What Goes on Behind Open Doors: Fabrication Capabilities and Access Programs at UC Berkeley Microfabrication Laboratory

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Outline

• Berkeley Microlab Summary of Capabilities
• Access Programs and Recharge Rates
• Conclusions
• AlN Process Update
The First University IC Lab

…was built in 1962 at UC Berkeley

The Microlab

…expanded around the IC lab and opened in 1982

A shared facility:

The Microlab has supported research across 7 departments, multiple campuses, and national labs for 20 yrs
Overview UC Berkeley Microlab Tools

Thermal process (oxidation, diffusion, anneal)
- 11 atmospheric furnaces, 3 RTP systems
- solid source boron doping, POCl3 doping
- SiC tube available for up to 1200 C

CVD
- 9 LPCVD tubes poly-Si, poly-Ge, poly SiGe, Si3N4, SiO2, SiC
- 3 PP PECVD
- recent install Applied Materials P5000 TEOS,
- custom RTCVD for high k dielectric HfO2

Litho
- ASML 6" 248nm, 5:1 stepper,
- Karl Suss up to 6" contact align/bond aligner, backside capable
- 2 GCA 10:1 4" steppers, (g-line, i-line)
- Quintel up to 6" contact align, backside capable
- 6" and 4" SVG coat and develop tracks
- Pattern generator for in-house mask making

Etch
- Lam oxide, poly, nitride, aluminum etchers (4”/6”)
- STS DRIE (4”)
- Technics parallel plate nitride etcher
- 3 O2 asher/etcher
- XeF2 reactor for silicon etch
- Wet etch: Al, poly-Si, KOH, TMAH, H3PO4, HF, CPD
- 10/2003 AMAT Centura: deep trench Si and SiO2 ME-RIE (6”)

PVD
- Novellus 6" 5 chamber sputter deposition (Al, AlN, Ti, TiN, Mb)
- CPA 4 target sputter dep (Al/2% Si, Ti, W, Ni)
- 3 thermal, 2 ebeam evap
- 4 additional multi-target sputter deposition systems

Planarize and Package
- Strasbaugh 6”/4” CMP, 6” Disco dicing saw, Au / Al wire bond
- Karl Suss SB6 wafer bonder

Metrology ellips, profilometer, SEM, FIB w EDX, AFM
Almost everything but implantation
Access Programs
Berkeley Sensor and Actuator Center

• Full details can be found at: http://www-bsac.eecs.berkeley.edu/
• An NSF/Industry/University Cooperative Research Center
• Annual membership fee provides direct access to research projects and faculty through closed meetings and limited distribution research reports

• BSAC members are supported by BSAC engineers who have full laboratory access and can provide process details, process review, limited processing services
• 100% of UCB tools are available to BSAC engineers
• BSAC members are guaranteed BMLA membership

• BSAC members may also sponsor specific research projects with UCB faculty. This provides full access to laboratory through sponsorship of graduate student and post-doctoral researchers

Courtesy account to shadow a sponsored researcher available

Access Programs
MEMS Exchange

• Full details can be found at: http://www.mems-exchange.org/
• Supported by DARPA, Defense Advanced Research Projects Agency
• Hosted by CNRI, the Corporation for National Research Initiatives

• Coordinated network of distributed fabrication centers
  • Berkeley, Stanford, Cornell, Michigan, Illinois, Case Western, Louisiana
  + ~15 industrial labs

• MEMS exchange is a fee for service program; it does not enable laboratory access

• Approximately 75% of UCB tools available through MEMS Exchange
Access Programs
BMLA Berkeley Microlab Affiliates

• Full details at: http://argon.eecs.berkeley.edu:8080/text/bmla.html
• Cooperative Agreement between Member companies and U.C.; for educational, training, research or other experimental purposes,
• BMLA membership provides complete laboratory access; BMLA is not a fee for service program
• 100% of UCB tools available through BMLA
specialty tool modifications and gases considered
• BSAC members receive $5K BMLA discount
• Requirements:
  • brief summary of proposed processing reviewed with Operations Manager and Faculty Director
  • training in safety, facilities procedures, and equipment operation

