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Micro/Nano Technology Center

Nano News

UNIVERSITY OF LOUISVILLE
J.B. SPEED SCHOOL OF ENGINEERING

It's Happening Here

Director's Message

Welcome to the Fall 2011 MNTC Newsletter. It has been an exciting and productive period for our expanding Center. Through a recent $4.6M research/infrastructure grant, we have acquired many new fabrication and characterization tools in the cleanroom. I encourage you to survey our expanding list of advanced capabilities highlighted on the back of this newsletter. The UofL faculty involved in micro/nano research have been as productive as ever, with cumulative recent awards exceeding $2M in the last couple of months. More and more external customers in industry and academia are using our state-of-the-art facility. Our new grayscale lithography capability continues to generate new opportunities and excitement. Our photo mask generation is utilized by a wide variety of users nationwide. The field of Nanotechnology is predicted to grow globally from a $400B commercial industry today to over $2.5 TRILLION by 2020! It is also anticipated that the world will need 2,000,000 nanotechnologists by 2020, a dramatic increase from the estimated 20,000 which exist today. Academia certainly has its work cut out, but I expect she will be up to the challenge with the United States hopefully leading the way. It's an exciting time to be involved in micro/nano both here at UofL and globally. Please enjoy the Fall 2011 Newsletter and feel free to send feedback to me and/or the MNTC staff.

MNTC Staff Opening

The MNTC has an immediate managerial opening for its center. We seek an experienced, qualified, enthusiastic, team-oriented candidate to manage the safe and efficient operation of the MNTC, which consists a $30M, 10,000 sq. ft. class 100/1000 cleanroom, a packaging/characterization lab, and a small MEMS modeling lab. Technical questions can be forwarded to Dr. Kevin Walsh (MNTC Director) at walsh@louisville.edu. However to apply for this position, candidates need to go to www.louisville.edu/jobs and view Job Posting ID 27512. If you need assistance with the application process, please contact UofL Human Resources at (502) 852-6542.

RESEARCH HIGHLIGHT

NIH Funds Smart Chip for Detecting Cancer Cells

The National Institutes of Health (NIH) announced that it had accepted a research proposal from Dr. Balaji Panchapakesan (UofL ME Dept.) titled, "Nanotube Antibody Arrays for Profiling Circulating Diseased Cells." This 2-year project starts Aug 2011 and will receive $422,722 from NIH. Dr. Panchapakesan's project focuses on the development of sensitive quantitative technologies for molecular characterization of scant cells in easily-accessible bodily sources such as fine needle aspirates, biopsies, whole blood, saliva and urine, with an ultimate goal of detecting the presence of cancer cells. Such technologies have the potential to significantly impact the life sciences and clinical practice.

"Current laboratory procedures used for cancer biomarker testing require collection of the body fluids and aspirates, followed by transfer of those materials to a laboratory for testing. Turn-around times in the range of a day to several days are typical. This delay can lead to phenotypic/apoptotic changes of sampled cells." states Dr. Panchapakesan. "Our research will develop nanotube-antibody biosensor arrays for the rapid (within minutes) profiling of circulating tumor cells in blood." Using miniature sensor arrays micro fabricated in the UofL MNTC, Dr. Panchapakesan's Team will develop a practical diagnostic device for detecting and profiling circulating breast cancer cells. The new technologies will be evaluated relative to standard immunoassays such as enzyme-linked immunosorbent assay (ELISA).

UofL Faculty Recently Awarded over $2M for Micro/nano Research

Dr. Thomas Berfield, Assistant Professor of ME and director of the Micro-Scale Testing Lab, received a 3-year $250,000 research grant from the National Science Foundation to study the failure of thin films and their use as a next-generation novel patterning technology. The project, titled "Micro-Patterning Through Mechanics and Cracking of Drying Thin Films," began September 1, 2011.

Dr. Shamus McNamara, Associate Professor of ECE and Associate director of the MNTC, received a 3-year $289,249 NSF award titled "Nano-Porous Thermoelectric Based Knudsen Gas Pumps". The goal of this work is to develop a new gas pump technology with the following objectives - (1) improve the efficiency of the Knudsen gas pump, (2) develop a method to integrate the Knudsen pump with microfluidic applications in a simple, efficient manner, (3) better model and understand gas pumps based upon the thermal transpiration effect through unobstructed channels, and (4) explore efficient methods of using the Knudsen Pump to generate pneumatic energy from heat sources, such as body heat and solar thermal energy. The project runs from Sept.1, 2011 to 8/31/2014.

