

BSAC News

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FOUNDED IN 1986

Design of New Berkeley Microlab Underway

In July of 2001, the state of California approved Berkeley's proposal to become the center of one of the California Institutes of Science and Innovation. The Berkeley proposal (The Center for Information Technology Research in the Interest of Society - CITRIS) was championed by several faculty members from the Electrical Engineering Computer Science Department and included as a key component construction of a new 20,000 sf microfabrication laboratory. The stage is finally set for the New Berkeley Microlab.

Detailed design meetings for the new lab were initiated November 2001. Though the new Microlab is one of the key pieces of the CITRIS proposal; it must be integrated within a new building that will support many other CITRIS components. Early design meetings focused upon de-

fining which criteria are critical to long-term laboratory success and which criteria are flexible so as to accommodate several equally important additional CITRIS programs. One of the most critical issues for the new Microlab is hazard classification. It is paramount that the new Microlab satisfy all building code requirements for an H6 hazard classification. Though the H6 classification requirements are extremely demanding, it was specifically developed for semiconductor fabrication facilities and insures the new Microlab will be able to safely accommodate the widest variety of gases, chemicals and processes in the future. To achieve this classification, the Microlab will be consolidated in one wing of the building and consist of two stacked clean rooms (each approximately 10,000 sqft.) rather than spread

out across an entire floor. However, these cleanrooms will function as a single laboratory, have a single gowning area and be linked by both elevators and stairways within the clean envelope.

Of greatest interest to the BSAC community is the processing capability of the new laboratory. The laboratory will support 8" silicon wafers and deep UV lithography to meet the needs of the electron device focused researchers and enable transfer of substrates with industrial partners. The laboratory will also support 6" silicon substrates, contact lithography, multiple substrate bonding and thick film LPCVD to meet the needs of MEMS researchers and insure compatibility of substrates with the 6" based Bioengineering Nanotechnology Center, to be located in the new Stanley Hall. The laboratory will also support com-

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Equipment Donated by Fanuc Ltd.

Late last year Fanuc Ltd. made the decision to close the Fanuc Berkeley Laboratory in Union City, CA. This compact (1500 square foot) research laboratory was completely outfitted for independent development of MEMS devices to enhance Fanuc robotic systems. Rather than attempt to relocate or sell the laboratory tools, Fanuc Ltd. offered to donate the entire tool set to the College of Engineering at U.C. Berkeley. All manufacturing and shop tools were donated through Professor Masayoshi Tomizuka of Mechanical Engineering and will provide a significant upgrade to the Mechanical Engineering Department

shop. All microfabrication tools were donated through Professor Albert P. Pisano, Fanuc Chair of Mechanical Systems and one of the Directors of the Berkeley Sensor and Actuator Center. The microfabrication tool set will ultimately be housed in a new Stanley Hall laboratory and includes lithography, bonding, LPCVD, PVD, etch and metrology tools -- all tools are 6" capable. This extensive tool set will provide the foundation for the Fanuc BioMEMS Laboratory to be built as part of the Bioengineering Nanotechnology Center in the new Stanley Hall. Rather than putting these tools in long term storage while waiting for

completion of the new building, many of these tools will be put to use in the existing Microlab supporting multiple BSAC projects. The lithography tool set will support a new undergraduate BioMEMS instructional laboratory. Thanks to the Berkeley Microlab, BSAC Directors, and several additional Microlab faculty for supporting the not insignificant cost of packing and moving the large number of tools involved. Thanks especially to Fanuc Ltd. for this extremely generous donation; the long standing relationship between U.C Berkeley and Fanuc Ltd. continues to grow stronger.

BSAC presented nine papers at MEMS '02 in Las Vegas and seven papers at the ASME IMECE in New York.