BMLA Membership Fee
Effective 7/1/02 – 10/30/03

<table>
<thead>
<tr>
<th>Number of employees per member company</th>
<th>Annual BMLA membership fee</th>
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<tr>
<td>1</td>
<td>$15K</td>
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<td>2</td>
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<td>3-4</td>
<td>$35K</td>
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<tr>
<td>5-6</td>
<td>$50K</td>
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maximum of 6 employees from any member company
**BMLA Recharge Rates**

*Effective 7/1/02 – 10/30/03*

<table>
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<tr>
<th>Category</th>
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<tr>
<td>Access Fee</td>
<td>$83.70/month</td>
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<tr>
<td>Lab Fee</td>
<td>$32.40/hour</td>
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<tr>
<td>Special Equipment</td>
<td>$30.00/hour</td>
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<td>Exceptional Equipment</td>
<td>$34.00/hour</td>
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<tr>
<td>Staff Services</td>
<td>$66.00/hour</td>
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University researcher standard rates

Overhead fee: 50% higher.

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**BMLA List of Companies**

*as of May, 2003*

- Acorn Technologies, Inc.
- Active Optical Networks, Inc.
- Robert Bosch Corporation
- Brion Technologies, Inc.
- Integrated Nanosystems, Inc.
- Iris AO, Inc.
- Kovio, Inc.
- MEMS PI
- MicroAssembly Technologies
- MicroPropulsion
- Nanochip, Inc.
- Nanomix, Inc.
- Nanosys, Inc.
- NanoTelecom, Inc.
- OnWafer Technologies, Inc.
- Photon Imaging, Inc.
- Sandia National Laboratories

17 present members, 2002: 22 members, high ~28
Sample Microlab Use by BMLA Companies

- Nanomix: http://www.nano.com/
  Developing carbon nanotube based sensors. Nanotube furnace at Nanomix, use Microlab for metal contact deposition, lithography, test equipment and autoprobe.

  Designs, manufactures and markets silicon wafer-mounted sensor systems. These "SensorWafers" contain wafer-state sensors, measurement electronics, power source, memory, and wireless communication system. OnWafer develops sensors and uses wide array of process tools in the Microlab to test these wafer mounted sensor systems.

BMLA Success Stories

Alien Technology: http://www.alientechnology.com/

Fluidic Self Assembly (FSA) Process enabling low cost high volume assembly of RFID tags and related products – developed in the Microlab (Prof J.S. Smith).

Alien used the Microlab for incubator research for 2+ years prior to leasing first R&D space in Hayward, CA then moving to production facility in Morgan Hill, CA January 6, 2003.

BMLA Success Stories

• Timbre Technology:  http://www.timbrecom.com/index.htm

Timbre’s Optical Digital Profilometry (ODPÔ) provides accurate profile, CD, and film thickness measurements at geometries of 0.18µ and below. In place of CD-SEMs, ODPÔ employs ordinary spectrographic ellipsometers and reflectometers such as those already used for thin film measurement. Extensive metrology data required for development of Timbre’s unique software package was collected in the Microlab.

TOKYO--(BUSINESS WIRE)--Feb. 5, 2001--Tokyo Electron Limited (TEL; Head Office: Minato-ku, Tokyo; C.E.O., President: Tetsuro Higashi), has reached a definitive agreement to acquire Timbre Technologies Inc. (Head Office: Fremont, Calif.; CEO & Chairman: Alan Nolet).

Conclusions

• There are several mechanisms providing ready access to the UC Berkeley Microlab

• Industrial use benefits the lab AND the member company

  • affordable access for process development by start up companies

  • access to flexible tools for large companies with rigid laboratory processes

  • financial support for lab maintenance and upgrade

  • student exposure to a commercial prospective
Process Update: Al N Characterization
BSAC Eng Office: Matt Wasilik and Roger Su

• 2\textsuperscript{nd} order effect observed with low power - low pressure
• lower dep rate at low power believed to allow better crystal orientation

• Another run to be performed at high temperature (350C), low power (600watt), and low pressure (3mtorr) – should produce optimized piezoelectric response

• For related info see:
  Gianluca Piazza  APP62

"Thornton" Diagram