

08/01/2007

## **CURRICULUM VITAE**

### **RAJ MUTHARASAN**

Frank A. Fletcher Professor of Chemical and Biological Engineering  
Drexel University, 3141 Chestnut St, Philadelphia, PA 19104

(215)-895-2236  
Mutharasan@drexel.edu

## PERSONAL

*Date of Birth* Jan 1, 1947  
*Marital Status* Married to Karpagavalli Pandurangan (Hudson United Bank, West Chester)  
*Address* 312 Tarbert Drive, West Chester, PA 19382  
*Telephone* (215)-895-2236 (office)  
*Citizenship* United States of America

## EDUCATION

Ph.D. Drexel University, 1973  
Thesis: Direct Digital Control of a Class of Distributed Parameter Systems. Advisor: D.R. Coughanowr

M.S. Drexel University, 1971  
Thesis: Time Delay Simulation Using Analog Memory Units. Advisor: D.R. Coughanowr

B.S. Indian Institute of Technology, Madras, India, 1969  
Design: Ammonia Synthesis Gas from Naptha. Advisor: Dr. Davies

## PROFESSIONAL EXPERIENCE

Drexel University, Philadelphia, PA  
Interim Dean, College of Engineering, 7/97 – 1/00  
Frank A. Fletcher Professor of Chemical Engineering, 1995- present  
Professor, Chemical Engineering, 1984 - present  
Associate Professor, Chemical Engineering, 1980 - 84  
Assistant Professor, Chemical Engineering, 1976 - 80  
Visiting Assistant Professor, Chemical Engineering, 1974-76

Massachusetts Institute of Technology, Cambridge, MA  
Visiting Professor, Department of Chemical Engineering and Biotechnology Process Engineering Center, 8/89 - 1/90. Host: D. I. C. Wang

Lehigh University, Bethlehem, PA  
Visiting Professor, Department of Chemical Engineering, Center for Cellular and Molecular Biology, 1/90 - 5/90. Host: A. E. Humphrey

University of Toronto, Toronto, Canada  
Post Doctoral Fellow, Department of Chemical Engineering and Applied Chemistry, 8/73 - 7/74. Contact: Rein Luus

### *Summer experiences while an undergraduate*

Regional Research Lab, Hyderabad, India. Summer 1968. Pilot plant, coal gasification unit.  
Durgapur Steel Plant, Durgapur, India. Summer 1967, Career Trainee, Coke Oven Division.

## PROFESSIONAL ACTIVITIES

*Professional activities are classified as membership in organizations, appointments and activities in professional societies, academia, industry, government, and civic appointments.*

### *Membership in National Organizations*

American Institute of Chemical Engineers (AIChE), 1974 - present  
Food, Pharmaceutical and Bioengineering Division (FPBD)  
The Metals Society (TMS-AIME), 1977 -2001  
American Society of Engineering Educators (ASEE), 1993-2002  
American Chemical Society (ACS), 1981 - present  
Industrial Chemistry  
Biotechnology  
American Association of Advancement of Science (AAAS), 1989-92, 2004- present  
Association for Research in Vision and Ophthalmology (ARVO), 2000-03

AIChE, Programming Chair, Biotechnology (Area 15C), 1987-90

AIME - TMS, Aluminum Committee, 1998 - 2001  
AIME - TMS, Awards Committee, 1988 - 91  
AIME - TMS, Continuing Education Committee, 1986 - 88  
AIME - Metallurgical Transactions B  
Editorial Board of Metallurgical Transactions B, 1983 – 86

AIME - TMS, Symposium Chair, Melt Treatment, AIME Annual Meeting, San Antonio, TX, Feb 1998  
AIChE, Education Project Committee, 1981- 84.  
AIChE-Delaware Valley Section, Meeting Arrangements Chair, 1976  
Mid-Atlantic Biotechnology Consortia Annual Meeting, Conference Chair, Philadelphia, 3/1992.  
Engineering Foundation, Conference Co-Chair, "Biochemical Engineering VII," Princeton, NJ, July 1993.

