Prof. Carlos H. Mastrangelo

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I. Education:

- B.S. in Electrical Engineering, UC Berkeley, July 1985, EE Department.
- M.S., UC Berkeley, May 1988, EECS. Advisor: Richard S. Muller.
- Ph.D., UC Berkeley, January 1991, EECS. Advisor: Richard S. Muller.

II. Publications:

- 254 research papers (**74 journal, 180 refereed conference**)
- 4 book chapters
- 1 monograph

III. Awards and Honors:

- 1987 AT&T four-year Ph.D. fellowship recipient 1987-1991.
- 1991 Tucker Departmental Award for best thesis work in the department.
- 1991 Council of Graduate Schools/University Micro-films Distinguished Dissertation Award for best technical thesis of 1991 in US and Canada.
- 1994 National Science Foundation Presidential Young Investigator Award.
- 1998 Developed first microfluidic integrated nanoliter DNA analyzer chip along UM collaborators, *Science* 1998 paper
- 1999 IEEE Best Paper Award, J. Semic. Manufacturing, Sept. 2000.
- 2017 Developed microfluidic adaptive eyeglasses technology selected by NIH-NIBIB/AIMBE as one of the best eight medical technologies for 2016. Presented at AIMBE Congressional Exhibition at Capitol Hill, Washington DC, May 5th 2017

IV. Professional Experience:

1. ***Research Engineer*** developing micro sensors for automotive applications at the Electronic Materials and Devices Department, Ford Motor Company Scientific Research Laboratories, Dearborn, MI from 1/91 to 12/92.
2. ***Assistant Professor*** University of Michigan, 1/93-1/99. Teaching introductory and advanced courses in electrical engineering and computer science.
3. ***Associate Professor*** University of Michigan, 1/99-5/2000. On leave 5/2000-5/2002. Teaching introductory and advanced courses in electrical engineering and computer science.
4. ***Vice President of Engineering***, Corning-Intellisense, 5/2000-12/2003. Directly responsible for the development of all engineering projects and due diligence on $700M acquisition. Supervised development of optical MEMS projects directly controlling more than 40 engineers and scientists.
5. ***Project Director*****,** Biochemical Technologies Dept., Sullivan Park Research Center, Corning Inc., Corning, NY, 1/2004-5/2005. Responsible for development of bioMEMS projects for Corning Life Sciences division.
6. ***Associate Professor,*** Case Western Reserve University, 7/2005-. Teaching bioMEMS and MEMS subjects.
7. ***Director, Microfabrication Laboratory,*** Case Western Reserve University, 2/2007-
8. ***USTAR Professor, ECE and BME Depts,*** University of Utah, 7/2008-
9. ***Associate Director,*** University of Utah Nanofabrication Facility, 2014-

V. Professional Service:

1. IEEE student advisor 1994-1997.
2. Appointed Section Editor of the Sensors and Actuators Journal since November 1995-Aug. 2001.
3. Technical committee member and section chair at the 1995 SPIE Conference on Micromachined Devices, Austin, TX, October 23-24, 1995.
4. Technical committee member and section chair at the 1996 International Electron Devices Meeting, (IEDM), San Francisco, CA, December 1996.
5. Technical committee member and section chair at the 1996 SPIE Conference on Micromachined Devices, Austin, TX, October 1996.
6. Technical committee member and section chair at the 1997 SPIE Conference on Micromachined Devices, Austin, TX, October 1997.
7. Technical committee member at the 1998 SPIE Conference on Micromachined Devices and Components IV, Vol 3514, Santa Clara, CA, Sep. 21-22, 1998.
8. Technical committee member and section chair at the 1998 SPIE Conference on Microfluidic Devices and Systems, Vol. 3515, Santa Clara, CA, Sep. 21-22, 1998.
9. Technical committee member at the 2000 Hilton Head Solid-State Sensor Workshop, June 2000.
10. General Chair, 2001 SPIE Conference on Microfluidics and BioMEMS, Vol. 4560, Santa Clara, CA, Sep. 2001.
11. Member of editorial board, Sensors and Actuators Journal, 2001-.
12. Section editor, IEEE Journal of Microelectromechanical Systems, 2004-.
13. Technical committee member, Transducers' 07.
14. Technical committee member, Transducers' 17.

VI.3 Ph.D. Committee chairs: (24)

Quals	Prelim	Cand.	Student	Sponsor	Project	Grad. Date
Y	Y	Y	M. H. Zaman	NSF	Process compilation	June 1997
Y	Y	Y	B. P. Gogoi	Ford	Feedback pres. sensors	Dec 1998
Y	Y	Y	J. R. Webster	NIH	DNA Microseparation stage	Jan 1999
Y	Y	Y	P. F. Man	NIH	Microfluidic pumps	June 1999
Y	Y	Y	C. C. Liu	SRC	Infrared detector	Dec 1998
Y	Y	Y	E. Carlen	NSF	Process compilation	June 1999
Y	Y	Y	C. C. Wang	Motorola	Press. Sensors	Dec 2000
Y	Y	Y	P.C. Hsu	DARPA	Microphone/sound detector	June 1999
Y	Y	Y	P. Sethu	DARPA	Plastic MEMS	Dec 2002
Y	Y	Y	P. Selvaganapathy	NIH	Electrochemical detection of DNA	Dec 2002
Y	Y	Y	J. Zheng	NIH	Single-strand DNA integrated detection	Jun 2003
Y	Y	Y	S. Mutlu	DARPA	Porous pump	Dec 2004
Y	Y	Y	F. Azizi	NIH	Microfluidic DACs	July 2009
Y	Y	N	Y. Xie	NIH	Microfluidic temporal filtering	July 2008
Y	Y	Y	T. Ghosh	USTAR	FT-SPR	July 2012
Y	Y	Y	R. Surapaneni	DARPA	GRSC	July 2014
Y	Y	Y	N. Banerjee	NSF	Particle Manometry	July 2016
Y	Y	Y	N. Hasan	NIH/U01	Variable focus eyeglass	July 2017
Y	Y	Y	R. Likhite	NSF/Industry	Parametric Gas Sensor/Neuroprobe	Dec 2019
Y	Y	Y	S. Pandey	NSF	microRailguns/Chip Destruction	Dec 2018
Y	Y	Y	A Banerjee	DARPA	Nanogap tunneling switching sensors	July 2019
Y	N	N	M. Karkhanis	NIH/U01	Autofocusing eyeglasses	July 2020
Y	N	N	C. Ghosh	Industry/NSF	Contact tunable lenses	July 2021
Y	N	N	E. Pourshaban	NSF	Contact lenses wireless power	July 2022
Y	N	N	Adwait Deshpande	NSF	Contact lenses microsystems	July 2022
Total Ph.D. Students:			**25**			