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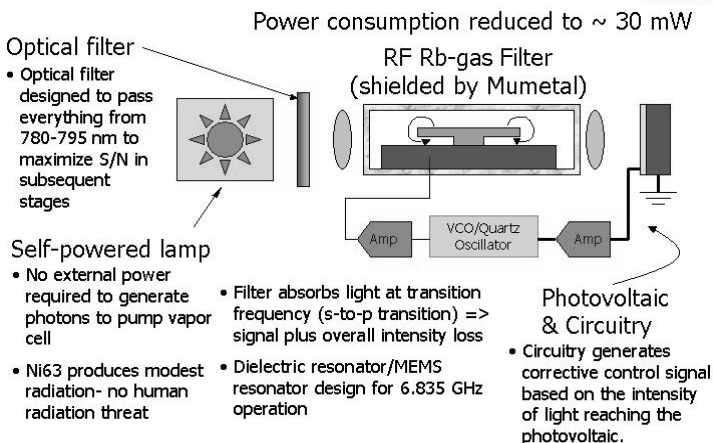
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BSAC Begins Atomic Clock Research

The US military and DARPA MTO in particular have recognized the importance of a reduction in size, mass, and power consumption of atomic clocks. In response, a multidisciplinary team composed of Frequency Electronics, University of Wisconsin and the University of California at Berkeley, led by Prof. Albert P. Pisano, has proposed an Integrated, Nano Mechanically Regulated Atomic Clock that utilizes MEMS technology to make the reductions in

size, mass and power possible. The primary reductions in power (and subsequently in mass and size) come primarily from: a self-powered Rb⁸⁵ lamp that requires only 10 milliwatts for heating alone, an array of lenslets that concentrate the

Rb-based Block System



photons from the Rb⁸⁵ lamp at the very location in the resonance cell at which the magnetic field fluctuations are the greatest in magnitude, and a resonance cell employing Rb⁸⁷ as the transition frequency reference. In addition, an array of Mumetal®

resonators modulate a constant magnetic field (created by a simple magnet) to provide magnetic flux reversals at 6.835 GHz using a mechanical resonance of only 3.4175 GHz. The integrated package will be about 2 cm x 2 cm x 2 cm, resulting in extreme shock tolerance and easy-to-control thermal management. DARPA MTO awarded this proposal in December of 2001 and team members are undergoing funding negotiations for work to commence in the fall of 2002. Additional BSAC members involved in the project include Prof. Luke Lee and Prof. Liwei Lin. Other members of the team are Professor Amit Lal (a BSAC alumnus) and Professor Susan Hagness of the University of Wisconsin and Dr. Thomas McClelland of Frequency Electronics.

Meet the Growing BSAC Staff

Jontae Gray, Purchasing Assistant

Jontae Gray joined BSAC in October 2001 in the newly created position of Purchasing Assistant to manage the ever-increasing volume of purchases, reimbursements, and travel vouchers generated by BSAC researchers and faculty.

Jontae grew up in the temperate climate of the Bay Area and is currently working on her college degree at Merritt College in Oakland.

Jontae worked in purchasing and customer service before coming to UCB in early 2000 where she worked in the ERL business office assisting account administrators and purchasing personnel. Jontae brought those experiences to BSAC and is molding this new position into an efficient purchasing desk. She is implementing improved procedures, designing better tracking systems, training student assistants, and streamlining work flow; all with a goal of improving customer service, increasing BSAC's response time on purchasing, and expediting reimbursements.

Jontae loves people and spends her time away from BSAC with family and at social gatherings.

Peggy Kingsley, Grants Administrator

Peggy Kingsley started with BSAC just after the fall 2001 IAB as Grant Administrator for Roger Howe, Dorian Liepmann, and Al Pisano and a number of Affiliate Faculty that are co-PI's with those professors.

Peggy grew up in the cold winters of Michigan. Peggy graduated Cum Laude with a BA from Kalamazoo College with a Health Science Major and a Biopsychology Minor where she was awarded the Heyl Scholarship for four years. Peggy was also Valedictorian at her High School.

Prior to coming to UCB, Peggy worked for both the Kalamazoo College and the University of Iowa Hospitals and Clinics. Peggy came to UCB in 2000 hired as a Grant Administrator / Administrative Assistant in the Electronics Research Lab on the 5th Floor working for three professors. Her experience there enabled Peggy to quickly come up to speed with the grants work in BSAC.