AIChE, Symposium Chair, "Measurement, Instrumentation and Control of Fermentation Processes," Nov 1983.  
Engineering Foundation, Session Chair, "Microbial Production of Fuels," in Biochemical Engineering II, Galway, Ireland, October 1984.  
ACS, Symposium Chair, "Sensors for Fermentors - Physical and Algorithmic," Philadelphia, Sep 1984.  
ACS, Symposium Chair, "Kinetics and Reactor Design in Anaerobic and Microaerobic Fermentation," Chicago, Sep 1985.  
AIME, Symposium Chair, "Modeling in Process Metallurgy," Annual AIME meeting, New York, Feb 1985.  
AIChE, Symposium Chair, "Metabolic Regulation via Physical/Chemical Environmental Control," AIChE Meeting, Miami, Nov 1986.  
AIChE, Symposium Chair, "Advances in Mammalian Cell Technology: Metabolic Studies," San Francisco, and Nov 1989.  
AIChE, Symposium Chair, "Advances in Mammalian Cell Technology: Reactor Studies," San

Francisco, Nov 1989  
AIChE, Symposium Chair, "Transport Processes in Bioreactors: Fundamentals and Applications,"  
Los Angeles, Nov 1991.  
Engineering Foundation, Session Chair, "Advances in Biochemical Engineering," in "Biochemical  
Engineering VI," Santa Barbara, CA, March 1991.  
ACS, Symposium Chair, "Biosensors," Boston, August 2007.

### *Appointments and Activities -Academia*

Provost's Advisory Committee on Research Initiatives, Worcester Polytechnic Institute, Worcester,  
MA, 1991.

IST Dean Search Committee, 1998  
CoE Dean Search Committee, 1997  
tDEC Council, 1996 -2000  
Academic Committee, Drexel's Future, 1992-94.  
Strategic Planning Conference (President Gaither, Drexel), 1985.  
Faculty Council, 1986-88  
Graduate Dean's Advisory Committee, 1983-87.  
Faculty Representative, Hershey Planning Conference (President Hagerty, Drexel), 1981.  
Joint Engineering-Science College Computer Committee, 1977-79.  
College of Engineering Computer Committee, 1977-79.  
College Tenure and Promotion Committee, 1985-90, 1992-97  
Chair, Departmental Graduate Committee, 1979 – 1997; 2001-02  
Several Ad Hoc College Committees, 1974 - present  
Several Standing and Ad Hoc Departmental, College and University Committees, 1974 – present

### *Appointments and Activities -Industrial*

Served in an advisory or consulting capacity to the following organizations:

Praxair, 1999  
Aluminum Company of America, Pittsburgh, PA, 1999  
Apogee Technologies, 1997 - present  
Aluminum Company of America, Pittsburgh, PA, 1978 - 96  
Metaullics Inc, Cleveland, Ohio, 1994-96  
Centacor, Malvern, PA, 1994-95.  
Sterling Drugs, Malvern, PA, 1993-95.  
Smith Kline Beechum, Philadelphia, PA, 1993-94  
United Engineers, Philadelphia, 1993.  
Short Course on "Aluminum Melt Treatment," TMS, Feb 1991, 93, 96  
BioChemTechnology Inc, Malvern, PA, 1982 -92  
Tosho SMD, Columbus, Ohio, 1992-94  
Corning, NY, 1984-86  
Solar Energy Research Institute, Boulder, CO, 1980-81  
SOHIO, Cleveland, Ohio, 1980-82  
United Nations, 1978-80  
Foote Mineral, 1978 - 80

### *Appointments and Activities -Civic*

Member of the Board, Council of Indian Organizations in Philadelphia, 1988-90, 96-98.  
Organizing Committee, 50th Anniversary Celebration of India's Independence, 1997.  
Advisory Committee on Indian Ethnicity, Balch Institute, Philadelphia, 1997 - 1999

### **AWARDS AND HONORS**

- Elected - Fellow of American Institute of Chemical Engineers, 2001
- Elected – Fellow of American Institute for Medical and Biological Engineering, 2006
- Appointed to the Editorial Board of *Sensors Letters*, 2005
- Awarded O. Hugh Schuck Best Paper Awards at 1998 JACC for the paper titled, “Multi-Rate Nonlinear State and Parameter Estimation in a Bioreactor,” co-authored with M. Soroush and S. Tatiraju
- Awarded Allied Chemical Foundation Research and Teaching Prize, June 82 and June 83.
- Drexel University 10<sup>6</sup> Research Award, 2003
- College of Engineering Distinguished Service Award, 2003
- Lindback Teaching Award, June 1988
- University Research Achievement Award, Feb 1986
- Nominated to Dow Outstanding Young Faculty Award, 1980.
- Invited to present "Filtration as a Refining Process for Steel" in the symposium on Innovative Steelmaking Technologies, Office of Technology Assessment, U.S. Congress, May 1979.