VI.4 Ph.D. Committee membership (subset of students):

Student	Department	Chair	Status
J.C. Shean	MEAM	S. Kota	graduated
T.M. Keller	EECS	L. Katehi	graduated
K. Ma	EECS	K. Najafi	graduated

M. Nardin	EECS	K. Najafi	graduated
J. Chen	EECS	K. Wise	graduated
A. Oliver	EECS	K. Wise	graduated
J. Robertson	EECS	K. Wise	graduated
P. Bergstrom	EECS	K. Wise	graduated
A. Selvakumar	EECS	K. Najafi	graduated
S. Rakshandderhoo	EECS	S. Pang	graduated
R. De Souza	EECS	K. Wise	graduated
N. Yazdi	EECS	K. Najafi	graduated
J.-S. Kim	EECS	K. Wise	graduated
C. Rich	EECS	K. Wise	graduated
T. Sammarco	Chem Eng.	M. Burns	graduated
B. Amirparviz	EECS	K. Najafi	graduated/Amazon VP/Google X founder

VII. Research:

VII.1 Major Research Accomplishments:

When I joined the faculty at UM, I have pursued a very strong course of research. My research is focused on advanced surface-micromachined sensors and their fabrication technology. These items include novel fabrication technologies as well as fabrication design tools. I have had a group of 15 graduate students under my supervision working on these topics. My publication record consists of 45 journal papers, 79 conference papers and three book chapters. The paragraphs below describe some of my previous and current research thrusts.

During the first year at UM, I received a NSF Research Initiation Award for the development of a silicon process compiler for thin film devices. This tool generates process flow for micromachined and thin film devices directly from a description of their cross section. The compiler uses graph theory and poset theory to generate all feasible flows for a particular device. Along with the basic theory an important set of existence theorems and cardinality estimates for the number of solutions were found.

The first results of this work were presented at the 1994 IEEE MEMS Conference in Oiso Japan. In 1994, I was awarded the National Science Foundation Young Investigator Award which I have used to pursue this work further. The work continued over the next two years yielding two additional conference papers at the 1995 International Workshop on Numerical Modeling of Process and Devices for Integrated Circuits, and the 1995 International Conference on Solid-State Sensors and Actuators. Two journal papers has been published at the IEEE Transactions on Computer Aided Design and the IEEE Transactions of Semiconductor Manufacturing. The methods developed for process compilation have been implemented in the world's first process compilation software (called MISTIC) which roughly consists of 250,000 lines of C code. This code has the potential of revolutionizing the field of CAD tools for semiconductor processing. More recent results describing the internal models and compilation algorithms have been published at the 1997 SPIE Semiconductor Manufacturing Conference, at SISPAD'98, and more recently a two paper set has been accepted for publication at the IEEE Transactions of Semiconductor Manufacturing. A total of four conference papers and four journal papers have been published in this subject. In 2000 we received the *IEEE best paper of the year award* in the Transactions of Semiconductor Manufacturing.

My interests also spread to advanced surface micromachining processing. I have focused my attention on a pervasive problem suffered in microstructure adhesion. Because microsensors are constructed with thin films, they have a strong tendency to adhere to their substrates through capillary action. This phenomena causes a catastrophic loss of device yield hence it is essential to understand how this phenomena works as well as develop cures to this problem.

Through my research I have developed a model for the microstructure adhesion which explains the observed experimental results. The models have been published as a set of two papers in the Journal of Microelectromechanical Systems. Three additional papers in the subject have been presented at the 1995 International Conference on Solid-State Sensors and Actuators and the IEEE Journal of Microelectromechanical Systems on an electromagnetic pulse-force release technique. A third paper regarding the development of an anti-adhesion layer was presented at the 1996 MEMS Conference and later published in the Journal of Microelectromechanical Systems. I am widely recognized as one of the piooners in this area with numerous citations. I have also written two recent invited review papers at the NSF Tribology Opportunities in MEMS Workshop (Kluwer 1998) and at Tribology Letters.

