaphragm atrophy.  
Book publication: Authored a book “Silicon Micromechanical Resonators: Thermomechanical isolation – design and optimization”, VDM Verlag Publishing, (ISBN: 978-3-639-18176-0)

## KEYSKILLS

Domain	MEMS/NEMS, Silicon packaging, Metrology, Mechanical systems, Mechatronics
Design	Mechanical systems, Resonator, Sensor, Energy scavengers, feedback control system
Analysis	Stress, Thermal, Vibration, Finite element analysis, Shape optimization
Manufacturing	Statistical process/quality control, DOE, Six sigma, Lean, Process optimization
Software	MATLAB, COMSOL, JMP, ANSYS, L-EDIT, Solidworks

## PROJECTS

Silicon micro-processor packaging	INTEL, USA	Since 2008
Silicon MEMS resonator	DARPA + BOSCH, USA	2004 - 2008
MEMS vibration energy scavenging	AUDI, Germany	2007 - 2008
Computational shape optimization	DRAPER Lab, USA	2007 - 2008
Mechanical systems design for import substitutes	BARC, India	1997 - 2004

## EXPERIENCE

**Intel Corporation**, Chandler, AZ, USA Sept 2008 - Present  
Sr. Process Technology Development Engineer, Chip Attach Module - Assembly Technology

- Leading a working group for R&D activities to develop a state of the art optical sensor based real time inspection metrology system to inspect latest micro-processors being developed at Intel for potential defects. The objective is to increase yield and reduce cost for high volume manufacturing.

**Stanford University**, Stanford, CA, USA

2004 - 2008

Graduate Researcher, Microstructures and Sensors Lab

Project sponsors: DARPA HERMIT, BOSCH RTC, AUDI and DRAPER Lab

- Designed, fabricated and tested encapsulated MEMS resonator from concept to final product.
- Reduced the power consumption of an ovenized MEMS resonator by **20x** using a unique and simple to fabricate thermal isolation technique.
- Improved the dynamic thermal response of ovenized MEMS resonators by **50x**. The dynamic thermal response of a resonator is very crucial in maintaining the temperature stability of the resonators.
- Designed and developed a unique MEMS resonator based digital **temperature sensor**. The resolution of this temperature sensor was estimated to be better than any CMOS based digital temperature sensor available today.
- Analyzed the external acceleration, vibration and shock effect on MEMS resonators and reduced the acceleration sensitivity of ovenized MEMS resonators by more than **100x**
- Optimized the shape of thermally isolated ovenized MEMS resonators for increased stiffness using FEM based “0-1” computational topology optimization technique (coded in MATLAB), resulting in overall reduction of power consumption by **40x** and increase in mechanical stiffness by **10x**.
- Designed and developed a MEMS vibration **energy scavenging** device for harvesting power from the vibration of a running car.

Research Mentor

2004 – 2008

Mentored and guided graduate students in research projects. Some of them are Jim Salvia, Gaurav Bahl, Vijay, Shingo, Cathy, and Mandy of Kenny Research Group.

Teaching Assistant

Winter 2007

Introduction to mechatronics (ME210) - basic architecture of a micro-processor and simple A/D, D/A, OpAamp and filter based circuits for sensing and control.

**Bhabha Atomic Research Centre**, Mumbai, India

1997 - 2004

Scientific Officer (C), Mechanical Systems Design

1997 - 2000

- Successfully completed one year technical orientation course equivalent to masters degree
- Designed and developed:-
  - An **indigenous** zero leakage metering pumps and bellow-sealed valves with a unique leak-less mechanical coupler for remote attachment. Designed for toxic and acidic applications.
  - A novel diaphragm-rupture detection system for metering pump.
  - Microprocessor controlled remote maintenance system.
  - SS lined vacuum assisted hot cells, fume hoods and glove boxes for active operation.
  - Embedded pipes, plates and structural parts designed for active safety.

Scientific Officer (D), Mechanical Systems Design

2000 - 2004

- Continued the design and development work after being promoted to grade (D) on a **fast track**.
- Successfully implemented the sanctioned project of indigenous development of mechanical equipments for import substitutes. The responsibilities included management of the given projects from **concept to development to launch**.
- Project Management:-
  - Scheduling, planning and team management
  - Procurement, tendering and vendor evaluation
  - Interaction with industry for engineering procurement and construction (EPC) contracts
  - Interaction with different departments for techno-commercial requirements
  - Plant commissioning by interacting with site engineers

**LML Ltd.**, Kanpur, India

1996 - 1997

Engineer

Helped and participated in a team that improved the fuel efficiency of a 125 cc two-wheeler automobile. This work was done in collaboration with PIAGGIO Italy.

