BIOGRAPHICAL SKETCH

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NAME: Mastrangelo, Carlos Horacio

eRA COMMONS USER NAME (credential, e.g., agency login): CMASTRANGELO

POSITION TITLE: USTAR Professor of Electrical and Computer Engineering and Bioengineering

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
U. C. Berkeley	BS	1985	Electrical Engineering
U. C. Berkeley	MS	1988	Electrical Engineering
U. C. Berkeley	PhD	1990	Electrical Engineering

NOTE: The Biographical Sketch may not exceed five pages. Follow the formats and instructions below.

A. Personal Statement

Microsensor and nanotechnology provides the basis for interfacing of complex computing platforms with the physical world. The presence of these interface devices has grown from essentially none to the inclusion of a dozen imaging sensors over the past decade, and with many more projected to be used in high volumes for decades to come to address the ever growing needs of health monitoring. These augmented systems will be pervasive over the next two decades. My research interests are focused on the technology development, modeling, micro and nanofabrication and integration of micro sensor systems with circuits and embedded computing, in particular for imaging sensor applications. I was fortunate enough to enter the microsystems field at an early stage and after 27 years of work in this area I have accumulated a great deal of expertise in MEMS materials, microsensor design, microsensor process technology, CAD systems for MEMS design, microfluidics, microphones, pressure and inertial sensors and I am one of the pioneers of this area.

In particular I had the privilege of being a member and co-PI of the University of Michigan one and only microsystems engineering center which was completely focused to the development of new technologies and devices in this area. I was also one of the PIs responsible for the development of the first ever integrated microchip for DNA amplification and separation analysis developed back in 1996. In addition to this academic experience, I developed a great deal of *optical MEMS devices* while on leave from Michigan, as the Vice President of Engineering of Corning-Intellisense. Many of these systems were based on precision micromirror arrays for switching of broadband fiberoptic communication signals. While in industry I have learned many factors that lay outside of academia, but are essential to the success and longevity of commercial based MEMS products and subsystems. Due to the breadth and depth of my experience I am uniquely qualified to address the unique integrations problems that are present in real systems such as the proposed nano-particle-based remote imaing that require integration of many nano-devices, optics, electromagnetic sensors, signal processing, communications and control systems.

B. Positions and Honors

PROFESSIONAL EXPERIENCE

1991-1993 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.

1993-1999 Assistant Professor University of Michigan,

1999-2002 Associate Professor University of Michigan
2000-2004 Vice President of Engineering, Corning-Intellisense, Supervised development of optical MEMS projects directly controlling more than 40 engineers and scientists.
2004-2005 Project Director, Biochemical Technologies Dept., Sullivan Park Research Center, Corning Inc., Corning, Responsible for development of bioMEMS research projects for Corning Life Sciences division.
2005- 2008 Professor of Electrical Engineering, Case Western Reserve University
2007-2008 Director, Microfabrication Laboratory, Case Western Reserve University

2008- USTAR Professor of Electrical Engineering and Bioengineering, University of Utah
2014- Associate Director, University of Utah Nanofabrication Laboratory

Honors

1994 National Science Foundation Presidential Young Investigator Award.
1998 EECS departmental research award for work on microreactors
1998 Interdisciplinary team college research award
1999 IEEE Best Paper Award, J. Semic. Manufacturing, Sept. 2000.

Service

1. Section Editor of the Sensors and Actuators Journal since November 1995-Aug. 2001.
2. Technical committee member and section chair at the 1995 SPIE Conference on Micromachined Devices, Austin, TX, October 23-24, 1995.
3. Technical committee member and section chair at the 1996 International Electron Devices Meeting, (IEDM), San Francisco, CA, December 1996.
4. Technical committee member and section chair at the 1996 SPIE Conference on Micromachined Devices, Austin, TX, October 1996.
5. Technical committee member and section chair at the 1997 SPIE Conference on Micromachined Devices, Austin, TX, October 1997.
6. Technical committee member at the 1998 SPIE Conference on Micromachined Devices and Components IV, Vol 3514, Santa Clara, CA, Sep. 21-22, 1998.
7. 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.
8. Technical committee member at the 2000 Hilton Head Solid-State Sensor Workshop, June 2000.
9. General Chair, 2001 SPIE Conference on Microfluidics and BioMEMS, Vol. 4560, Santa Clara, CA, Sep. 2001.
10. Member of editorial board, Sensors and Actuators Journal, 2001-.
11. Section editor, IEEE Journal of Microelectromechanical Systems, 2004-.
12. Technical committee member, Transducers' 07.
13. Technical committee member, IEEE MEMS 2016.

C. Contribution to Science

1. Pioneer in Stiction for Microsystems: One of my earliest significant contributions has been on the study of adhesion failure in MEMS devices. MEMS devices are slender and flexible and are suspended or built a few micrometers off their respective support substrates. These devices are thus subject to large surface forces that makes them stick and collapse thus resulting in failures. I was the first researcher to investigate this phenomena in 1990. I developed the earliest mathematical models for the presence of the failure based on merging of mechanical and surface energies. I also developed several methods to prevent the failure itself. The understanding and solution of this failure mode directly affects the manufacturing reliabilty and fabrication of several billion inertial MEMS devices fabricated every single year.
    a. C. H. Mastrangelo, "Adhesion related failure mechanisms in micromechanical devices," invited paper, Trib. Letters, Vol. 3, pg. 223-238, 1997.
    b. 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.
    c. 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.