My research interests also extend to microsensor development. In 1994, I was awarded a NIH grant to develop a microfluidic device for the sequencing of DNA. This is a new research area of great academic and economic importance for medical applications. This project is the result of a multidisciplinary effort of faculty at the Human Genetics, Electrical Engineering, and Chemical Engineering Departments. In 1996, I was awarded supplementary funding from the Xerox corporation to investigate the same topic. Currently I have two graduate students supported under these contracts. The first results of this work consisting of a surface micromachined separation stage were presented at the 1996 IEEE MEMS Conference, San Diego, CA, Feb 11-15, 1996. This work was later extended to include new microfabrication techniques for plastic fluidic devices presented at the 1997 MEMS Conference, the fabrication of plastic DNA separation stages with on-chip detectors (Transducers' 97) and high resolution passive separation stages (Micro Total Analysis Workshop, Alberta, October 1998), as well as microinjectors (MEMS 1998 Conference) among other published results. The Michigan group currently has developed a complete demonstration genotyping system with the unique capability of sensing DNA fragments on-chip. This effort has been highly successful leading to the publication of a major review paper at the IEEE Proceedings and an article at the prestigious Genome Issue of Science, October 16, 1998. We are currently the only group in the world that has detected individual DNA band migration on an integrated microfluidic chip. This is a major milestone which paves the road to the development of portable, handheld, DNA diagnostic equipment.

The DNA analysis project funding was supplemented by two additional DARPA contracts. The first DARPA contract involved the development of micromachining techniques for plastic MEMS. Several microfluidic fabrication techniques and devices were developed under this contract including microfluidic channels constructed out of surface micromachined p-xylylene (parylene). We demonstrated reaction chambers, microfluidic injectors, and passive stop valves maded with this technology. This baseline technology is now commonly used by several research groups worldwide, most noticeably at Caltech, UCLA, UI, and Hong-Kong University. We also developed bulk microcasting techniques for the construction of expoxy-based microfluidic substrates. These type of substrates have been commercially used by Motorola biotechnology divisison. Under the same contract we developed a solid-to-liquid phase change actuator constructed by

micromachining of waxy polymers. These unique material can result in an extremely high energy density actuator (10^7 J m^{-3}) with volumetric expansions of up to 30% when heated to ~100C. We formed the actuator by enclosing a micromachined, evaporated wax patches on top of a heater with a flexible membrane. Several valving devices were demonstrated and a flow controller was implemented using this technology.

The second DARPA contract involves the use of porous polymers for pumping and valving applications. These devices use pore-size-independent electro-osmotic field induced flows to drive the sample forward with a very low hydrostatic pressure backflow (because it is proportional to the inverse of the cubic of pore diameter). We developed several microfluidic pumping devices which were embedded within the parylene channel technology developed earlier that utilize low voltages, produce reversible flows and eliminate the pervasive bubble generation problem observed in conventional electro-osmotic pumping.

In 1999, in collaboration with Prof. Wise, Najafi, Nguyen, and Brown, I received funding from NSF for the formation of an Engineering Research Center (ERC) on MEMS Wireless Integrated Microsystems. This is the only MEMS ERC in existence. I was the team leader for the Microsensor Task, the largest task of the ERC, supervising the activities of 12 graduate students under 5 different faculty. A large part of the task consists of the fabrication of a micropower micromachined gas chromatograph for environmental monitoring. This project pushes the limits of operation achievable for power consumption, sensitivity, and selectivity of this type of field analytical instrumentation. The ERC is one of the largest engineering centers in the UM campus.

In 2000, I joined Intellisense as Vice President of Engineering heading a development group with over 40 scientists and engineers. The main focus of the work was microfabricated MEMS for optical telecommunications. At Intellisense myself and my team of engineers developed several electrostatic micromirror systems. We introduced the first parallel plate microactuators that are able to suppress pull-in behavior through the utilization of raised side electrodes presented at the Transducer's 2003 Conference. We also developed the first completely self aligned vertical comb drive devices which permit the fabrication of submicrometer gaps and low voltages. We also introduced ultracompact robust sliding mode control schemes for these micromirror systems. Many of these leading edge developments are now published or under reviews in the literature.

In July 2005, I joined the EECS Dept. of Case Western Reserve University as an associate professor. My research has been focused back onto bioMEMs for DNA analysis and drug discovery. In Oct. 2006, I received an $815K award from NHGRI to fund the development of nanopore sequencing systems. At Case I am pursuing several microfluidic projects for chemical signal generation, sequencing, and drug discovery (kinetics analyzer) applications. Our initial results have been published at μTAS 2006 in Tokyo, Japan, resulting in a journal paper at the Lab-On-A-Chip journal in 2007. I am also pursuing the utilization of Fourier techniques in microfluidics to develop several spectral filtering and separation techniques. All of these devices are based on a new kind of technique that I call *switched-flow microfluidic circuits*. Several papers were published in μTAS 2007 and are also in press in Lab-On-A-Chip for 2008.

In July 2008, I joined the ECE Dept. of the University of Utah as a full USTAR professor. My research at the University of Utah has been focused on microfluidic systems and microfabricated sensors. I received a large $5.4M DARPA contract for developing zero velocity updates to inertial motion units (IMUs) based on velocity estimation derived from measurements on flexible MEMS-based shear and pressure imagers. While at Utah we also developed frequency-based microfluidic chips for determination of protein binding

kinetics. We also developed flowable physical sensors for pressure mapping in microfluidic systems and multisensor platforms. In 2016 I was awarded a $1M U01 cooperative agreement from NIH NIBIB to develop *smart adaptive eyeglasses* that are based on relatively large aperture (~3cm) tunable microfluidic liquid lenses. Adaptive lenses are needed to replace the lost accommodation function of the eye's crystalline in age-related presbyopia. However none of the existing corrective technologies inclusive of laser refractive surgery or multifocal eyeglasses can provide it. Presbyopia affects more than one billion people worldwide as most people over 50 years old suffer from a severe loss in their ability to focus on objects placed at different distances.

