Microsystems and Nanotechnology Research Group
The University of British Columbia

Annual Report – 2008

Microsystems and Nanotechnology
Research Group

1 About the MiNa Group

We are:

- A leading-edge research group, engaged in many areas of microsystems and nanotechnology
- Distinguished by our level and range of expertise
- Driven by the potential impacts on society and the environment
- Actively looking to attract high quality students and engage industry partners in advancing research

We are engaged in many areas of microsystems and nanotechnology, with a particular focus on devices and systems, experimentation and fabrication. Applications of MiNa research span over many areas, including biomedical devices, nano-computing, nano-devices, communication, energy, sensors and actuators.

Areas of MiNa Application:

- **Bio-medical devices**: lab-on-a-chip, single-cell characterisation, micro-electrode arrays for neural implants, scaffolds for tissue engineering, implantable devices such as stents wireless cardiac monitoring using artery-implanted stents, MEMS devices for navigated surgery, hearing-aid prosthesis, MEMS ultrasound imaging, bio-photonics, DNA sequencing, targeted drug delivery.
- **Nano-devices and computing**: carbon nanotube devices, nano- and organic electronics, silicon nanowire gate-all-around transistors, nanowire memory devices, nanoscale electron emitters, nanocomputing using quantum cellular automata, Schroedinger-Poisson solvers for nanotransistors, SiGe materials and devices, process modeling and simulations.

- **Energy**: super-capacitors based on nano-structured (polymer, nanotube) materials, nanowire and nano-composite solar cells, nanowire electrodes for batteries and energy storage.
- **Optical communications**: high frequency optical modulators, fiber communication, and semiconductor laser, vertical cavity lasers, photonics.
- **Sensors and actuators**: fiber optic high-voltage electric-field sensors, nanowire and nanocomposite sensors, plastic health monitoring devices, artificial muscles, adaptive MEMS sensors and actuators.
- **Development of Micro- and Nano-fabrication Technologies**: including controlled nanofabrication, inkjet micro-fabrication, 3D fabrication by micro-electro-discharge machining, catalytic chemical vapor deposition of carbon nanotubes, nanowire (silicon, germanium) growth, nanocomposite inks for inkjet printing, stamping and electrospinning, high resolution lithography and microscopy, microfluidic devices.

MiNa is a dedicated team of visionary and exploratory researchers from the departments of Electrical and Computer Engineering (ECE), Mechanical Engineering (ME), Chemical and Biological Engineering (CHBE), Materials Engineering (MTRL) and Physics and Astronomy (PHYS). A number of us are also members of ICICS – the Institute for Computing, Information and Cognitive Systems. MiNa holds collaboration as a core value; this is reflected in the fact that 25% of the group's publications have at least two MiNa faculty members as co-authors.

The MiNa group is currently well funded, with an annual NSERC Discovery Grant budget of **$489,320**, **$10,892,414** in current project grants (e.g. NSERC Strategic Grants), and **$3,494,862** in recent equipment grants.

Group Members:

Faculty Members	Department	Expertise, Research Interests
Karen Cheung	ECE	BioMEMS, microelectrodes, lab-on-a-chip
Mu Chiao	ME	MEMS, BioMEMS
Lukas Chrostowski	ECE	Semiconductor Lasers, VCSELs, Photonics
Edmond Cretu	ECE	MEMS, adaptive microsystems
Carl Hansen	PHYS	Microsystems Technology for Biological Applications
Andre Ivanov	ECE	Nanoelectronics Design for Manufacturability, SoC
Nicolas Jaeger	ECE	Integrated Optics, Photonics
Frank Ko	MTRL	Nanofibres, Biomaterials
Eric Lagally	CHBE	Integrated microsystems for cells & molecule biology
John Madden	ECE	Molecular Mechatronics
Alireza Nojeh	ECE	Nanostructures and nanodevices, Carbon Nanotubes
David Pulfrey	ECE	Nanoelectronics, Carbon Nanotubes
Peyman Servati	ECE	Nanowires, Nanocomposites, Nanoelectronics
Boris Stoeber	ME, ECE	MEMS, Microfluidics
Kenichi Takahata	ECE	MEMS, Fabrication, Implantable microdevices
Shuo Tang	ECE	Biophotonics, OCT/MPM imaging
Konrad Walus	ECE	Nanoelectronics, Quantum-Dot devices, sensors
Guangrui Xia	MTRL	Nanomaterials, Simulation and modeling, CMOS