Dr. Cindy Harnett, Assistant Professor of ECE, received a 2-year Research Initiation Grant from NSF titled "Can Maker spaces Improve Undergraduates' Research Initiative and Creativity?" Dr. Harnet's Team will be examining how the environment of "maker spaces" (also called "hacker spaces" --community-based engineering and craft workshops) influences undergraduate engineering students' creativity, initiative, and overall ability to make progress on the type of ill-structured problems that are common in the engineering profession. The project award is $150,000 and extends from 1/1/2012 through 12/31/2013. Dr. Harnett also received a grant from the Kentucky Science and Engineering Foundation (KSEF) titled "Emerging Ideas: Light-Powered Hybrid Microactuators for Biotechnology". The award amount is $90,000 and the time period is 2 years beginning 7/1/11. The long-term goal of this project is a system of light-powered microactuators for exploring cells' response to mechanical stimuli. These cellular-scale devices offer potential therapies for heart disease and osteoporosis, and will increase our fundamental understanding of tissue response to everyday mechanical stresses at the molecular level.

Dr. Stuart Williams, Assistant Professor of ME, was awarded in July of 2011 an 2-year $80,000 grant from KSEF entitled "Dielectrophoretic Nano needles for trapping and characterization of sub-cellular entities". This project focuses on the design and fabrication of a coaxial Nano needle that will be used to trap micrometer and nanometer particles. An alternating electric field will be applied across the coaxial electrodes at its tip and produce an electrokinetic force enabling the trapping and manipulation of particles. The goal is to use the Nano needle to characterize sub-cellular biological species like organelles.

Dr. Bruce Alphenaar, Professor of ECE (PI) and Dr. Sergio Mendes, Associate Professor of Physics and Astronomy (Co-PI) received a 3-year, $671,422 NSF MRI grant for the "Development of an Electron State Depletion Microscope at the University of Louisville". The project period is 9/2011 to 8/2014.

Word Search

C	Z	F	S	E	R	W	P	U	S	I	R	E	C	X	D	L	A
E	A	F	A	X	T	U	S	T	Z	E	Q	T	A	B	R	A	P
F	Y	R	G	C	N	A	I	Q	W	U	F	A	L	I	A	R	R
A	G	C	B	A	E	C	N	O	V	A	I	U	C	Z	C	G	O
S	S	L	E	O	K	S	H	O	A	Q	E	C	I	J	L	E	N
A	D	L	O	Y	N	S	H	Z	G	S	H	A	U	C	A	S	B
R	C	S	M	V	Y	D	G	I	H	L	J	V	M	Y	N	P	D
T	P	A	M	T	E	A	I	O	E	I	A	E	G	B	I	I	X
K	T	A	E	P	C	S	E	O	R	L	D	C	L	A	D	L	G
Y	E	F	X	I	A	C	W	Z	X	C	D	T	Y	Q	R	L	A
X	A	V	D	I	O	S	N	E	P	I	G	K	C	A	A	A	P
S	Q	S	W	V	P	P	E	C	T	G	D	Z	O	B	C	I	H
Y	J	G	E	E	Z	K	K	W	D	F	T	E	N	I	P	T	S
Y	O	R	N	N	O	I	T	A	T	S	H	S	A	W	E	Y	E
L	S	H	A	Z	M	A	T	A	L	A	R	M	T	L	B	U	Z
Y	H	O	L	M	D	B	B	O	L	V	Y	I	E	A	A	I	R
M	R	A	L	A	E	R	I	F	M	E	R	C	U	R	Y	R	O
B	J	R	V	D	Z	L	W	E	P	P	M	E	H	U	J	J	M

Lab Safety
By
Caitlin Grothaus

Find the answers in the word search above.

1. Whenever you use a machine, you should _____ your usage by writing down the date, your name and the various parameters of your run.
2. The only writing utensil allowed in the cleanroom are _____
3. Before you leave the cleanroom, the most important thing you can do to make it nice for the person after you is to _____
4. Before you step foot into the gowning room you need to put these over your shoes
5. What do you step on before you enter the cleanroom?
6. To enter, you scan your _____ once. To exit, you scan your _____ twice.
7. The three essential pieces of PPE (Proper Protective Equipment) are: _____, _____ and _____.
8. Before using a chemical you should always read the _____ (abbreviation).
9. Never use _____ in Base or Solvent hoods.
10. If you hear or see the _____, _____ or _____ going off, you should evacuate the building immediately and meet in Lutz Hall's lobby.
11. If someone gets chemical on their body, where should they go to wash it off?
12. The _____ is for someone who gets chemicals in their eyes.
13. You should always wear _____ (abbreviation) when working with chemicals.
14. _____ (chemical name) or _____ (the trade name) is used when someone gets HF (Hydrofluoric Acid) on them.
15. A spill is a _____ if it spreads rapidly, is toxic, endangers people or property, endangers the environment outside of the building, is hydrofluoric acid and/or is more than ½* a gallon of liquid.
16. If a _____ lamp explodes, you should push the HAZMAT alarm and evacuate the cleanroom.
17. When you _____ the cleanroom, you should not try to finish an experiment, you should warn others on your way out and you should not try to figure out why the alarm(s) is sounding. You should not worry about unbunnying and should go straight to Lutz Hall's lobby.
18. The most important thing is for you to be _____ in the cleanroom.