The convergence of recent advances in low-power embedded computing, sophisticated digitally processed sensors, low energy mobile communications and advances in microfluidics makes the realization of such cyber-physical adaptive eyewear possible. At the University of Utah we developed the first set of adaptive lenses that can change focus by roughly 6D with very little energy consumption. The results of tour research have been recently published at *Optics Express*, Vol 25, p1221-1233 (2017). We are currently implementing a full set of adaptive eyeglasses that incorporates embedded computing, mobile communications, object distance ranging sensors and variable-focus microfluidic lenses. A preview of the set was presented at the 2017 OSA Imaging conference, June 26th, 2017, San Francisco, CA. This technology was named as one of the eight most important biomedical technologies of 2016 by the American Institute for Medical and Biological Engineering (AIMBE), and a demonstration of this technology was presented and displayed at the Congressional Medical Technology Exhibition on Capitol Hill, US. Congress, Washington DC, May 5th, 2017.

VII.2 Grants and Contracts:

The table below shows a summary of research grants and contracts obtained at the University of Michigan, Intellisense, and CWRU. Since 1993 I raised/received about $13M in government grants and contracts of my own (excluding collaborator funding) and $1M in instrumentation grants. In addition to this I managed a $40M development budget at Corning-Intellisense.

Past Funding

Title	sponsor	dates	Total amount	PI and Co-PIs	GSRA/Staff (mine)
Acquisition of mask making machine	DRDA	3/93	$11K	C. H. Mastrangelo	0
Micromechanical process synthesis	NSF Research Initiation	8/93-7/96	$100K	C. H. Mastrangelo	1
Feedback pressure sensors	Ford	7/93-7/97	$70K	C. H. Mastrangelo	1
Microfluidic DNA Analyzer	NIH	4/94-5/99	$3.15M ($1.5M)	D.T. Burke, C. H. Mastrangelo, M. A. Burns	3
Young Investigator Award	NSF	7/95-8/99	$337.5K	C. H. Mastrangelo	1
Feedback pressure sensors	Ford	2/95-3/98	$135K	C. H. Mastrangelo	1
Microfluidic Research	Xerox	12/95-1/99	$30K	C. H. Mastrangelo	0
NSF Instrumentation Grant	NSF	7/95	$250K (with matching)	K.D. Wise, K. Najafi, C. H. Mastrangelo, C. T. Nguyen	0
Infrared Detectors	SRC	7/95-8/98	$1.1M/yr ($180K)	K.D. Wise, F. L. Terry, M. Elta, S. Pang, others C.H. Mastrangelo	1
Microinstrumentation cluster	DARPA	1/96-8/98	$3.3M ($180K)	K.D. Wise, K. Najafi, S. Pang, C. H. Mastrangelo, C.T. Nguyen	1
Microseparation stages	NIH	4/96-5/99	$1.1M ($300K)	M.A. Burns, D.T. Burke, C.H Mastrangelo	2

Vacuum Microsensor	Varian	8/97-8/98	$53K	C.H. Mastrangelo	1
Pressure Sensors	Motorola	5/97-12/99	$93K/yr	C. H. Mastrangelo	1
Technology for Plastic MEMS	DARPA	7/98-6/01	$2.2M	C. H. Mastrangelo, M.A. Burns, L. Lin	3
Major Research Instrumentation	NSF	9/98	$700K (with matching)	C. H. Mastrangelo K.D. Wise, D. Pavlidis, et al.	0
Pressure sensors	Motorola	9/98	$15K/yr	C. H. Mastrangelo	0
Porous Microfluidic Valves	DARPA	3/00-12/03	$1.2M	C. H. Mastrangelo J.M. Frechet, UCB	3
Center for Wireless Microsystems, MEMS ERC	NSF ERC	12/00-12/04	$15M ($1.5M)	K. Wise, K. Najafi, C. Mastrangelo, R. Brown and others	2
Ultrahigh Density Scalable Digital MEMS Control	NIST/ATP	5/02-6/06	$2M	C. H. Mastrangelo	7
Nanopore array DNA sequencing	NHGRI	10/06-9/10	$815K	C. H. Mastrangelo	3
Soldier Navigation via Gait-Corrected IMUs	DARPA	2/08-1/11	$5.4M	C. H. Mastrangelo	6
Plasma Nanotorch	DARPA	4/08-3/11	$3.0M	T-Azar and C. H. Mastrangelo	2
Nanochannels	NSF	7/08-7/11	$330K	C. Mastrangelo and S. Bhunia	2
Micropump	NSF	7/13-7/16	$330K	C. H. Mastrangelo	2
Integrating μ-Gyro	DARPA	7/15-7/16	$600K	C. H. Mastrangelo	3
Current Funding					
Smart Adaptive Eyeglasses	NIH/NIBIB U01	2/16-2/19	$1M	C. H. Mastrangelo, H. Kim, N Patwari	4
Zero-power nanogap sensors	DARPA	9/15-7/18	$2M	H. Kim, C. H. Mastrangelo	2

Microcapsule neural probes	NSF EAGER	7/15-8/17	$300K	C. H. Mastrangelo, D. Young	2
Multisensors	Versana	7/15-	$100K	C. Mastrangelo	1

VII.3 Publications:

Journal Articles (Printed or accepted)