When she gets away from her desk in BSAC, Peggy trains for Olympic-distance triathlons with the YMCA Tri-Club.

Tom Parsons, Grants Administrator

Tom Parsons has been with BSAC since July 1999. Hired as a Grants Assistant, Tom was promoted to the position of Grants Administrator in August 2001. Tom supports Professors Luke Lee, Liwei Lin, Richard Muller, Kris Pister, and Richard White.

Tom grew up in the hot summers of Arizona. Tom graduated Magna Cum Laude with a BM in Music History and an MM in Choral Conducting from Northern Arizona University.

Tom worked in church music and in purchasing before coming to BSAC. While Tom is working hard to learn the increased tasks of Grant Administrator he has been a leader in helping to train all new staff in the BSAC way. Tom's experience was invaluable during both Fall 2001 and Spring 2002 IAB planning when there was substantial staff turnover.

Tom's musical interests involve him in a second career as a member of Sonos Handbell Ensemble, which tours throughout the United States and is planning a Japan tour next December.

New Microlab

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beginning to take shape. Lithography (8", 6" and manual) and some metrology on the first level to minimize vibration; wet process (and related hot processing) on the first level to accommodate liquid waste streams; dry etch, PVD, CMP, and assembly on the second level; and gowning and storage on the second level with the main lab entrance.

In conclusion, the new laboratory will not only maintain but also attempt to expand its broad interdisciplinary scope. Every effort is being made to insure that the tools, processes, and procedures of the new Microlab support the largest cross section of researchers.

Degrees Earned

Moshiur Mekhail Anwar M.S.
Immunosensor: A CMOS/
MEMS-Based Protein Sensor

Pamela F. Caton Ph.D
Microfiltration and Flexural
Plate Wave Devices

Ningning Zhou Ph.D
Simulation and Synthesis of
Micro Electro Mechanical
Systems

BSAC PUBLICATIONS – September 2001 to March 2002

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- B. Warneke and J.A. Chediak, "Chip Manufacturing", Computer Science for Students, Ed. Kathleen Edgar, 3 vols. Macmillan Reference USA/The Gale Group, 2002.
- H. Jiang, K. Yoo, J.A. Yeh, Z. Li, and N.C. Tien, "Fabrication of Thick Silicon Dioxide Sacrificial and Isolation Blocks in a Silicon Substrate", Journal of Micromechanics and Microengineering, Vol. 12, 2002, pp 87-95.
- C.L. Muhlstein, E.A. Stach, and R.O. Ritchie, "Mechanism of Fatigue in Micron Scale Films of Polycrystalline Silicon for Micro Electro Mechanical Systems", Applied Physics Letters, Vol. 80, 2002, pp. 532-534.
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- J. Tsai and L. Lin, "Micro-to-Macro Fluidic Interconnectors with an Integrated Polymer Sealant", Journal of Micromechanics and Microengineering, Vol.11, No. 5, September 2001, pp. 577-581.
- M. Chiao and L. Lin, "Hermetic Wafer Bonding Based on Rapid Thermal Processing", Sensors and Actuators, Vol. 91A, July 2001, pp. 404-408.
- T. Remtema and L. Lin, "Active Frequency Tuning for Microresonators by Localized Thermal Stressing Effects", Sensors and Actuators, Vol. 91A, July 2001, pp. 326-332.
- Y.T. Cheng, L. Lin, and K. Najafi, "A Hermetic Glass-Silicon Package Formed Using Localized Aluminum/Silicon-Glass Bonding", IEEE/ASME Journal of Micro Electro Mechanical Systems, Vol. 10, No. 3, pp. 392-399, 2001.
- L. Doherty, B.A. Warneke, B.E. Boser, and K.S.J. Pister, "Energy and Performance Considerations for Smart Dust", International Journal of Parallel Distributed Systems and Networks, Vol. 4, No. 3, 2001, pp. 121-133.
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- C.L. Muhlstein, S.B. Brown, and R.O. Ritchie, "High-cycle Fatigue of Single Crystal Silicon Thin Films", Journal of Micro Electro Mechanical Systems, Vol. 10, 2001, pp. 593-600.