### **ARTICLES ABOUT MUTHARASAN’S LAB IN MEDIA**

“10-minute test for deadly stomach bug” in New Scientist, Feb 06, 2006.

[http://www.newscientist.com/article.ns?id=mg18925376.600&feedId=mech-tech\\_rss20](http://www.newscientist.com/article.ns?id=mg18925376.600&feedId=mech-tech_rss20)

Handheld sensor detects pathogens within 10 minutes at Labtechnologist.com

Discoveries and Breakthroughs in Science: <http://www.ivanhoe.com/science/story/2006/11/213a.html>

### **RESEARCH INTERESTS**

#### ***Biosensors***

Sensing extremely small number of pathogens (in the order of a few in one mL of liquid) or quantifying the presence of 10,000 protein molecules in body fluids are enabling technologies toward both health care, drug discovery and biosecurity. My lab develops three sensor platforms: piezoelectric-excited millimeter-sized cantilever sensors, tapered fiber evanescent field sensors and magneto-elastic resonating sensors. All three platforms have shown exquisite sensitivity, yet are robust for field applications. For example, we can observe in real time attachment of 28kD toxin, Staphylococcus enterotoxin B (SEB) to an antibody-immobilized sensor at a concentration of 100 femtogram/mL. We have filed for provisional patents on the cantilever and tapered fiber sensors, as both have shown sensitivity at femtograms. Further, we have recently discovered novel mechanical oscillators that show promise at 1.8 and 4.2 MHz which in our initial work show sub-femtogram sensitivity under liquid immersion conditions. These structures that are of millimeter scale are currently being developed for detecting biomolecules.

## ***Bioreactors***

Production of recombinant proteins for clinical applications requires cultivation of shear-sensitive somatic and other cells in scales of 1,000 to 10,000 liters. In the reactors, the cells are subjected to normal stresses due to agitation and damaging gas-liquid interface due to aeration. Such an environment induces subtle, yet measurable intracellular changes. Our working hypothesis is such changes alter non-template driven reactions such as glycosylation due to significant departures in intracellular pH. Our current focus is to develop a method of measuring intracellular pH of cells under cultivation conditions and then to link this property to changes observed in glycosylation. Our model system is a CHO cell line expressing beta-interferon. Our broader interests are manipulation of cellular catabolic pathways by suitable cultivation environment, development of novel bioreactors and operating strategies for mammalian cell systems, and the use of fluorescence technique(s) in assessing physiological state of cultures in production systems.

## ***Process Metallurgy***

About a third of all aluminum produced in the US is for the beverage can industry. The side wall of a typical beverage can is about 10 microns. Aluminum ingots, the starting point for can production, therefore must be devoid of particles and "gas voids" of dimension 10 microns. Processes for removing micron-sized inclusions from melt systems at processing rates of over 100,000 lb per hour offers interesting challenges. My work over the past 20 years has focused on depth filtration technology for molten aluminum, dynamics of depth and cake filters, role of liquid phase inclusion filter stability, methods of efficient hydrogen removal, and automation in casting processes. Recent work with Department of Energy funded via Apogee Technology Inc. (Pittsburgh, PA) has lead into melting technologies. Our work at Drexel has focused on mathematical modeling of heat transfer to metal flowing past bank of electrical heaters whose internal temperatures exceed 1000 °C.

### **RESEARCH FUNDING (LAST 10 YEARS)**

"*In Situ* Composite Processing in Ti-containing Al Alloys," ALCOA, \$150,000, 4/1/94 to 6/30/98, Joint-PI with Mike Koczak.

"Plasma Pyrolysis of Energetics," PTI/Alliant Tech., \$335,400, 6/1/93 - 9/30/95, Joint-PI with Ron Smith.

"Advanced Materials Processing," NSF, \$179,000, 9/1/93- 8/31/96, Joint-PI with Alan Lawley.

"Engineering Biotechnology," Gateway Coalition/NSF, \$284,939 (sponsor: \$167,000), 6/1/95 - 8/31/97, PI, (Co-PI: W. Magee, M. A. Wheatley, Y.H. Lee)

"Fundamentals of Manufacturing Engineering," Gateway Coalition/NSF, \$115,630(sponsor: \$69,000), 6/1/95 - 8/31/97, PI, (Co-PI: C. B. Weinberger).