1. Y. C. Tai, C. H. Mastrangelo and R. S. Muller, "Thermal conductivity of heavily doped low-pressure chemical vapor deposited polycrystalline silicon films," J. *Appl. Phys*. 63 (5), pp. 1442-1447, March 1, 1988, and 66 (7), pp. 3420, Oct. 1, 1989.
2. C. H. Mastrangelo and R. S. Muller, "Thermal diffusivity of heavily doped low pressure chemical vapor deposited polycrystalline silicon films," *Sensors and Materials.* Vol. 3, pp.133-137, 1988.
3. C. H. Mastrangelo, Y. C. Tai and R. S. Muller, "Thermophysical properties of low-residual stress, silicon-rich, LPCVD silicon nitride films," *Sensors and Actuators*, Vol. 23(A), pp. 856-860, 1990.
4. C. H. Mastrangelo, R. S. Muller and S. Kumar, "Microfabricated incandescent lamps," *Applied Optics*, Vol. 30, pp. 868-872, 1991.
5. C. H. Mastrangelo, H.-J. Hyeh and R. S. Muller, "Electrical and optical characteristics of vacuum-sealed polysilicon microlamps," *IEEE Transactions on Electron Devices,* June 1992, Vol.39, (no.6) pp. 1363-75.
6. C. H. Mastrangelo and C. H. Hsu, "Mechanical stability and adhesion of microstructures under capillary forces: part I: basic theory," *IEEE Journal of Microelectromechanical Systems,* Vol. 2, pp. 33-43, March 1993.
7. C. H. Mastrangelo and C. H. Hsu, "Mechanical stability and adhesion of microstructures under capillary forces: part II: experiments", *IEEE Journal of Microelectromechanical Systems*, Vol. 2, pp. 44-55, March 1993.
8. B. P. Gogoi and C. H. Mastrangelo, "Adhesion release and yield enhancement of microstructures using pulsed Lorentz forces," *IEEE Journal Microelectromechanical Systems*, Vol. 4, pp. 185-192, Dec. 1995.
9. C. H. Mastrangelo, X. Zhang and W. C. Tang, "Surface micromachined capacitive differential pressure sensor with lithographically-defined silicon diaphragm", *IEEE Journal of Microelectromechanical Systems*, Vol. 5, pp. 98-105, June 1996.
10. Z. He, G. F. Knoll, D. K. Wehe, R. Rojeski, C. H. Mastrangelo, M. Hamming, C. Barret and A. Uritani, "1-D position sensitive single carrier semiconductor radiation detector," *Nucl. Inst. Meth. Phys. Res*., Vol A380, pp. 228-231, Oct 1, 1996.
11. M. A. Burns, C. H. Mastrangelo, T. Sammarco, P. F. Man, J. R. Webster, B. Johnson, B. Foerster, D. K. Jones, E. Field, A. Kaiser and D.T. Burke. "Microfabricated structures for DNA analysis," *Proc. Natl. Acad. Sci. USA*, Vol. 93, pp. 5556-5561, 1996.
12. M. Hasanuzzaman and C. H. Mastrangelo, "Process compilation of thin film microdevices," *IEEE Transactions on Computer Aided Design*, Vol. 15, pp. 745-763, 1996.

13. D. T. Burke, M. A. Burns and C. H. Mastrangelo, ”Microfabrication technologies for integrated nucleic acid analysis,” *Genome Research*, Vol.7, pp. 189-202, March 1997.
14. P. F. Man, B. P. Gogoi, and C. H. Mastrangelo, ”Elimination of post-release adhesion in microstructures using conformal fluorocarbon coatings,” *IEEE Journal of Microelectromechanical Systems,* Vol. 6, pp. 25-34, March 1997.
15. F. Ying, C. H. Mastrangelo, M. A. Burns and D. T. Burke, ”Electrophoretic separations using sweeping fields”, *Electrophoresis,* Vol. 19, pp. 1388-1393, August 1998.
16. E. T. Carlen and C. H. Mastrangelo, ”Statistical model for spatial correlation in thin film deposition and reactive growth”, *IEEE Trans. Semic. Manufacturing,* Vol. 11, pp. 511-521, August 1998.
17. M. A. Burns, B. N. Johnson, S. N. Brahmasandra, K. Handique, J. R. Webster, M. Krishnan, T. S. Sammarco, P. F. Man, D. K. Jones, D. Heldsinger, C. H. Mastrangelo and D. T. Burke”, An integrated nanoliter DNA analysis device”, *Science*, Vol. 282, pp. 484-487, 16 October 1998.
18. M. H. Zaman, E. T. Carlen and C. H. Mastrangelo, ”Automatic generation of thin film process flows: Part I: basic algorithms”, *IEEE Trans. Semic. Manufacturing*, Vol. 12, pp. 116-128, Feb. 1999.
19. M. H. Zaman, E. T. Carlen and C. H. Mastrangelo, ”Automatic generation of thin film process flows: Part II: recipe generation, flow evaluation, and system framework”, *IEEE Trans. Semic. Manufacturing*, Vol. 12, pp. 129-138, Feb. 1999.
20. B. P. Gogoi and C. H. Mastrangelo, ”Force balanced micromachined pressure sensors,” *IEEE Trans. Electron. Dev.*, Vol. 48, pp. 1575-1584, Aug. 2001.
21. C. C. Liu and C. H. Mastrangelo, ”CMOS uncooled heat-balancing infrared imager,” *IEEE J. Solid-State Circuits*, Vol. 35, pp. 527-535, April 2000.
22. K. Handique, D. T. Burke, C. H. Mastrangelo, and M. A. Burns, “Nanoliter liquid metering in microchannels using hydrophobic patterns,” *Analytical Chemistry*, Vol. 72, pp. 4100-4109, Sep. 2000.
23. J. R. Webster, M. A. Burns, D. T. Burke and C. H. Mastrangelo, ”Monolithic capillary electrophoresis device with integrated fluorescence detector,” *Analytical Chemistry*, Vol. 73, pp. 1622-1626, April 2001.
24. C. C. Wang, B. P. Gogoi, D. J. Monk and C. H. Mastrangelo, ”Contamination-insensitive differential capacitive pressure sensors,” *IEEE Journal of Microelectromechanical Systems*, Vol. 9, pp. 538-549, Dec. 2000.
25. K. Handique, D. T. Burke, C. H. Mastrangelo and M. A. Burns, “On-chip thermopneumatic pressure for discrete drop pumping,” *Analytical Chemistry*, Vol. 73, pp. 1831-1838, April 2001.
26. S. N. Brahmasandra, V. M. Ugaz, D. T. Burke, C. H. Mastrangelo, and M. A. Burns, “Electrophoresis in Microfabricated Devices Using Photopolymerized Polyacrylamide Gels and Electrode-Defined Sample Injection,” *Electrophoresis*, 22, 300-311 (2001).
27. S. N. Brahmasandra, D. T. Burke, C. H. Mastrangelo, and M. A. Burns, “Mobility, Diffusion and Dispersion of Single Stranded DNA in Sequencing Gels,” *Electrophoresis*, 22, 1046-1062 (2001).
28. M. Krishnan, S. Brahmasandra, D. T. Burke, C. H. Mastrangelo and M. A. Burns, “A novel strategy for the design of multiple reaction systems for genetic analysis,” *Sensors & Actuators*, Vol. A95, pp. 55-58, Jan. 2002.