2 Equipment Available

Equipment	Investigators	Description
Micro- Nano- Fabrication Equipment		
XeF2 Silicon Etcher	M. Chiao	
Critical Point Dryer	L. Chrostowski	Release of NEMS/MEMS structures
Microdrop Inkjet System	K. Walus	
Parylene coater	K. Takahata	
Lapping machine	K. Takahata	
Dicing saw	N. Jaeger	
Chemical Vapour Deposition Furnaces	P. Servati	For growth of nanowires and nanostructures
Chemical Vapour Deposition (CVD) furnace	A. Nojeh	For growth of Carbon Nanotubes
Thermal and electron-beam evaporator	AN, KT, EC, PS	
CNC mill	E. Lagally	For drilling holes (100 um dia.) in glass and silicon
Headway spinner	AN, KT, EC, PS	for resist deposition
Laurell spinner	K. Cheung, B. Stoeber	for resist deposition
Laurell EDC system for controlled wet etch	EL, LC, KC, BS	
Glove box	A. Nojeh	
Glove box	J. Madden	With a thermal metal evaporator
Mammalian cell culture: biosafety cabinet, incubator, centrifuge	K. Cheung, B. Stoeber	
Bacterial pathogen Biosafety level 2 lab	E. Lagally	Incubators, biosafety cabinets, and aerobic/anaerobic culture equipment
Characterization Equipment		
Atomic Force Microscope	J. Madden	
Philips 525 scanning electron microscope	AN, KT, EC, PS	
Laser Doppler Vibrometer	M. Chiao	
Optical Profiler, Wyko NT1100	B. Stoeber	
MEMS Probe Station	M. Chiao	
Cryogenic Vacuum Probestation	P. Servati	For electro-optical measurements on nanoscale devices (6 probe heads)
Inverted Fluorescence Microscope	M. Chiao	

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Equipment	Investigators	Description
Inverted Epifluorescence Microscope	K. Cheung	
Confocal microscope	K. Cheung, B. Stoeber	
High sensitivity color camera	K. Cheung	for single molecule detection
High speed camera (100,000 frames/s)	K. Cheung, B. Stoeber	
Fluigent pressure flow control system	K. Cheung, B. Stoeber	
Micro PIV system	B. Stoeber	Measurement of flow field in microfluidic devices
Ultra-high vacuum test chamber with electron source and detector	A. Nojeh	Multipurpose
Photonics		
Spectra-Physics Beamlok Gas	A. Nojeh	Ar Ion visible laser
Spectra-Physics WaveTrain	A. Nojeh	frequency doubler for UV generation
Coherent Verdi solid-state green laser	A. Nojeh	
Coherent Verdi-310	L. Chrostowski	Argon Ion visible laser
Optical Spectrum Analyzers	N. Jaeger	Ando AQ6317B, HP, Agilent 86146B, 2 wavelength meters
Monochromator	L. Chrostowski	Oriel Cornerstone 260 1/4m
Optical Amplifiers	L. Chrostowski, N. Jaeger	IPG Photonics 2W, Oprel, Avanex
Tunable Lasers	N. Jaeger	3 HP 8164A with 81682A tunable C-band plug-ins
Lightwave Signal Analyzer	N. Jaeger	HP 71401c (to 2.9 GHz), HP 71400c (to 20 GHz)
Electrical Test and Measurement Equipment		
Electrometer	A. Nojeh	Keithley 6517A
Sub-fempto-amp meter	A. Nojeh	Keithley 6430
Vector Network Analyzer	L. Chrostowski	Agilent E8361A, 67 GHz
Vector Network Analyzer	N. Jaeger	Agilent 8510C, 50 GHz
Anristu 12.5 Gb/s Bit Error Rate Test-set	N. Jaeger	
Keithley 4200 SCS/PIV semiconductor characterization	P. Servati	Low noise DC/pulsed electrical measurement
Semiconductor Parameter Analyzers	L. Chrostowski	5 Keithley 2602
Nortel OpTera OC-192 switches	N. Jaeger	
FPGA Development stations	E. Cretu (CMC)	with FPGA-MEMS interface module

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Equipment	Investigators	Description
Agilent 54845 Digital Storage Oscilloscope	A. Nojeh	4 Channel, 1.5GHz
Agilent Arbitrary Waveform Generators	K. Walus, B.Stoeber	2X 80 MHz
Agilent Oscilloscopes	K. Walus, B.Stoeber	2X 300 MHz
Agilent Sampling Oscilloscope	N. Jaeger	40 GHz
RF Signal Generators	N. Jaeger	For signals up to 60 GHz: various synthesizers (20 GHz) with HP 8341B frequency multipliers, 20 and 65 GHz microwave amplifiers
Electrical Spectrum Analyzer	N. Jaeger	Tektronics 494p, up to 21 GHz with mixers to 40 GHz.
Impedance analyzer: Agilent 4294A	K. Cheung	
Lock-in amplifiers	K. Cheung	SR844
Lock-in amplifier	L. Chrostowski	SR810
Temperature Controllers	L. Chrostowski	Newport 3040, ILX 5910B