"Curriculum Innovations Development - Coalition Project Area," Gateway/NSF, \$43,000 (sponsor: \$30,000), 9/1/95 - 8/31/97, PI.

"Institutionalization of Engineering Curriculum," with Bruce Eisenstein, NSF: Gateway Coalition II, 9/97 – 8/98, \$428,000; continued 9/98 – 8/99, \$387,000; continued 9/99 – 8/99, \$ 350,000; continued 9/99 – 8/00, \$330,000, continued 9/00 – 8/01, \$290,000; continued 9/01 – 8/03, \$240,000. This

project has multiple segmented tasks which were carried out by several Co-PIs.

“Aluminum Melting Heater System Optimization,” Department of Energy/Apogee Technologies, \$239,000, 4/1/01 - 3/31/04. **PI.**

“Femtogram Biomolecular Recognition Using Piezoelectric Microcantilevers,” NSF, \$100,000, 9/1/01 to 8/31/03. Co-PI (33%). (PI: W. Shih)

“Ultra-sensitive Pathogen Quantification in Drinking Water Using Highly Piezoelectric PMN-PT,” EPA, \$449,000, 4/1/02 to 12/31/05, Co-PI(33%). (PI: W. Shih)

“Ultra-sensitive High-Temperature Selective Gas Detection Using Piezoelectric Microcantilevers ,” Department of Energy, \$50,000, 10/01/02-9/31/03, Co-PI(33%). (PI: W. Shih)

“Quantitative Array Piezoelectric Microcantilever Sensors,” NIH-NIBIB, \$1,056,258, 9/1/02 to 8/31/06. Co-PI(33%). (PI: W. Shih). This is a multiple investigator award in which my lab is responsible for the cantilever sensor, interfacial chemistry and detection technology.

“Metabolic Sensing at Single Cell Level Using Biophotonics,” Nanotechnology Institute/Ben Franklin Partnership, \$120,000, 9/01/02-6/31/06, PI.

“Portable Anthrax Detector,” Department of Transportation (PA-26-0017-00), \$3,750,000, 9/1/2004 – 3/31/2008, Co-PI (25%). (PI: Banu Onaral).

“Rapid assay of prostate cancer biomarkers in urine for point-of-care applications,” PA Department of Health, \$99,500, 1/1/2007 – 12/31/2007, PI (Co-PI: F. U. Garcia)

#### **ACTIVE GRANTS AND CONTRACTS**

"Label-free Attogram Biosensors", \$317,000, 09/01/2008-08/31/2011, NSF Award CBET-0828987, **PI.**

"Femtogram Biomarker Serum Analyzer", NIH/Leversense LLC, \$75,591, 5/1/2008 - 5/1/2009, **PI.**

"Near-Real Time, Highly Sensitive and Selective Field-Deployable Biosensor for Cyanotoxins and Cyanobacteria using Antibodies and DNA-Signatures". This grant will provide a total amount of \$599,999, 6/1/2008 - 5/31/2011, **PI**

“An Integrated Research and Educational Program on Highly Sensitive and Selective Biosensors for Food borne Pathogens and Toxins”, \$560,000, 9/1/2006 – 8/31/2009, USDA 2006-51110-03641, **PI**

“Robust Piezoelectric-excited millimeter-sized cantilever sensors for detecting pathogens (1 cell/mL) in drinking water”, \$567,000, 9/15/2006 – 9/14/2009, EPA: RD-83300701-0, **PI**

“Ultra Sensitive Continuous Tapered Fiber Biosensors for Pathogens and Bioterrorism Agents,” NSF, \$455,917, 9/1/03 – 8/31/07, BES 329793, **PI.** (Co-PI: P. M. Shankar).