29. E. T. Carlen and C. H. Mastrangelo, ”Electrothermally activated paraffin microactuators,” *IEEE Journal of Microelectromechanical Systems*, Vol. 11, pp. 165-174, June 2002.
30. E. T. Carlen and C. H. Mastrangelo, ”Surface micromachined paraffin-actuated valve,” *IEEE Journal of Microelectromechanical Systems*, Vol. 11, pp. 408-420, Oct. 2002.
31. P. Selvaganapathy, Y-S. L. Ki, P. Renaud and C. H. Mastrangelo, ”Bubble-free electrokinetic pumping,” *IEEE Journal of Microelectromechanical Systems*, Vol. 11, pp. 448-453, Oct. 2002.
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174. Nazmul Hasan, Mohit Karkhanis, Fariha Khan, Tridib Ghosh, Hanseup Kim, and Carlos H. Mastrangelo, "Adaptive optics for autofocusing eyeglasses," presented at the *2017 OSA Imaging and Applied Optics Congress*, San Francisco, CA, June 26-27, 2017, OSA Technical Digest (online) (Optical Society of America, 2017), paper AM3A.1, doi: /10.1364/AIO.2017.AM3A.1
175. C. H. Mastrangelo (2018). Systems for autofocusing eyeglasses. ARVO 2018 Conference. Article, Refereed Conference Proceedings.
176. N. Hasan, M. Karkhanis , C. Ghosh, F. Khan, T. Ghosh, H. Kim & C. H. Mastrangelo (2018). Lightweight smart autofocusing eyeglasses. SPIE Proceedings Volume 10545, MOEMS and Miniaturized Systems XVII; 1054507 (2018). Vol. 10545.
177. C. Ghosh, A. Mastrangelo, A. Banerjee, H. Kim and C. H. Mastrangelo, "Micropower Object Range and Bearing Sensor for Smart Contact Lenses," *2020 IEEE SENSORS*, Rotterdam, Netherlands, 2020, pp. 1-4, doi: 10.1109/SENSORS47125.2020.9278622.
178. S. K. M. Truong *et al*., "Demonstration of $155.1\ \mu\mathrm{W}$ Wake-Up Gas Sensor Node Toward 8 Month Lifetime," *2020 IEEE 33rd International Conference on Micro Electro Mechanical Systems (MEMS)*, Vancouver, BC, Canada, 2020, pp. 622-625, doi: 10.1109/MEMS46641.2020.9056262.
179. S. H. Khan *et al*., "Threshold Point Modulation of a Wake-Up Nano-Gap Gas Sensor," *2020 IEEE 33rd International Conference on Micro Electro Mechanical Systems (MEMS)*, Vancouver, BC, Canada, 2020, pp. 733-736, doi: 10.1109/MEMS46641.2020.9056280.
180. R. Likhite *et al*., "Mems Stiction Suppression Using Low-Stress Camphor Sublimation," *2020 IEEE 33rd International Conference on Micro Electro Mechanical Systems (MEMS)*, Vancouver, BC, Canada, 2020, pp. 291-294, doi: 10.1109/MEMS46641.2020.9056436.

Refereed Conference Papers (Submitted)

1. F. Khan, A. Banerjee, M. Hasan, H. Kim and C. H. Mastrangelo, "Microfabricated single-lens Shack-Hartmann light angle sensor," Submitted, *IEEE Sensors 2017,* Nov. 2017
2. A. Banerjee, S. S Pandey, and C. H. Mastrangelo, "MEMS stiction supression with sacrificial polystyrene nanoparticles," Submitted, *IEEE Sensors 2017*, Nov. 2017

Other Conference Papers (Invited)

1. C. H. Mastrangelo, "DNA analysis systems on a chip," invited paper, in *Proc. International Ceramics Symposium (CIMTEC'98),* Florence, Italy, June 1998.
2. C. H. Mastrangelo, "Microfluidics at Michigan," invited presentation, *AIAA Space Technology Conference and Exposition* in Albuquerque, NM, 28-30 September, 1999.
3. C. H. Mastrangelo, P. Sethu, M. A. Burns, and D. T. Burke, "Microchips for DNA Sequencing", invited presentation at the *1999 Nanotech Conference*, Montreaux, Switzerland, Dec 1999.