2.1 Computing Resources Available

Software	PI	Description
Dell Computer Cluster	K. Walus	160 Processor Cores
MEMS Pro	E. Cretu (CMC)	
Coventorware	E. Cretu (CMC)	
Ansys	E. Cretu (CMC)	
Comsol Multi-Physics	K. Walus, K.Cheung, B.Stoeber	Finite-element modeling
Matlab	ECE, UBC	
LabView	UBC	
Lumerical FDTD	L. Chrostowski	Optical simulations
Crosslight PICS3D	L. Chrostowski	Optoelectronics simulations
Synopsys Sentaurus Device	D. Pulfrey, L. Chrostowski (CMC)	Optoelectronics, Nanoelectronics simulations
CleWin	K.Cheung, B.Stoeber	Mask layout
Design Workshop dw-2000	L.Chrostowski (CMC)	Mask layout

2.2 AMPEL Nanofabrication Laboratory

This is a shared facility for the fabrication and characterization of advanced materials and devices. The laboratory is shared on a continual basis by 20 faculty and 60 students from UBC as well as about 6 faculty and a dozen students from SFU and UVic. Occasional users also come from other academic institutions and local small industry (eg. Angstrom Power, Ballard). The AMPEL Nanofabrication Facility is a fee-based service laboratory open to UBC and outside users. The facility is subsidized by an NSERC MFA grant, and provides highly reduced fee access for academic users.

The cleanroom consists of a gowning room, a class 1000 lithography room (35 m^2), a class 10000 thin-film room (48 m^2), and a class 10000 thin-film / metrology room (50 m^2). The cleanrooms are equipped for most micro- and nano-fabrication needs.

The lithography room houses 2 wetbenches, with equipment to spin on photoresist and perform wet chemistry, two mask aligners (3 inch masks front align only and 4 inch masks with backside alignment) and a Nomarski microscope equipped with a CCD camera and computer capture. It also houses a Scanning Electron Microscope (SEM) that has been programmed for electron-beam (e-beam) lithography. Also available in the yellow room is a dry clean bench, typically used for sample cleaving and preparation, and storage cabinets for the wet chemistry dishware.

The thin-film room houses a state of the art Electron Cyclotron Resonance (ECR) plasma etcher, with the following gases: Cl_2, BCl_3, O_2, Ar, He. It also houses equipment for sputter, e-beam and thermal evaporation of metals and dielectrics, a Plasma Enhanced Chemical Vapor Deposition (PECVD) system for deposition of SiO_2 and SiN films and also usable as a reactive ion etcher (RIE) using CF_4 and O_2 chemistry, two Rapid Thermal Annealling (RTA) ovens, a few conventional dry N_2 atmosphere ovens, a Reactive Ion Etching (RIE) chamber with CH_4, a XeF_2 etcher for Micro-Electro-Mechanical-Systems (MEMS) applications, a travelling probe alpha-step profilometer, and a wire bonder.

The class 10000 thin-film / metrology room is used for the following equipment: two thermal oxidation furnaces, and a Reactive Ion Etching (RIE) chamber with CF_4, O_2, N_2, Ar, He gases. There is room for expansion for new equipment in this room.

3 Grants

3.1 MiNa Member Grants: Basic funding

Granting Agency	Subject	Year	Investigator
NSERC Discovery Grant	BioMEMS: on-chip cell culture and characterization; implantable flexible neural arrays	2006–2009	K. Cheung
NSERC Discovery Grant	Anti-biofouling nanoporous membrane for implantable devices	2004–2009	M. Chiao
NSERC Discovery Grant	Optical Injection Locking of Vertical Cavity Surface Emitting Lasers	2005–2010	L. Chrostowski
NSERC Discovery Grant	Synergic Inertial Microsystems for Bio-Medical Applications	2006-2010	E. Cretu
NSERC Discovery Grant	Two-Phase Microfluidics	2008–2009	C. Hansen
NSERC Discovery Grant	Infrastructure Intellectual Property (IP) for Systems on Chip (SoCs)	2004–2009	A. Ivanov
NSERC Discovery Grant	Novel optical sensors and ultrahigh-speed optical modulators	2004–2008	N. Jaeger
NSERC Discovery Grant	Parallel Microsystems for Affinity Reagent Selection	2007–2010	E. Lagally
NSERC Discovery Grant	High Energy Density Actuators	2008–2013	J. Madden
NSERC Discovery Grant	Controllable nanoscale electron emitters	2007–2011	A. Nojeh
NSERC Discovery Grant	Deep sub-micron integrity issues	2004–2007	D. Pulfrey
NSERC Discovery Grant	Morphologically Engineered Silicon Nanowire Devices	2007–2011	P. Servati
NSERC Discovery Grant	Thermally responsive polymer solutions - flow physics of complex microflows and microflow control	2006–2010	B. Stoeber
NSERC Discovery Grant	Implantable Wireless Microdevices for Pinpoint Diagnosis and Therapy	2006–2010	K. Takahata
NSERC Discovery Grant	Multi-Modality Optical Imaging in Tissues Using Ultrafast Lasers	2007–2011	S. Tang
NSERC Discovery Grant	Quantum-dot Cellular Automata Circuits	2006–2010	K. Walus
TOTAL	**$489,320**	in 2008	