CONFERENCE PRESENTATIONS – September 2001 to March 2002

- 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", IEEE Solid State Sensor and Actuator Workshop (Hilton Head 2002), June 4-7, 2002.
- A.A. Seshia, W. Low, S.A. Bhave, R.T. Howe, and S. Montague, "Micromechanical Pierce Oscillator for Resonant Sensing Applications", Proceedings of the Modeling and Simulation of Microsystems conference, April 22-25, 2002.
- R.S. Muller, "MEMS Now, MEMS Future," invited seminar, Dept of Mechanical Engineering, Stevens Institute of Technology, Ho-

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boken, New Jersey, February 6, 2002.

- J.V. Clark, D. Bindel, N. Zhou, J. Nie, W. Kao, E. Zhu, A. Kuo, K.S.J. Pister, J. Demmel, S. Govindjee, Z. Bai, M. Gu, and A.M. Agogino, "Addressing the Needs of Complex MEMS Design," Proceedings of the 15th IEEE International MEMS Conference, Las Vegas, Nevada, January 20-24, 2002, IEEE, ISBN 0-7803-7187-9, 2002, pp. 204-209.
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- L. Zhou, K. Pister, and J. Kahn, "Assembled Corner-cube Retroreflector Quadruplet MEMS 2002", 15th IEEE International Conference on Micro Electro Mechanical Systems, Las Vegas, Nevada, January 20-24, 2002, pp. 556-559.
- D. Joachim and L. Lin, "Selective Polysilicon Deposition for Frequency Tuning of MEMS Resonators", Proceedings of IEEE Micro Electro Mechanical Systems Conference, Las Vegas, January 2002, pp. 727-730.
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- L. Lin, "Thermal Challenges in MEMS Applications: Phase Change Phenomena and Thermal Bonding Processes", Proceedings of the International Conference Thermes 2002, Thermal Challenges in Next Generation Electronic Systems, Santa Fe, January 2002, pp. 35-44.
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- H. Jiang, Z. Li, and N.C. Tien, "Reducing Silicon-Substrate Parasitics of On-chip Transformers", Proceedings of IEEE International Conference on Micro Electro Mechanical Systems (MEMS), Las Vegas, Nevada, January 2002, pp. 649-652.
- M. Wasilik, "Low Frequency Etching for Silicon on Insulator Substrates", SPIE International Symposium on MEMS & Microelectronics; Adelaide Australia, December 2001.
- K. Fu, A. Knobloch, F. Martinez, D.C. Walther, C. Fernandez-Pello, A.P. Pisano, D. Liepmann, K. Miyaska, and K. Maruta, "Design and Experimental Results of Small-Scale Rotary Engines", Proc. 2001 International Mechanical Engineering Congress and Exposition (IMECE), New York, November 11-16, 2001.
- K. Fu, A. Knobloch, F. Martinez, D.C. Walther, C. Fernandez-Pello, A.P. Pisano, D. Liepmann, "Design and Fabrication of a Silicon-Based MEMS Rotary Engine", Proc. 2001 International Mechanical Engineering Congress and Exposition (IMECE), New York, November 11-16, 2001.
- B. Stoeber, E. Espanol, and D. Liepmann, "Operational Limits of Suspension Flow through Sudden Contractions", Proceedings of the 2001 ASME International Mechanical Engineering Congress and Exposition, New York, New York, November 11-16, 2001.
- C.W. Chang, T. Budde, H.H. Gatzert, and R.S. Muller, "A Magnetically Actuated Scanner for Intravascular Ultrasound Imaging", ASME Winter Meeting 2001, IMECE, Technical Digest: MEMS-Vol. 2001, New York, New York, November 11-16, 2001.
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- N. Zhou, B. Zhu, A. Agogino, K. Pister, "Evolutionary Synthesis of MEMS (Microelectronic Mechanical Systems) Design", Proceedings of ANNIE 2001, Intelligent Engineering Systems through Artificial Neural Networks, Volume 11, ASME Press, pp. 197-202.