2. Pioneer in Single-Chip Microfluidic Systems for DNA Analysis: 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. The Michigan group developed the first 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.
    a. C. H. Mastrangelo, M. A. Burns and D. T. Burke, "Microfabricated devices for Genetic Diagnostics," Invited paper, IEEE Proceedings, Vol. 86, pp. 1769-1787, August 1998.
    b. 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.
    c. 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.
3. Pioneer in Optical MEMS: 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.
    a. M. R. Dokmeci, A. Pareek, S. Bakshi, M. Waelti, C. D. Fung, K. H. Heng and C. H. Mastrangelo, "Two axis single-crystal silicon micromirror arrays," IEEE Journal of Microelectromechanical Systems, Vol. 13, pp. 1006-1017, Dec. 2004.
    b. E. T. Carlen and C. H. Mastrangelo, **"**High-aspect ratio vertical comb-drive actuator with small self-aligned finger gaps**,**" IEEE Journal of Microelectromechanical Systems, Vol. 14, pp. 1144-1155, 2005.
    c. A. Pareek, M. R. Dokmeci, S. Bakshi and C. H. Mastrangelo, "Torque multiplication and stable range tradeoff in parallel plate angular electrostatic actuators with fixed DC bias," IEEE Journal of Microelectromechanical Systems, Vol. 14, pp. 1217-1222, 2005.

Complete List of Publications

*(*205 research papers (63 journal, 142 refereed conference), 4 book chapters, 1 monograph)
http://www.ece.utah.edu/~mastrangelo/Publications.html

Selected Journal Articles:

1. 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.
2. M. Hasanuzzaman and C. H. Mastrangelo, "Process compilation of thin film microdevices," IEEE Transactions on Computer Aided Design, Vol. 15, pp. 745-763, 1996.
3. 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.
4. E. T. Carlen and C. H. Mastrangelo, "Electrothermally activated paraffin microactuators," IEEE Journal of Microelectromechanical Systems, Vol 11, pp. 165-174, June 2002.
5. E. T. Carlen and C. H. Mastrangelo, "Surface micromachined paraffin-actuated valve," IEEE Journal of Microelectromechanical Systems, Vol. 11, pp. 408-420, Oct. 2002.
6. M. R. Dokmeci, A. Pareek, S. Bakshi, M. Waelti, C. D. Fung, K. H. Heng and C. H. Mastrangelo, "Two axis single-crystal silicon micromirror arrays," IEEE Journal of Microelectromechanical Systems, Vol. 13, pp. 1006-1017, Dec. 2004.
7. L. Chen, F. Azizi and C. H. Mastrangelo, "Generation of dynamic analyte signals with microfluidic C-DACs," *Lab Chip*, 2007, 7, 850–855.

8. J. Zheng, J. R. Webster, C. H. Mastrangelo, V. M. Ugaz, M. A. Burns, D. T. Burke, "Integrated microfluidic plastic device for ssDNA separation," Sensors and Actuators, Vol. B125, pp. 343-351 (2007).

D. Research Support

Ongoing Research Support

NSF ECCS-1550743 EAGER: Implantable Particle-Based Wireless Neural Probes
NSF 1550743 Mastrangelo (PI) 9/01/15-8/30/17
The goal of this grant is the development of particle based neural probes that minimize tissue damage

NSF ECCS-1310013: Molecular Micropumps
NSF 1310013 Mastrangelo (PI) 6/15/13-05/31/16
The goal of this grant is the development of high-vacuum micromachined pumps that enable mass specs on a chip

DARPA NZERO: ZDIBCA – A Zero Power Chemical Analyzer
DARPA NZERO Mastrangelo (co-PI) 09/01/15-07/30/18
This collaborative grant involves the use of tunneling molecular junctions as chemical sensors.
OVERLAP
None.

Pending

CMMI (Mastrangelo) 12/01/2016 – 12/31/2018 1.00 calendar
NSF
Micrpfluidic Multimaterial Two-Photon Deposition System $529,077
This grant aims to develop a microfluidic 2PD platform for additive manufacturing

ECCS (Mastrangelo) 7/01/2016 – 6/30/2018 1.00 calendar
NSF
Ultrasensitive Amplified VOC gas sensors for environmental monitoring $433,111
This grant aims to develop a very sensitive volatile organic compound sensor for environmental monitoring

NBIB (Mastrangelo) 1/01/2016 – 12/31/2018 1.56 calendar
U01
CPS: Synergy: CPS for Smart Corrective Eyeglasses $999,341
This grant aims to develop smart adaptive eyeglasses based on adaptive optics

NIH (Kim) 12/01/2016 – 11/30/2018 0.72 calendar
R21
Development of low-cost sensor microsystems for continuous monitoring of air quality exposures among pediatric asthmatics *$418,080*
This grant aims to develop a wearable and silent VOC exposure monitoring tool for pediatric asthma study.

NIH (Mastrangelo) 12/01/2016 – 12/31/2018 1.0 calendar
R21
A label-free platform tool for a wide sprectrum of point-of-care testing $500,000
This grant aims to develop an LSPR microfluidic platform for POC diagnostics
OVERLAP
None.

Completed Research Support

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 $12M 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 maker	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	3
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
Particle based manometry	NSF	03/12-04/15	$330K	C. Mastrangelo	2