3.2 MiNa Member Grants: Research Projects

Granting Agency	Subject	Year	Investigators
NSERC Strategic	Ultrasonic medical imaging system using capacitive micromachined transducer array	2008–2009	E. Cretu, S. Mirabbasi, R. Rohling, S. Salcudean
NSERC Strategic	MEMS based drug delivery devices	2007–2010	M. Chiao, S. Mirabbasi, R. Rohling, Burt
NSERC Strategic	High-speed transistor-VCSELs for Optical Communications	2007–2010	L. Chrostowski, D. Plant, D. Pulfrey, N. Jaeger
NSERC Strategic	Supercapacitors for Power Quality and Energy Storage	2006–2009	J. Madden, MacLachlan, M. Wolf, Michal
NSERC Strategic	Forward viewing Doppler optical coherence tomography with artificial muscle actuation	2006–2009	V. Yang, J. Madden, G. Wright
NSERC Strategic	Autonomous flow-following smart sensors for deployment of multiphase chemical reactors	2006–2009	C. Bennington, S. Mirabbasi, M. Chiao, J. Madden
BC Innovation Council	High-Speed Microring Lasers	2008–2010	L. Chrostowski
US Dept. of Defense	Microfluidic Prostate Cancer Biosensors	2008–2011	E. Lagally, Y. Xiao, K. Plaxco
Canadian Lung Association	Integrated microsystems for electrokinetic detection of *Mycobacterium tuberculosis*	2008–2009	E. Lagally, P. Tang
Canadian Diabetes Association	Demonstration of Glucose Monitoring using Vertical Cavity Lasers	2008–2010	L. Chrostowski
CIHR Team Grant	Microfluidic Technologies to Accellerate Stem Cell Research	2007–2011	C. Hansen, et. al.
CIHR NSERC CHRP	U-STAR: Universal Sequence-Tag Array Technology for Absolute Quantification of Per Cell Transcript Profiles in Eukaryotic Organisms	2006–2009	C. Haynes, M. Blades, R. Turner, L. Chrostowski

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Granting Agency	Subject	Year	Investigators
CIHR NSERC CHRP	Microfluidic technologies for high-throughput monoclonal antibody production	2008–2011	J. Schrader, C. Hansen
MSFHR	Career Investigator Award	2007–2013	C. Hansen
MSFHR	Team for Monitoring and Control of Abnormal Brain Dynamics	2007–2010	M. McKeown, E. Cretu, et.al
Semiconductor Research Corp.	Combining Formal Analysis, Architectural Features, and Circuit Structures for Post-Silicon Debugging	2007–2010	A. Hu, A. Ivanov, S. Wilton, T. Aamodt
UBC Martha Piper Fund		2008	K. Walus
BC Clean Air Research Fund	Identification and Monitoring of Airborne Volatile Organic Compounds (VOCs)	2008-2010	K. Walus, B. Stoeber
CIHR Catalyst	Microfluidic Instrumentation for High-Throughput Proteomics Using MALDI Mass Sepctrometry	2006-2008	C. Hansen, C. Haynes
CIHR Tools	Megapixel PCR with application to non-invasive prenatal diagnostics	2008–2011	C. Hansen
Genome Canada Technology Development	Towards Single Cell Genomics	2008-2010	C. Hansen, M. Marra
TOTAL	**$10,892,414**		

3.3 MiNa Member Grants: Equipment

Granting Agency	Subject	Year	Investigators
CFI/BCKDF - LOF	Enabling Advances in Healthcare and Biomedical Research: Microfluidics Concepts for Innovative Bioanalysis Methods	2007–2011	K. Cheung, B. Stoeber
CFI/BCKDF - LOF	Molecular Diagnostics	2007–2011	E. Lagally
CFI/BCKDF - LOF	Laboratory for carbon nanotube-based turnstile vacuum nanoelectronics	2007–2011	A. Nojeh
CFI/BCKDF - LOF	Nanowire and Nanostructured Device Characterization Laboratory	2007-2011	P. Servati
CFI/BCKDF - LOF	NanoSystems Laboratory for Optical Clocking of Quantum-Dot Cellular Automata Circuits	2006–2010	L. Chrostowski, K. Walus
CFI/BCKDF - LOF	Infrastructure for MEMS fabrication and characterization	2004-2008	M. Chiao
NSERC RTI	Advanced fabrication infrastructure for integrated microsystems	2008	E. Lagally, K. Cheung, B. Stoeber, A. Nojeh, L. Chrostowski
NSERC RTI	Metrology, etching and contact annealing tools for fabrication of microsystems and nanotechnology devices	2008	L. Chrostowski, et. al.
NSERC RTI	Characterizing Wet Materials and Actuators	2008	J. Madden, F. Ko
NSERC RTI	Three-dimensional nanomanipulation, gating and probing of nanostructures in ultra high vacuum	2008	A. Nojeh, P. Servati, E. Cretu
Western Economic Development	Toward Single-Cell Genomics	2008–2009	C. Hansen, M. Marra
TOTAL	**$3,494,862**		

MiNa Patents and Publications, 2008

[1] J. D. Bull, A. R. Reid, and N. A. F. Jaeger, "Method and apparatus for enhancing the extinction ratio in mode converters," US Patent 7,330,611, 2008.