## HONORS/AWARDS

- Intel ATTD award for solving component current-leakage under biased HAST condition – 2009
- James F. Lincoln Gold Award (top prize in the US national competition) for the development of a novel technique to treat Glaucoma - 2006.
- R. D. Sethna scholarship for higher education - 2004

## AFFILIATIONS

American Society of Mechanical Engineers (ASME)  
Institute of Electrical and Electronics Engineers (IEEE)  
Microstructures and Sensors Lab, Stanford, CA, USA  
ASHA Stanford – a non-profit organization for providing basic education to underprivileged children

## INVITED PRESENTATIONS

SiTime Inc., Sunnyvale, CA – 23<sup>rd</sup> Oct 2007  
BOSCH Research and Technology Centre, Palo Alto, CA – 28<sup>th</sup> Nov 2007  
Dim-Sum seminar, Stanford University, Stanford, CA – 7<sup>th</sup> Dec 2007  
Integrated Device Technology (IDT), San Jose, CA – 26<sup>th</sup> Sept 2008

## MEMS

Device fabrication, design and simulation (MATLAB, COMSOL, ANSYS), Layout design (LEDIT), lithography, etching, LPCVD, epitaxial silicon deposition, thermal oxidation, probing, dicing, wire bonding, circuit building, MATLAB based device testing using GPIB interface. Test instruments include Network Analyzer, Spectrum Analyzer, Oscilloscope, Function Generator, Counter, Laser Vibrometer, etc.

## INTERESTS

Extra activities include playing badminton, tennis and chess. Social services include building schools for under privileged children, working for energy independence and efficient irrigation in rural India.

## JOURNAL PUBLICATIONS

1. **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," selected for Virtual Journal of Nanoscale Science & Technology, August 2007 as an area of frontier research.
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," American Institute of Physics, Applied Physics Letters, 91, 074101-3, August 2007
3. **C. M. Jha**, Hopcroft M.A.; Chandorkar S.A.; Salvia J.C.; Agarwal M.; Candler R.N.; Melamud R.; Bongsang Kim; Kenny T.W.; "Thermal Isolation of Encapsulated MEMS Resonators," IEEE Journal of Microelectromechanical Systems, vol. 17, no. 1, pp. 175-184 Feb 2008.
4. **C. M. Jha**, J. Salvia, S. A. Chandorkar, R. Melamud, E. Kuhl, and T. W. Kenny, "Acceleration insensitive encapsulated silicon microresonator," American Institute of Physics, Applied Physics Letters, 93, 234103, December 2008.
5. 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," American Institute of Physics Applied Physics Letters, vol. 89, no. 21, pp. 4105-07, 2006.
6. Renata Melamud, Bongsang Kim, Saurabh A. Chandorkar, Matthew A. Hopcroft, Manu Agarwal, **C. M. Jha** and Thomas W. Kenny, "Temperature-Compensated High-Stability Silicon Resonators," Applied Physics Letters, 90, 1, 2007.
7. 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," American Institute of Physics, Applied Physics Letters, 91, 013505, July 2007
8. Manu Agarwal, Saurabh A. Chandorkar, Harsh Mehta, Robert N. Candler, Bongsang Kim, Matthew A. Hopcroft, Renata Melamud, **Chandra M. Jha**, Gaurav Bahl, Gary Yama, Thomas W. Kenny, and Boris Murmann, "A study of electrostatic force nonlinearities in resonant microstructures," American Institute of Physics Applied Physics Letters, vol. 92, no. 10, March 2008.
9. Bongsang Kim; Hopcroft, M.A.; Candler, R.N.; **Jha, C. M.**; Agarwal, M.; Melamud, R.; Chandorkar, S.A.; Yama, G.; Kenny, T.W., "Temperature dependence of quality factor in MEMS resonators," IEEE Journal of Microelectromechanical Systems, vol. 17, no. 3, pp. 755-766 June 2008.
10. B. Kim, R. N. Candler, **C. M. Jha**, R. Melamud, S. Yoneoka, H. K. Lee, M. A. Hopcroft, G. Yama, and T. W. Kenny, "Hermeticity and Diffusion Investigation in Polycrystalline Silicon Encapsulation for MEMS Devices," Journal of Applied Physics, vol. 105, pp. 013514, Jan 2009.
11. A. K. C. Nallani, S. Choi, S. Nemetz, Z. Zhou, A. Raman, P. K. M. Srinath, **C. M. Jha**, R. V. Tanikella, "A study of lead-free SMT ceramic chip capacitors' failure modes under biased highly accelerated stress conditions," IATT Journal, vol. 12, 2009