## GRADUATE STUDENTS DIRECTED

### *Post-Doctoral Fellows*

G. Giger (1977-78)	Xiaming Tao (1990)
C. Romanowski (1980-82)	Guang Wu Du (1991 -92)
V. Kannan (1984-86)	Zhong Cai (1992-94)
R. Sachdev (1984-86)	Anne Huhtala (1995- 97)
K. F. Teng (1984-85)	Yanjun Ding (2008- )
S. Luk (1985-87)	

### *Doctor of Philosophy Dissertations*

- Gencer, M. A., "Ethanol Fermentation in a Yeast Immobilized Tubular Fermentor," 1981. (Current Position: Director R&D, Process and Waste Treatment, BF Goodrich)
- Fireoved, R. L., "Inhibition Kinetics of Acid Hydrolyzate Byproducts on Yeast," 1983. (at Corn Products Corp., IL)
- Ali, S., "Removal of Solid Inclusions From Steel Melts," Co-advised with D. Apelian, 1984.
- Teng, K. F., "Hydrolysis Kinetics of Cellulose in Concentrated Slurry Systems at Short Reaction Times," Co-advised with E. D. Grossmann, 1984.
- Menawat, A., "Optimal Control of Fed Batch Bioreactors," Co-advised with D. R. Coughanowr, 1986.
- Shukla, R., "Enzyme-mimicking Inorganic Catalysts," 1986.
- Srinivas, S. P., Representation of Physiological States in the Modeling of ABE Fermentation and of Culture Fluorescence, 1987. (Current Position: Associate Professor, School of Optometry, Indiana University, Bloomington, IN)
- Rao. G., "Directed Metabolic Flow in *Clostridium Acetobutylicum*," 1987. [Current Position: Head of Dept. of Chemical and Biochemical Engineering, University of Maryland, Baltimore County, Baltimore, MD)
- Eckert, C.E., "An Analysis of the Effects of Substrate Hydrophobicity on Poiseuille Flow in Capillaries," Co-advised with D. Apelian, 1989. (Current Position: President, Apogee Technology Inc., Pittsburgh, PA)
- Siano, S., "Coenzyme Fluorescence Responses of Yeast and Hybridoma Subjected to Induced Metabolic Transitions," 1990. (Senior Research Engineer, Agilent, San Jose, CA)
- Ramirez-Reivich, O.T., "Cultivation of Hybridoma Cells under Hydrodynamic Stress: Structural and Metabolic Considerations," 1990. (Head, Molecular Medicine and Bioprocesses, University of Mexico, Mexico)
- Sureshkumar, G. K., "Intracellular pH-Based Cultivation: Application to Yeast and Hybridoma," 1994. [Current position: Head, Dept of Biotechnology, Indian Institute of Technology

Madras, India]

Qian, Feng, "Transport Processes in Liquid Baths and Gas-Liquid Interfaces due to Impinging Gas and Plasma Jets," Co-advised with B. Farouk, 1995.

Kent, B., "The Effect of Growth Surface Properties on the Cultivation of Anchorage Dependent Animal Cells and the Development of Novel Surfaces for Cell Culture," 1995.

Shtessel, V., "Reactive Pressureless Infiltration Techniques for Cu Alloy/Titanium Diboride and Other *in situ* composites: Processes and Models," Co-advised with M. J. Koczak, 1997.

Ozkan, Pinar, "Role of Intracellular pH in rProtein Production: Kinetics and Yield," 2001. (Biogen, Boston, MA)

Lall, Raman, " Ozonation of a class of Indigo Dyes," 2002. Co-advised with Y. T. Shah (Research Associate, University of South Carolina).

Gossett Campbell, "Ultra Low Pathogen Detection using Piezoelectric-Excited Millimeter-Sized Cantilevers," 2006. (Current position: Product Manager, GlaxoSmithKline, Philadelphia, PA)

Angela Leung, "Antibody-immobilized Evanescent Field Sensors," June 2007. (Current position: Validation Engineer, Merck)

Kishan Rijal, " Self Assembly and Patterning of Antibodies on Cantilever Biosensors," June 2007. (Current position: Senior Research Engineering, Merck)

David Maraldo, "Novel Piezoelectric Excited Mechanical Oscillators for Biosensing," September 2007. (Current position: Manufacturing Research Manager, Merck)

Xen Su, "DNA sensors", in progress (1<sup>st</sup> year).

Sharma, Harsh, "Waterborne and foodborne pathogen and toxin sensors," in progress (1<sup>st</sup> year).

Tam Tran, "Cantilever biosensors," in progress (1<sup>st</sup> year).