[2] B. Stoeber, S. Zimmermann, D. Liepmann, and A. Pisano, "Monitoring method and/or apparatus," US Patent 7,415,299, 2008.

[3] R. A. Mathies, W. H. Grover, B. Paegel, A. Skelley, E. T. Lagally, C. N. Liu, , and R. Blazej, "Fluid control structures in microfluidic devices," US Patent 7,445,926, 2008.

[4] F. Balagadde, C. Hansen, E. Kartalov, and S. Quake, "Microfluidic chemostat," US Patent 7,407,799, 2008.

[5] C. L. Hansen, M. Sommer, and S. Quake, "Microfluidic protein crystallization," US Patent 7,459,022, 2008.

[6] J. Liu, C. Hansen, and S. Quake, "Microfluidic rotary flow reactor matrix," US Patent 7,413,712, 2008.

[7] S. R. Quake, C. L. Hansen, and J. Berger, "High throughput screening of crystallization of materials," US Patent 7,326,296, 2008.

[8] A. Nojeh, "Electron-induced field-emission from carbon nanotubes," in *Particles*, Orlando FI, USA, 2008.

[9] A. Nojeh, K. Ioakeimidi, S. Sheikhaei, and R. F. W. Pease, "Photoemission from single-walled carbon nanotubes," *Journal of Applied Physics*, vol. 104, pp. 054 308–1 – 054 308–6, 2008.

[10] A. Nojeh, P. Pande, A. Ganguly, S. Sheikhaei, B. Belzer, and A. Ivanov, "Reliability of wireless on-chip interconnects based on carbon nanotube antennas," in *14th International Mixed-Signals, Sensors and Systems Test Workshop (IMS3TW)*, Vancouver BC, Canada, 2008.

[11] F. Khademolhosseini, R. K. N. D. Rajapakse, and A. Nojeh, "Torsional buckling of carbon nanotubes using a non-local elastic thin-shell model," in *45th Annual Technical Meeting of the Society of Engineering Science*, University of Illinois at Urbana-Champaign, IL, USA, 2008.

[12] J. M. Michan, K. Walus, and A. Nojeh, "Numerical simulation of electron field-emission from carbon nanotubes," in *Cascadia Nanotechnology Symposium*, Vancouver BC, Canada, 2008.

[13] P. P. Pande, A. Ganguly, B. Belzer, A. Ivanov, and A. Nojeh, "Novel interconnect infrastructures for massive multicore chips," in *IEEE International Symposium on Circuits and Systems (ISCAS)*, Seattle WA, USA, 2008.

[14] P. Yaghoobi, A. Nojeh, and K. Walus, "Negf modeling of electron-stimulated field-emission from single-walled carbon nanotubes," in *Cascadia Nanotechnology Symposium*, Vancouver BC, Canada, 2008.

[15] S. M. Chandani, A. Kulpa, and N. A. F. Jaeger, "Correction to 'nondestructive determination of cladding thickness in d-fibers'," *IEEE Photonics Technology Letters*, vol. 20, p. 384, 2008.

[16] S. M. Chandani and N. A. F. Jaeger, "Refractive index sensor based on etched d-fibers with wavelength adjustable operating point and resolution," in *Proceedings of the SPIE*, vol. 7099, 2008, pp. 709 924–1 to 709 924–12.

[17] J. D. Bull, H. Kato, and N. A. F. Jaeger, "Asymmetrically strained ridge waveguide for passive polarization conversion," *IEEE Photonics Technology Letters*, vol. 20, pp. 2186–2188, 2008.

[18] G. B. Abadir, K. Walus, R. F. B. Turner, and D. L. Pulfrey, "Biomolecular sensing using carbon nanotubes: A simulation study," *International Journal of High Speed Electronics and Systems*, vol. 18, pp. 879–887, 2008.

[19] B. Faraji, W. Shi, D. L. Pulfrey, and L. Chrostowski, "Small-signal modeling of the transistor laser in common-emitter and common-base configurations," in *IEEE Lasers and Electro-Optics Society, 21st Annual Meeting*, 2008, pp. 681–682, http://www.mina.ubc.ca/files/leos2008.pdf.

[20] M. S. K. Cretu, "Noise-based optimisation and noise analysis for resonant mems structures," in *Symposium on Design, Test, Integration and Packaging of MEMS/MOEMS*, Nice, France, 2008.

[21] W. Shi, B. Faraji, and L. Chrostowski, "Numerical study of a transistor vertical cavity surface emitting laser," in *Pacific Centre for Advanced Materials and Microstructures (PCAMM) Annual Meeting*, 2008.

[22] M. ngel Guilln Torres, N. Rouger, R. Vafaei, S. M. Amin, R. Boeck, B. Faraji, B. Francis, A. Kulpa, J. M. Michaan, L. Chrostowski, N. Jaeger, and D. Deptuck, "Soi nanophotonic devices analysis and fabrication," in *Pacific Centre for Advanced Materials and Microstructures (PCAMM) Annual Meeting*, 2008.