Book Chapters/Monograms

1. C. H. Mastrangelo and W. C. Tang, ”Semiconductor sensor technologies”,Chap.2, pg. 17-96, in Semiconductor Sensors, S. M. Sze, Ed., Wiley 1994.
2. S. N. Brahmasandra, K. Handique, M. Krishnan, V. Navasimayam, D. T. Burke, C. H. Mastrangelo,and M. A. Burns, ”Microfabricated Devices for Integrated DNA Analysis”, Chap.12, pg. 229-249, in Biochip Technology, J. Cheng and J. Kricka, Ed., Hardwood 2001.
3. E. T. Carlen and C. H. Mastrangelo, “Process Synthesis,” Chap 8, pg. 1-38, in Optimal Synthesis Methods for MEMS, G. Ananturesh, Ed., Kluwer, 2003.
4. R. Selvaganapathy, E. T. Carlen, and C. H. Mastrangelo, “Integrated Microfabricated Systems for Genetic and Protein Analysis,” in Encyclopedia of Sensors, C. A. Grimes, E. C. Dickey, and M. V. Pishko, Editors, American Scientific Publishers, 2005.
5. Y. Xie and C. H. Mastrangelo, Chemical Analysis with Fourier Microfluidics; concepts and methods, VDM Verlag (August 18, 2009), ISBN 3639160827. Book/Monograph, published, 08/18/2009.

Patents and Invention Disclosures (Partial List)

1. C. H. Mastrangelo ”Dry-release method for sacrificial layer microstructure fabrication,” U.S.Patent 5258097, Issued Nov. 2, 1993.
2. R. S. Muller, C. H. Mastrangelo ”Vacuum-sealed silicon incandescent light,” U.S.Patent 5285131, Issued Feb. 8, 1994.
3. C. H. Mastrangelo ”Capacitive surface micromachined differential pressure sensor,” U.S.Patent 5332469, Issued July 26, 1994.
4. C. H. Mastrangelo ”Silicon-on-insulator capacitive surface micromachined absolute pressure sensor,” U.S. Patent 5369544, Issued Nov. 29, 1994.
5. C. H. Mastrangelo ”Method for producing silicon-on-insulator capacitive surface micromachined absolute pressure sensor,” U.S. Patent 5470797, Issued Nov. 8, 1995.
6. R. S. Muller, C. H. Mastrangelo, and K. R. Williams, ”Sealed micromachined vacuum and gas filled devices,” U.S. Patent 5493177, Issued Feb. 20, 1996.
7. M. A. Burns, Y. D. Fields, D. T. Burke, B. N. Johnson, B. R. Foerster, A. R. Kaiser, J. R.Webster, D. K. Jones, P. F. Man, T. S. Sammarco, and C. H. Mastrangelo, ”Integrated DNA processor,” Invention Disclosure, UM File 0827, Feb 10, 1993.
8. C. H. Mastrangelo, J. R. Webster, and P. F. Man, ”Polymer-based micromachining technology for microfluidic devices,” Invention Disclosure, UM File 1258, Aug. 8, 1996.
9. C. H. Mastrangelo, ”TFSTAT, a MEMS material database,” Invention Disclosure, UM File1383, April 23, 1997.
10. C. H. Mastrangelo, ”MISTIC, a process compiler for thin film devices,” Invention Disclosure,UM File 1382, April 23, 1997.
11. K. Handique, M. A. Burns, B. Gogoi, and C. H. Mastrangelo, ”Moving microdroplets,” Invention Disclosure, UM File 0827p2
12. C. H. Mastrangelo and C. C. Liu, ”An uncooled heat balancing thermal imager,” Invention Disclosure, UM File 1574, June 10, 1998.
13. C. H. Mastrangelo and E. T. Carlen, “Thermally activates polymer device,” US patent application US 2002/0037221 A1, Jun 5, 2001
14. T. Kudrle, C. H. Mastrangelo, M. Waelti, C. C. Wang, G. M. Shedd, G. A. Kirkos, G. Bancu, J. Hsiao, “Electrostatically actuated micromechanical actuated devices

and method of manufacture," US patent application US 2002/0146200 A1, Oct. 10, 2002.

15. H. Sane, N. Yazdi and C. H. Mastrangelo, "Modified sliding mode control for precision control of micromirrors," US patent application 17635, filed Nov 10, 2002.
16. S. Akkaraju, C. H. Mastrangelo and N. Iyer, "Micromechanical optical switch", US. 6473545B2, Oct. 29, 2002.
17. W. F. Taylor, E. T. Carlen, C. H. Mastrangelo, J. H. Bernstein, "Micro-electro-mechanical mirror devices having a high linear fill factor," US patent application US 2003/0031403, Feb. 13, 2003.

Book reviews

1. Reviewer, Rabaey, "Digital Integrated Circuits, a Design Perspective," Prentice-Hall, 1997.
2. Reviewer, Muller, "Device Electronics for Integrated Circuits," 4th edition, Wiley, 1999.

Government Reports

1. Participated and helped to assemble an U.S. Army report at the U.S. Army workshop on MEMS, Park City, Utah, March 20-23, 1993.
2. Participanted and helped to assemble an U.S. Department of Energy report at the Batelle workshop on energy applications of MEMS, Richmond, Washington, March 16-18, 1994.
3. Participated and helped to assemble a NSF report at the NSF MEMS Design Workshop, Pasadena, CA, Nov. 16-18 1996. In this report, recommendations for future areas of NSF research funding were established.