### ***Master of Science Thesis***

R. Gautam (1976)\*

J. Fuhrman (1977) \*

I. Er (1981)

P. Geleta (1981)

M. P. McGuinness (1981)

J. C. Chesna (1982)

D. R. Whitcraft (1982)

A. Takeuchi (1982) \*

V. G. Ullal (1982) \*

R. Gopalakrishnan (1983) \*

J. K. Lee (1983)

S.P. Bui (1984)

E. J. McCallion (1984)

P. A. Howley (1984)

M. Givehchi (1984)

B. G. Pike (1984)

R. C. Dougherty (1985) \*

P. J. Ward (1986)

F. C. Siu (1986)

O. T. Ramirez-Reivich (1987)

S. Jones (1987) \*

N. D. K. Fournogerakis (1987)

Y. T. Luan (1987)

J. S. Zakrewski (1987)

C. Schade(1988) \*

W. M. Eickhoff (1990)

E. Tefft(1993)

H. Zhang (1993)

B. Somani (1994) \*  
L. Montalvo(1996)  
S. Gupta (1997) \*  
Qinghua Hou (1997) \*  
B. Garapati (1998)  
K. Sudhakar (2001)  
Hong Sang (2002)

Pawel Wiejata (2002)  
Angela Labadessa(2004)  
David Moraldo(2003)  
Edwin Chuy (2004)  
Raul Jackson (in progress)  
Htet Htet Winang (in progress)

\* Jointly directed with a faculty colleague.

## UNDERGRADUATE STUDENTS DIRECTED

Typically my lab accepts 2 to 3 undergraduates per year. There have been years when it has been as high as 5.

## PUBLICATIONS

### *Books Edited*

“Biochemical Engineering VII,” New York Academy of Sciences, Editors: D. DiBiasio, H. Pederson and R. Mutharasan, (1992)

### *Multimedia Instructional CDs*

**R. Mutharasan**, W. E. Magee, M. A. Wheatley, Y. H. Lee, “Engineering Biotechnology,” A self-standing multimedia learnware, June 1997. A 350-page browsable text book and multimedia lectures available for download. [Link](#).

**R. Mutharasan** and C. B. Weinberger, “Fundamentals of Manufacturing,” A self-standing multimedia learnware, September 1997. A 100-page browsable text book and a multimedia lectures available for download. [Link](#).

### *Chapters in Books*

Srinivas, S. P., G. Rao and **R. Mutharasan**, "Redox Potential in Anaerobic and Microaerobic Fermentation," Handbook on Anaerobic Fermentation, Marcel Dekker, Inc., New York, Editors: L. E. Erickson and D. Y. C. Fung, (1988).

Lee, Y. H. and R. Mutharasan, “Biosensors,” [Sensor Technology Handbook](#), pp 115-136, Editor: Jon Wilson, ISBN: 0-7506-7729-5, Elsevier, New York (2005).

Shankar, P. M. and **R. Mutharasan**. [Tapered fibers for cell studies, in Reviews in Fluorescence](#), pp 63-77, Editors: Chris D. Geddes and Joseph R. Lakowicz, ISBN: 0387236287, Springer Verlag, New York (2005).

Patil, T., Q. Zhao, **R. Mutharasan**, W. Shih and W.-H. Shih, “Microporous Silica Modified with Alumina as CO<sub>2</sub>/N<sub>2</sub> Separators,” in [Colloidal Ceramic Processing of Nano-, Micro-, and Macro-Particulate Systems](#), Ceramic Transactions Volume 152, Editors: Wei-Heng Shih,

Yoshihiro Hirata, William Carty. Published by American Ceramics Society, Westerville, OH. 2004.

Leung, A.; Shankar, P. M.; **Mutharasan, R.**, "Evanescent Field Tapered Fiber Optic Biosensors: Fabrication, Antibody Immobilization and Detection", *Optical Fibers Research Advances*, pp 15-49, Editor: Jurgen C. Schlesinger, Nova Science Publishers, Inc., ISBN: 978-1-60021-866-8, (2007).

Mutharasan, R., "Cantilever Sensors for Pathogen Detection," *Principles of Bacterial detection: Biosensors, recognition receptors and Microsystems*, Editors: Mohammed Zourab, Souna Elwary, and Anthony Turner, Springer-Science and Business Media Inc., New York, ISBN: 978-0-387-75112-2, in press; (2008)

Mutharasan, R., "Piezoelectric-Excited Millimeter-Sized Cantilever (PEMC) Biosensors," Editor: Avraham Rasooly, *Biosensors, Methods in Biotechnology*, The Humana Press Inc., Totowa, New Jersey, in press; (2008)