[23] F. Karim and K. Walus, "The characterization of the displacement tolerance of qca circuits," in *Nano Devices, Circuits and Systems 2008 (NDCS'08)*, 2008, pp. 49–53.

[24] A. Ahnood, P. Servati, F. Li, A. Nathan, and A. Sazonov, "Extraction of non-ohmic contact resistance in nanocrystalline silicon thin film transistors," in *Material Research Society (MRS) Spring Meeting. Symposium A: Amorphous and Polycrystalline Thin-Film Silicon Science and Technology*, San Francisco, CA, 2008.

[25] P. Beecher, P. Servati, A. Rozhin, A. Colli, V. Scardaci, S. Pisana, G.-W. Hsieh, A. Fasoli, D. Chu, F. Li, A. Nathan, B. Ong, A. Flewitt, J. Robertson, A. Ferrari, and W. Milne, "Ink-jet printing of carbon nanotube-based thin film transistors," in *Material Research Society (MRS) 2008 Spring Meeting, Symposium P: Carbon Nanotubes and Related Low-Dimensional Materials*, 2008.

[26] A. Fasoli, A. Colli, P. Beecher, P. Servati, S. Pisana, Y. Fu, A. Flewitt, W. Milne, J. Robertson, C. Ducati, S. D. Franceschi, S. Hofmann, and A. Ferrari, "Thermal and chemical vapor deposition of si nanowires: Shape control, electrical properties and dispersion," in *Material Research Society (MRS) Spring Meeting. Symposium O: Semiconductor Nanowires - Growth, Physics, Devices, and Applications*, San Francisco, CA, 2008.

[27] V. Bazargan and B. Stoeber, "Formation of temporary separating walls in microfluidic devices," in *6th ASME International Conference on Nanochannels, Microchannels, and Minichannels*, Darmstadt, Germany, 2008.

[28] K. Takahata and Y. Gianchandani, "Micromachined capacitive pressure sensor using a cavity-less structure with bulk-metal/elastomer layers and its wireless telemetry application," *Sensors*, vol. 8, pp. 2317–2330, 2008.

[29] V. Sridhar and K. Takahata, "A hydrogel-based wireless sensor using micromachined variable inductors with folded flex-circuit structures for biomedical applications," in *21st IEEE International Conference on Micro Electro Mechanical Systems*, 2008, pp. 70–73.

[30] K. Takahata and Y. Gianchandani, "A cavity-less micromachined capacitive pressure sensor for wireless operation in liquid ambient," in *Proc. Solid-State Sensor, Actuator and Microsystems Workshop*, 2008.

[31] C. Chaitanya and K. Takahata, "Micro-electro-discharge machining by mems actuators with planar electrodes microfabricated on the work surfaces," in *21st IEEE International Conference on Micro Electro Mechanical Systems*, 2008, pp. 375–378.

[32] M. Rafiq, Z. Durrani, H. Mizuta, A. Colli, P. Servati, A. Ferrari, W. Milne, and S. Oda, "Room temperature single electron charging in single silicon nanochains," *JOURNAL OF APPLIED PHYSICS*, vol. 103, p. 053705, 2008 2008.

[33] G. Abadir, K. Walus, R. Turner, and D. Pulfrey, "Effect of single-biomolecule adsorption on the electrical properties of short carbon nanotubes," in *IEEE Conference on Nanotechnology*, 2008, pp. 230–232.

[34] F. Karim, A. Navabi, K. Walus, and A. Ivanov, "Quantum mechanical simulation of qca with a reduced hamiltonian," in *IEEE Nano*, Arlington, Texas, 2008, pp. 327–330.

[35] B. Mustin and B. Stoeber, "Design considerations for robust suspension-based microfluidic systems for biomedical applications," in *14th IEEE International Mixed-Signals, Sensors, and Systems Test Workshop*, Vanvouver, BC, Canada, 2008.

[36] F. Karim, K. Walus, and A. Ivanov, "Testing of combinational majority and minority logic networks," in *International Mixed-Signals, Sensors and Systems Test Workshop 2008 (IMS3TW'08)*, 2008, pp. 1–6.

[37] W. Shi, L. Chrostowski, and B. Faraji, "Voltage controlled operation of a transistor vertical cavity surface emitting laser," in *IEEE 21st International Semiconductor Laser Conference*, 2008, pp. 89–90.

[38] V. Bazargan and B. Stoeber, "Moving temporary wall in microfluidic devices," *Physical Review E*, vol. 78, p. 4, 2008.

[39] W. Shi, L. Chrostowski, and B. Faraji, "Numerical study of the optical saturation and voltage control of a transistor vertical cavity surface emitting laser," *IEEE Photonics Technology Letters*, vol. 20, pp. 2141–2143, 2008.