Our Services Include:

Lithography

E-Beam: Raith 150 electron beam system which provides minimum feature sizes of 50nm on substrates up to 150mm in diameter. Equipped with In-lens and SE2 detection modes and provides <50 nm stitching error between write fields.

Photomasks and Direct Write: Heidelberg UV laser patterning system for the generation of photomasks and for direct write onto substrates, including die level. Provides critical dimensions down to 600 nm, substrates up to 9" square substrate direct write to the edge of substrate, and 128 level grayscale.

Contact Lithography: Suss MA6 and AB-M mask aligners provide back-to-front alignment capabilities. For individual dies to whole 6-in. wafers.

Image Reversal: Ammonia based photoresist image reversal systems by YES.

Thin Film Deposition

Plasma Enhanced Chemical Vapor Deposition system: Oxford and STS PECVD systems capable of depositing silicon nitride, silicon dioxide, oxynitride, amorphous silicon (undoped/doped), polycrystalline silicon (undoped/doped), silicon carbide, silicon nanowires, and carbon nanotubes. Oxford tool includes a 700 C high temperature chuck and a TEOS delivery system.

Sputtering: KJL and Technics three and two source systems for deposition of both metals and dielectrics. KJL tool features RF, RF/DC stacking, DC and ion beam assisted sputtering. Includes throttled pressure control and reactive gas mixing.

Evaporation: KJL thermal and e-beam assisted evaporation system for depositing a variety of thin films on substrates up to 6".

Parylene Coating: SCS vapor deposition tool for Parylene C and Parylene N.

Molecular Vapor Deposition: Applied MST MVD system for the deposition of organic surface coatings used as lubricants, anti-stiction layers, molecular glues, reactive adhesion layers, or to change the surface contact angle.

Electroplating: Pulse DC electroplating systems for Cr, Au, Cu and Ni MEMS processing using high aspect resists.

Atomic Layer Deposition: Beneq ALD system for the deposition of Al2O3, SiO2, and ZnO films.

Thermal Processing

Oxidation and Diffusion: Multiple tube furnaces for thermal processes include wet/dry oxidation, high temperature annealing and boron/phosphorous diffusion.

Rapid Thermal Processes: RTP system for silicon based gate oxide growth and rapid thermal annealing of implanted layers.

Vacuum Cure Oven: Programmable vacuum ovens capable of heating to 550C in an inert or forming gas environment. Primarily used for controlled curing of polymer films.

Etching, Machining and Bonding

Deep Reactive Ion Etch (Silicon): STS DRIE tool for silicon deep trench etching using the Bosch process. Has pulsed plate bias to minimize "footing" at oxide etch stops.

Anisotropic Silicon Wet Etching: Extensive experience with KOH, TMAH and EDP wet etchants.

Micro Milling: Dover Instruments ultra-high precision micro-milling CNC tool with nanometer spatial resolution for machining virtually any solid material (e.g., metals, polymers, ceramics, etc.).

Plasma Etching: Multiple RIE systems capable of providing selective silicon, SiO2 and Si3N4 etching, as well as ashing.

Xenon Di-Fluoride Etching: Xactix XeF2 system for efficient anisotropic dry etching of silicon microstructures prone to stiction.

Miscellaneous: Nano-imprinting, micro molding, chemical mechanical polishing, ultrasonic drilling, etc.

Wafer Level Bonding: Suss tool for Si/glass anodic bonding, glass/glass thermal compression bonding and Si/Si fusion bonding. All processes capable of 5um alignment.

Ion Milling: Two source ion beam based etching system capable of nanometer scale etching.

Critical Point Dryer: Critical point CO2 dryer for drying substrates in situations where stiction needs to be avoided.

Packaging

Dicing: Disco programmable saw for dicing silicon, glass and alternative substrates up to 6" diameter.

Wire Bonding: Multiple K&S wedge, ball and deep access bonders for aluminum and gold 1-mil wire bonding.

Flip Chip Packaging: Finetech Fineplacer "pico" system for die placement accuracy up to 5µm. Can handle SMCs up to 17-mm side length.

Printed Circuit Boards: LPKF automated milling system for custom PCBs with a resolution to 100um and hole diameters to 150um. A vacuum table and fiducial recognition camera system ensures precise front-to-back registration. Applications include through-hole and surface mount PCBs, stencils, templates, and engraved panels.