### *Journal Articles*

#### 2008

1. Leung, A.; Shankar, P. M., **Mutharasan, R.**, Label-free detection of DNA hybridization using gold-coated tapered fiber optic biosensors (TFOBS) in a flow cell at 1310 and 1550 nm, *Sensors and Actuators B: Chemical* **2008**, 131(2):640-645.
2. Maraldo, D.; Mutharasan, R., Mass-Change Sensitivity of Piezoelectric-Excited Millimeter-Sized Cantilever (PEMC) sensors: Model and Experiments, *Sensors and Actuators B: Chemical* **2008**, 132(1):140-148.
3. Leung, A.; Shankar, P. M., **Mutharasan, R.**, Model Protein Detection Using Antibody-Immobilized Tapered Fiber Optic Biosensors (TFOBS) in a Flow Cell at 1310 nm and 1550 nm, *Sensors and Actuators B: Chemical* **2008**, 129(2):716-725.
4. Campbell, G. A.; **Mutharasan, R.**, Near real-time detection of *Cryptosporidium parvum* oocyst by antibody functionalized Piezoelectric-Excited Millimeter-Sized Cantilever Biosensor. *Biosensors and Bioelectronics* **2007**, 23(7):1039-1045. [doi: 10.1016/j.bios.2007.10.017](https://doi.org/10.1016/j.bios.2007.10.017)

#### 2007

5. Maraldo, D., **Mutharasan, R.**, Preparation-free method for detecting *Escherichia coli* O157:H7 in the presence of spinach, spring lettuce mix, and ground beef particulates. *Journal of Food Protection* **2007**, 70(11):2651-2655.
6. Rijal, K.; **Mutharasan, R.**, A method of measuring DNA hybridization at femtomolar concentration directly in human serum and in the presence of copious non-complementary strands. *Analytical Chemistry* **2007**, 79 (19): 7392-7400. [doi: 10.1021/ac0712042](https://doi.org/10.1021/ac0712042)

7. Maraldo, D.; Garcia, F. U. and Mutharasan, R., A method for rapid quantification of a prostate cancer biomarker in urine without sample preparation. *Analytical Chemistry* **2007**, 79(20):7683-7690. [doi: 10.1021/ac070895z](https://doi.org/10.1021/ac070895z)
8. Marlado, D.; Mutharasan, R., Detection and confirmation of Staphylococcal Enterotoxin B in apple juice and milk using piezoelectric-excited millimeter-sized cantilever (PEMC) sensors at 2.5 femtograms/mL. *Analytical Chemistry* **2007**, 79(20):7636-7643. [doi: 10.1021/ac070589j](https://doi.org/10.1021/ac070589j)
9. Wilson, T. L.; Campbell, G. A., **Mutharasan, R.**, Viscosity and density values from excitation level response of piezoelectric-excited cantilever sensors. *Sensors and Actuators A: Physical* **2007**, 138(1):44-51. [doi: 10.1016/j.sna.2007.04.050](https://doi.org/10.1016/j.sna.2007.04.050)
10. Campbell, G. A.; Medina, M. B., **Mutharasan, R.**, Detection of Staphylococcus Enterotoxin B at picogram levels using Piezoelectric-Excited Millimeter-Sized Cantilever Sensors. *Sensors and Actuators B: Chemical* **2007**, 126(2):354-360, [doi:10.1016/j.snb.2007.03.021](https://doi.org/10.1016/j.snb.2007.03.021).
11. Campbell, G. A.; deLesdernier, D., **Mutharasan, R.**, Detection of airborne *Bacillus anthracis* spores by an integrated system of an air sampler and a cantilever immunosensor. *Sensors and Actuators B: Chemical* **2007**, 127(2):376-382. [doi:10.1016/j.snb.2007.04.038](https://doi.org/10.1016/j.snb.2007.04.038).
12. Maraldo, D., **Mutharasan, R.**, 10-Minute Assay for Detecting Escherichia coli O157:H7 in Ground Beef Samples using Piezoelectric-Excited Millimeter-Sized Cantilever (PEMC) Sensors. *Journal of Food Protection* **2007**, 70(7), 1670-1677. [PubMed Link](#) [JoFP link](#)
13. Leung, A.; Shankar, P. M., **Mutharasan, R.**, A Review of Fiber-Optic Biosensors. *Sensors and Actuators B: Chemical* **2007**, 123(2), 888-895. [doi: 10.1016/j.snb.2007.03.010](https://doi.org/10.1016/j.snb.2007.03.010)
14. Rijal, K.; **Mutharasan, R.**, A method for measuring self-assembly of alkanethiols on gold at femtomolar concentrations. *Langmuir* **2007**, 23(12); 6856-6863. [doi: 10.1021/la063768r](https://doi.org/10.1021/la063768r)
15. Maraldo, D., **Mutharasan, R.**, Optimization of antibody immobilization for sensing using piezoelectrically excited-millimeter-sized cantilever (PEMC) sensors. *Sensors and Actuators B: Chemical* **2007**, 123, (1), 474-479. [doi: 10.1016/j.snb.2006.09.034](https://doi.org/10.1016/j.snb.2006.09.034)
16. Rijal, K.; **Mutharasan, R.**, Piezoelectric-excited millimeter-sized cantilever sensors detect density differences of a few micrograms/mL in liquid medium. *Sensors and Actuators B: Chemical* **2007**, 121(1), 237-244. [doi:10.1016/j.snb.2006.12.043](https://doi.org/10.1016/j.snb.2006.12.043)
17. Maraldo, D.; Rijal, K.; Campbell, G.; **Mutharasan, R.**, Method for Label-Free Detection of Femtogram Quantities of Biologics in Flowing Liquid Samples. *Analytical Chemistry* **2007**, 79, 2762-2770. [doi: 10.1021/ac0621726](https://doi.org/10.1021/ac0621726)
18. Leung, A.; Shankar, P. M.; **Mutharasan, R.**, Real-time monitoring of bovine serum albumin at femtogram/mL levels on antibody-immobilized tapered fibers. *Sensors and Actuators B: Chemical* **2007**, 123(2), 888-895. [doi: 10.1016/j.snb.2006.10.056](https://doi.org/10.1016/j.snb.2006.10.056)
19. Campbell, G. A.; Uknalis, J.; Tu, S.-I.; **Mutharasan, R.**, Detection of *Escherichia coli* O157:H7 in ground beef samples using piezoelectric excited millimeter-sized cantilever (PEMC) sensors. *Biosensors and Bioelectronics* **2007**, 22, (7), 1296-1302. [doi: 10.1016/j.bios.2006.05.028](https://doi.org/10.1016/j.bios.2006.05.028)