[40] E. Ouellet, C. Lausted, L. Hood, and E. Lagally, "Parallel microfluidic arrays for spri detection," in *SPIE Optics and Photonics*, vol. 7035, San Diego, CA, USA, 2008, pp. 703 505–1.

[41] E. Beheshti, A. Nojeh, and P. Servati, "Atomistic simulation of hydrogen adsorption in single-walled carbon nanotubes," in *Pacific Centre for Advanced Materials and Microstructures (PCAMM) Annual Meeting*, 2008.

[42] A. Ahnood, K. Ghaffarzadeh, A. Nathan, P. Servati, F. Li, M. Esmaeili-Rad, and A. Sazonov, "Non-ohmic contact resistance and field-effect mobility in nanocrystalline silicon thin film transistors," *APPLIED PHYSICS LETTERS*, vol. 93, p. 163503, 2008.

[43] A. Takshi, M. Mohammadi, and J. D. Madden, "Study the effect of distribution of density of states on the depletion width of organic schottky contacts," *Solid-State Electronics*, vol. 93, p. 5, 2008.

[44] B. Faraji, W. Shi, D. L. Pulfrey, and L. Chrostowski, "Common-emitter and common-base small-signal operation of the transistor laser," *Applied Physics Letters*, vol. 93, p. 143503, 2008. [Online]. Available: http://link.aip.org/link/?APL/93/143503

[45] L. Chrostowski, Q. Gu, W. Hofmann, and M.-C. Amann, "High-speed bi-directional communication using optically injection-locked semiconductor lasers," in *IEEE 19th Annual Workshop on Interconnections within High Speed Digital Systems*, 2008.

[46] C. Siu and M. Chiao, "A microfabricated PDMS microbial fuel cells," *IEEE/ASME Journal of Microelectromechanical Systems*, vol. 17, pp. 1329–1341, 2008.

[47] M. A. Guilln-Torres, M. Sharma, K. Parsa, Y. Zeng, L. Chrostowski, and E. Cretu, "Optical readout for in-plane micro displacements," in *Pacific Northwest Microsystems and Nanotechnology Meeting (PANOMINO)*, University of Washington Friday Harbor Labs, Friday Harbor, WA, USA, 2008.

[48] T. Shoa, J. D. Madden, C.-W. E. Fok, and T. Mirfakhrai, "Rate limits in conducting polymers," *Advances in Science and Technology*, vol. 61, pp. 26–33, 2008.

[49] B. Faraji, D. L. Pulfrey, and L. Chrostowski, "Small-signal modelling of the transistor laser including the quantum capture and escape lifetimes," *Applied Physics Letters*, vol. 93, p. 103509, 2008. [Online]. Available: http://link.aip.org/link/?APL/93/103509

[50] T. Mirfakhrai, R. Krishna-Prasad, A. Nojeh, and J. D. W. Madden, "Electromechanical actuation of single-walled carbon nanotubes: an ab initio simulation study," *Nanotechnology*, vol. 19, pp. 315 706–315 714, 2008.

[51] P. Servati, J. Mertens, E. Beheshti-Zavareh, S. Ebadian, X. Xu, and F. Ko, "Nanowires and nanotubes as materials for novel photovoltaic devices," in *Micro Nano Breakthrough Conference (MNBC)*, Vancouver, WA, 2008. [Online]. Available: http://oregonstate.edu/conferences/MNBC/

[52] T. Mirfakhrai, J. Oh, M. Kozlov, E. C. W. Fok, M. Zhang, S. Fang, R. Baughman, and J. Madden, "Carbon nanotube yarns as high load actuators and sensors," *Advances in Science and Technology*, vol. 61, pp. 65–74, 2008.

[53] G. Hsieh, P. Beecher, F. Li, P. Servati, A. Colli, A. Fasoli, D. Chu, A. Nathan, B. Ong, J. Robertson, A. Ferrari, and W. Milne, "Formation of composite organic thin film transistors with nanotubes and nanowires," *Physica E*, vol. 40, pp. 2406–2413, 2008.

[54] Z. Ren, G. Pei, J. Li, F. Yang, R. Takalkar, K. Chan, G. Xia, Z. Zhu, A. Madan, T. Pinto, T. Adam, J. Miller, A. Dube, L. Black, J. W. Weijtmans, B. Yang, E. Harley, A. Chakravarti, T. Kanarsky, I. Lauer, D.-G. Park, D. Sadana, , and G. Shahidi, "Pdsoi nmosfets with embedded phosphorus-doped sic stressors for cmos technology," in *IEEE Symposium on VLSI Technologies*, 2008.

[55] E. Kymakis, P. Servati, E. Koudoumas, and G. Amaratunga, "Carbon nanotubes and nanohorns for organic photovoltaics," in *SPIE Photonics Europe: Organic Optoelectronics and Photonics*, vol. 6999, Strasbourg, France, 2008.