Metrology & Testing

Thin Film Stress Measurement: Toho system using noncontact multi-wavelength surface flatness techniques for evaluating thin film stresses from room temperature to 500C.

3-D Contact Profiling: Veeco system to provide down to 7.5 angstrom step height measurements with a vertical range up to 1 mm and a maximum scan length of 200mm. Low stylus forces allow scratch-free measurement of soft materials.

Noncontact 3D Optical Profiler: Zygo system capable of measuring surface topology of micro scale systems. Includes field stitching and dynamic module for measuring MEMS devices during actuation.

Midwavelength Thermal Imaging System: QFI system for capturing thermal images and videos of devices featuring 0.1C temperature resolution and 5 um spatial resolution.

Ellipsometry: Nondestructive measurement technique for determining the thickness and optical constants of single and multilayer films.

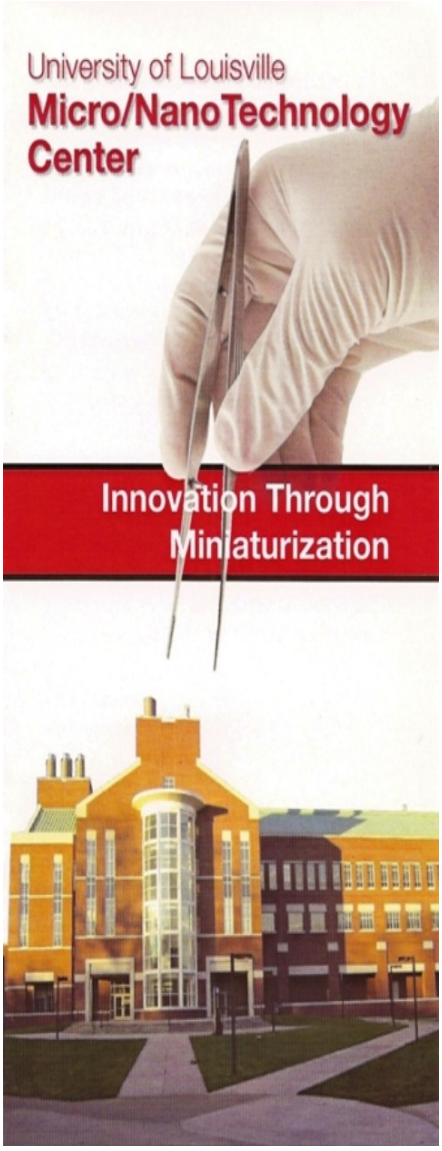
SEM, AFM, STM Capabilities: Dedicated SEM and AFM laboratory. Preferred access to multiple Zeiss and Leo SEMs including field emission, EDAX, variable chamber pressure, active specimen measurements and manipulation.

Testing: Suite of probe stations and electronic test instruments for measuring sheet resistance, TCR, I-V curves, C-V curves, and device performance.

Miscellaneous: Nano-imprinting, micro molding, chemical mechanical polishing, ultrasonic drilling, etc.

Design, Layout and Modeling

Full suite of computer-based tools for photo mask layout, custom analog and digital IC design, micro-scale tooling, and 2D/3D finite element models for virtual device evaluation. Software packages include: Tanner EDA, Silvaco TCAD, CoventorWare®, Solid Edge.



For more information on available services contact:

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Assoc. Director: Dr. Shamus McNamara, Associate Professor of ECE

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Dr. Julia Aebersold, Process Engineer

Mike Martin, Process Engineer

Dr. George Lin, Process Engineer

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Mahendra Sunkara

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John Naber
Kevin Walsh

Mechanical Engineering
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Roger D. Bradshaw
Balaji Panchapakesan
Stuart Williams

The University of Louisville Micro/NanoTechnology Center (MNTC) provides state-of-the-art fabrication and design services for numerous MEMS, microelectronic, electro-optic and nanotechnology applications. Services begin at the device design level and continue through single-step processing, complete device prototyping and small-scale production. The center encompasses core facilities for micro/nano fabrication, packaging, metrology & test, including a 10,000 sq. ft., 7-bay, class 100/1000 cleanroom. Our wide variety of micro/nano processing tools and 10-plus years of operating experience make our AGI-designed facility popular not only with researchers at UofL and other universities throughout the Ohio Valley region, but with industry and government laboratories nationwide, too. Several multi-million dollar grants from federal agencies support the research carried out in the MNTC including grants from NSF, NIH, DOD, DOE, NASA, and industry. The MNTC is housed in a 120,000 sq. ft. interdisciplinary research building and it allows UofL researchers to use a wide range of equipment and processes to fabricate, package, and test next-generation micro/nano devices and systems. The cleanroom is also a catalyst for start-up businesses and has had a positive impact on the technological economy of the Commonwealth of Kentucky.

http://louisville.edu/micronano