## CONFERENCE PUBLICATIONS

1. **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, "CMOS-Compatible Dual-Resonator MEMS Temperature Sensor with Milli-Degree Accuracy," Transducers 2007 Lyon France.
2. **C. M. Jha**, M. A. Hopcroft, M. Agarwal, S. A. Chandorkar, R. N. Candler, Vijay Subramanian, Renata Melamud, Suhrid Bhat, Bongsang Kim, Kwan K. Park and Thomas W. Kenny, "In-chip Device-layer Thermal Isolation of MEMS Resonator for Lower Power Budget," Proceedings of IMECE2006 2006 ASME International Mechanical Engineering Congress and Exposition November 5-10, 2006, Chicago, Illinois, USA
3. B. Kim, **C. M. Jha**, R. N. Candler, M. Hopcroft, S. Chandorkar, T. White, M. Agarwal, K. K. Park, R. Melamud and T. W. Kenny, "Temperature Dependence of Quality Factors in MEMS Resonators," presented at 19<sup>th</sup> IEEE MEMS Conf., Istanbul, Turkey, 2006.
4. B. Kim, M. Hopcroft, **C. M. Jha**, R. Melamud, S. Chandorkar, M. Agarwal, K. L. Chen, W. T. Park, R. Candler, G. Yama, A. Partridge, M. Lutz, and T. W. Kenny, "Using MEMS to build the device and the package," presented at Transducers & Eurosensors 2007, Lyon France.
5. R. Melamud, M. Hopcroft, **C. M. Jha**, B. Kim, S. Chandorkar, R. Candler, T. W. Kenny, "Effects of Stress on the Temperature Coefficient of Frequency in Double Clamped Resonators," Tranducers '05, vol. 1, pp. 392-395, 2005.
6. B. Kim, M. A. Hopcroft, R. Melamud, **C. M. Jha**, M. Agarwal, S. A. Chandorkar and T. W. Kenny, "CMOS Compatible Wafer-Scale Encapsulation with MEMS resonators" presented at ASME InterPACK 2007 Vancouver, Canada, Jul 2007.
7. M. Hopcroft, M. Agarwal, K. K. Park, B. Kim, **C. M. Jha**, R. N. Candler, G. Yama, B. Murmann and T. W. Kenny, "Temperature Compensation of a MEMS Resonator Using Quality Factor as a Thermometer," presented at 19<sup>th</sup> IEEE MEMS Conf., Istanbul, Turkey, 2006.
8. M. Agarwal, K. K. Park, R. N. Candler, M. Hopcroft, **C. M. Jha**, R. Melamud, B. Kim, B. Murmann and T. W. Kenny, "Non-Linearity Cancellation in MEMS Resonators for Improved Power-Handling," presented at IEEE Int. Electron Devices Meeting, Washington D.C., 2005.
9. S. A. Chandorkar, H. Mehta, M. Agarwal, M. A. Hopcroft, **C. M. Jha**, R. N. Candler, G. Yama, G. Bahl, B. Kim, R. Melamud, K. E. Goodson and T. W. Kenny, "Non-isothermal micromechanical resonators," presented at 20<sup>th</sup> IEEE MEMS Conf., Kobe (Japan), Jan. 2007.
10. 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," presented at 20<sup>th</sup> IEEE MEMS Conf., Kobe (Japan), Jan. 2007.
11. R. Melamud, B. Kim, M. A. Hopcroft, S. Chandorkar, M. Agarwal, **C. M. Jha**, K. K. Park and T. W. Kenny, "Composite Flexural Mode Resonator with Reduced Temperature Coefficient of Frequency," presented at Hilton Head Workshop, Hilton Head, SC, 2006.
12. T. Kenny, M. Lutz, A. Partridge, G. Yama, R. Candler, W. T. Park, M. Hopcroft, B. Kim, M. Agarwal, S. Chandorkar, R. Melamud, **C. M. Jha**, "Advances in MEMS Integration: MEMS First or MEMS Last?" presented at the 12<sup>th</sup> International Micromachine/Nanotech Symposium in Tokyo (Japan), Nov. 2006.
13. T. Kenny, A. Partridge, R. Candler, W. T. Park, M. Hopcroft, B. Kim, M. Agarwal, S. Chandorkar, R. Melamud, **C. M. Jha**, "Manufacturable MEMS: Building the MEMS, the Package and the Circuit in the Same Technology," presented at Intl. Forum on Micro-nano Hetero Sys. Int., Sendai (Japan), Nov. 2006.
14. M. Agarwal, K. K. Park, R. N. Candler, B. Kim, M. A. Hopcroft, S. A. Chandorkar, **C. M. Jha**, R. Melamud, T. W. Kenny and B. Murmann, "Nonlinear Characterization of Electrostatic MEMS resonators," presented at IEEE Frequency Control Symposium, Miami, FL, 2006.
15. M. Agarwal, K. K. Park, B. Kim, M. A. Hopcroft, S. Chandorkar, R. N. Candler, **C. M. Jha**, R. Melamud, B. Murrman and T. W. Kenny, "Amplitude Noise induced Phase Noise in Electrostatic MEMS Resonators," presented at Hilton Head Workshop, Hilton Head, SC, 2006.
16. G. Bahl, R. Melamud, B. Kim, S. Chandorkar, J. Salvia, M. A. Hopcroft, R. G. Hennessy, 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," presented at Hilton Head, USA, June 2008

## CITATIONS

Google Scholar Results 1 - 7 of 7 citing [Jha: High resolution microresonator-based digital temperature sensor](#). (0.06 sec)

Google Scholar Results 1 - 4 of 4 citing [Jha: Thermal Isolation of Encapsulated MEMS Resonators](#). (0.05 sec)

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