[56] S. T. Fard, W. Hofmann, P. T. Fard, G. Bohm, M. Ortsiefer, E. Kwok, M.-C. Amann, and L. Chrostowski, "Optical absorption glucose measurements using 2.3 μm vertical cavity semiconductor lasers," *IEEE Photonics Technology Letters*, vol. 20, pp. 930–932, 2008, http://ieeexplore.ieee.org/iel5/68/4509497/04515989.pdf?tp=&isnumber=&arnumber=4515989.

[57] R. Hoskinson and B. Stoeber, "High-dynamic range image projection using an auxiliary mems mirror array," *Optics Express*, vol. 16, pp. 7361–7368, 2008.

[58] L. Chrostowski and W. Shi, "High-speed, monolithically injection-locked micro-ring semiconductor lasers," *IEEE Journal of Lightwave Technology*, vol. 28, pp. 3355–3362, 2008. [Online]. Available: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4738526&isnumber=4738524

[59] Q. Gu, W. Hofmann, M.-C. Amann, and L. Chrostowski, "Optically injection-locked vcsel for bi-directional optical communication," in *The Conference on Lasers and Electro-Optic*, San Jose, California, USA, 2008, p. CMW6.

[60] ——, "Optically injection-locked vcsel as a duplex transmitter/receiver," *IEEE Photonics Technology Letters*, vol. 20, pp. 463–465, 2008. [Online]. Available: http://www.mina.ubc.ca/files/QingPTL2008.pdf

[61] S. Ebadian and P. Servati, "Embedding nanowires and nanotubes for effective carrier extraction in polymer photovoltaic devices," in *Cascadia Nanotech*, Vancouver, BC, Canada, 2008.

[62] X. Xu, A. Nojeh, and P. Servati, "Effect of surface passivation on electronic properties of silicon nanowires," in *Cascadia Nanotech*, 2008.

[63] E. B. Zavareh, A. Nojeh, and P. Servati, "Quantum simulation of hydrogen adsorption effects in single-walled carbon nanotubes," in *Cascadia Nanotech*, Vancouver, BC, Canada, 2008.

[64] M. Bahrami-Samani, C. D. Cook, J. D. Madden, G. M. Spinks, and P. G. Whitten, "Quartz crystal microbalance study of volume changes and modulus shift in electrochemically switched polypyrrole," *Thin Solid Films*, vol. 516, pp. 2800–2807, 2008.

[65] P. Yeh, R. Kainthan, Y. Zou, M. Chiao, and J. Kizhakkedathu, "Self-assembled mono thiol terminated hyperbranched polyglycerols on gold surface: A comparative study on the structure, morphology and protein adsorption characteristics with linear PEG," *Langmuir*, vol. 24, pp. 4907–4916, 2008.

[66] S. Hampl, D. Buescher, R. Hoskinson, and B. Stoeber, "A deformable micromirror for selective illumination," in *Pacific Northwest Microsystems and Nanotechnology Meeting (PANOMINO)*, Friday Harbor, WA, U.S.A., 2008.

[67] T. Siu, R. Rohling, and M. Chiao, "Power density requirement of a 4 MHz micro-ultrasonic transducer for sonodynamic therapy (article)," *Biomedical Microdevices*, vol. 10, pp. 89–97, 2008.

[68] P. Yeh, J. Kizhakkedathu, and M. Chiao, "Investigation on vibration-induced protein desorption mechanism using micromachined membrane and pzt plate," *Biomedical Microdevices*, vol. 10, pp. 701–708, 2008.

[69] Y. Zeng, "Design of a mems-based optical accelerometer with large measurable range and high sensitivity," Masters Thesis, University of British Columbia, Vancouver, British Columbia, Canada, 2008.

[70] S. T. Fard, "Glucose monitoring: Measuring blood glucose using vertical cavity semiconductor lasers (vcsels)," Master of Applied Science Thesis, University of British Columbia, Vancouver, 2008.

[71] A. Mercanzini, K. Cheung, D. L. Buhl, M. Boers, A. Maillard, P. Colin, J.-C. Bensadoun, A. Bertsch, and P. Renaud, "Demonstration of cortical recording using novel flexible polymer neural probes," *Sensors and Actuators A: Physical*, vol. 143, pp. 90–96, 2008. [Online]. Available: http://www.sciencedirect.com/science/article/B6THG-4PB0PJW-1/1/063d66ee11c83ea915aec7446e9b7b73

[72] J. Flueckiger and K. C. Cheung, "Integrated microfluidic systems for cell culture and characterization," in *14th IEEE International Mixed-Signals, Sensors, and Systems Test Workshop*, 2008.

[73] ——, "Locally defined thermally reversible hydrogel formation in microchannels," in *12th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS)*, 2008.

[74] M. C. Chen, M. Gupta, and K. C. Cheung, "Hydrogel-based microfluidic systems for co-culture of cells," in *30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 2008.

[75] R. Hoskinson, S. Hampl, and B. Stoeber, "High-contrast projection technology based on an analog mems mirror array," in *CMC Microsystems 2008 Annual Symposium*, Ottawa, Ont., Canada, 2008.