Other conference or symposium presentations:

1. C. H. Mastrangelo, "Adhesion of microstructures," invited paper presented at the 1993 Gordon Conference on Adhesion, Feb 1993.
2. C. H. Mastrangelo "Integration of Microsensors," invited talk, presented at the 1993 AIAA Conference, Ft. Lauderale, Fl, July 15 1993.
3. C. H. Mastrangelo, "Microsensor and Microactuator Fabrication," invited talk, presented at the MEMS Workshop of The Technical Management Society of America, Washington, DC, June 23-24, 1994
4. C. H. Mastrangelo, "Microsensors at Michigan," presented at the Batelle workshop on energy applications of MEMS, Richmond, Washington, March 16-18, 1994.
5. C. H. Mastrangelo "New Frontiers in Microelectromechanical Systems," presented at the 1995 JASON workshop on MEMS, La Jolla, CA, June 22, 1995.
6. C. H. Mastrangelo, "Structured design methods for MEMS: essential tools for rapid MEMS development," presented at the NSF MEMS Design Workshop, Pasadena, CA, Nov. 16-18 1996.
7. C. H. Mastrangelo, "Monolithic Microfluidic Devices," invited talk presented at the 1996 IBC Conference, San Francisco, CA, August 1996.
8. C. H. Mastrangelo, "New Frontiers in Micromechanical Systems", invited talk presented at the JASON MEMS Workshop, San Diego, CA July 1996

9. C. H. Mastrangelo, "MISTIC: A process compiler for micromachined devices," invited talk, presented at the IEEE Computer Society VLSI Symposium, Tampa, FL November 1996.

University/Government/National Lab Presentations (Subset):

10. C. H. Mastrangelo,"Automatic generation of process flows for surface micromachined devices," Research Symposium, MIT, Dept. of Electrical Engineering, July 1993.
11. C. H. Mastrangelo, "New Frontiers in Mechanical Engineering in MEMS," Seminar Symposium, Notre Dame University, Dept. of Mechanical Engineering, Oct. 14, 1993.
12. C. H. Mastrangelo, "Surface Micromachined Microelectromechanical Devices at Michigan", invited talk, Research Seminar, EECS Dept. University of Illinois, Urbana IL, January 1996.
13. C. H. Mastrangelo, "Process compilation of thin film microdevices," Seminar Symposium, UC Berkeley, CA, Feb. 1996.
14. C. H. Mastrangelo, "Microfluidic Devices for DNA Analysis", invited talk, Research Symposium, MIT Draper Laboratories, July 1998.
15. C. H. Mastrangelo, "Plastic Microfluidic Devices", invited talk, Research Symposium, California Institute of Technology, Pasadena, CA Dec. 7, 1998.
16. C. H. Mastrangelo, "Microfabrication Techniques for Plastic MEMS", DARPA program kickoff, Arlington, VA, Sept. 1998.
17. C. H. Mastrangelo, “Microfluidic MEMS Devices”, UCB, May 2003.
18. C. H. Mastrangelo, “Microfluidic Chips for DNA Assays”, Sandia, Livermore, May 2003.

Industrial Presentations: (Subset)

19. C. H. Mastrangelo, "Microsensors Research at Michigan," presented at HP Research Laboratories, Palo Alto, CA July 1993.
20. C. H. Mastrangelo, "Adhesion Control of Microstructures," presented at Analog Devices, Wilmington, MA July 1993.
21. C. H. Mastrangelo, "Process compilation of micromachined devices," presented at IBM Almaden Research Laboratory, San Jose, CA July 1993.
22. C. H. Mastrangelo, "Process compilation of semiconductor devices," presented at Intel Corporation, Santa Clara, CA July 1993.
23. C. H. Mastrangelo, "Micromachined feedback pressure sensor," presented at Ford Microelectronics Corporation, Colorado Springs, CO, Nov 20, 1993.
24. C. H. Mastrangelo, "Copper micromachined shock sensor," presented at Ford Microelectronics Corporation, Colorado Springs, CO, April 26, 1994.
25. C. H. Mastrangelo, "Micromachined Devices at Michigan", presented at IBM Almaden Research Laboratory, San Jose, CA Feb. 1996
26. C. H. Mastrangelo, "DNA Analysis on a Chip", presented at Affymetrix, Santa Clara, CA Feb. 1996
27. C. H. Mastrangelo, "Micromachined Devices at Michigan", presented at Xerox Research Labs, Rochester, NY March 1996.
28. C. H. Mastrangelo, "Surface Micromachined Devices at Michigan," presented at HP Research Laboratory, Palo Alto, CA, August 1996.

29. C. H. Mastrangelo, "Plastic Micromachined Electrophoretic Stage," presented at Affymetrix, Santa Clara, CA, August 1996.
30. C. H. Mastrangelo, "Overview of Research at Michigan," presented at Sarcos Corp., Salt-Lake City, UT, August 1996.
31. C. H. Mastrangelo, "Surface micromachined devices at Michigan", presented at Motorola, Phoenix, AZ, August 1996.
32. C. H. Mastrangelo, "DNA separation chips," presented at Myriad, Salt Lake City, UT, August 1996.
33. C. H. Mastrangelo, "MISTIC: A process compiler for micromachined devices," presented at Texas Instruments, Dallas, TX August 1996.
34. C. H. Mastrangelo, "Micromachined vacuum pressure sensor." presented at Varian Associates, Boston, MA August 1997.
35. C. H. Mastrangelo, "Progress on DNA chips", presented at Affymetrix, Santa Clara, CA, April 1998.

VIII Service:

Major committee assignments

1. IEEE student advisor 1994-1997.
2. Undergraduate counselor 1997-2000
3. Undergraduate recruiting committee 2005-2007

Service to government or professional organizations:

Government:

1. Participated in the review of 2 NSF grant proposals (1994).
2. Participated in the review of 4 NSF grant proposals (1995).
3. Participated in the review committee of the 1994 NSF Small Business Research Initiation program. I was responsible for ranking and reviewing 84 proposals submitted for this program.
4. Participated and helped to assemble an U.S. Department of Energy report at the Batelle workshop on energy applications of MEMS, Richmond, Washington, March 16-18, 1994.
5. Participated and helped to assemble a NSF report at the NSF MEMS Design Workshop, Pasadena, CA, Nov. 16-18, 1996.
6. Member of study group, NHGRI SBIR/STTIR/RG-01 review panel.