20. Campbell, G. A.; **Mutharasan, R.**, Method of measuring *Bacillus anthracis* spores in the presence of copious amounts of *Bacillus thuringiensis* and *Bacillus cereus*. *Analytical Chemistry* **2007**, 79, (3), 1145-1152. [doi: 10.1021/ac060982b](https://doi.org/10.1021/ac060982b)
21. Campbell, G. A.; **Mutharasan, R.**, A method of measuring *Escherichia coli* O157:H7 at 1 cell/mL in 1 liter Sample Using Antibody Functionalized Piezoelectric-Excited Millimeter-Sized Cantilever Sensor. *Environmental Science & Technology* **2007**, 41(5), 1668-1674. [doi:10.1021/es061947p](https://doi.org/10.1021/es061947p)

## 2006

22. Campbell GA, **Mutharasan R.** 2006. Piezoelectric-excited Millimeter-sized Cantilever (PEMC) Sensors Measure Albumin Interaction with Self-assembled Monolayers of Alkanethiols having different Functional Head Groups. *Analytical Chemistry*. 78(7); 2328-2334. [doi: 10.1021/ac0517491](https://doi.org/10.1021/ac0517491)
23. Maraldo, D. P. Mohana Shankar and **Mutharasan, R.** 2006. Measuring bacterial growth by tapered fiber and changes in evanescent field. *Biosensors and Bioelectronics*. 21(7): 1339-1344 [doi:10.1016/j.bios.2005.04.012](https://doi.org/10.1016/j.bios.2005.04.012)
24. Campbell GA, **Mutharasan R.** 2006. Piezoelectric-excited millimeter-sized cantilever (PEMC) sensors detect *Bacillus anthracis* at 300 spores/mL. *Biosensors and Bioelectronics*. 21(9):1684-1692 [doi:10.1016/j.bios.2005.08.001](https://doi.org/10.1016/j.bios.2005.08.001)
25. Campbell GA, **Mutharasan R.** 2006. PEMC Sensor's Mass Change Sensitivity is 20 pg/Hz under Liquid Immersion. *Biosensors & Bioelectronics* **2006**, 22, (1), 35-41. [doi:10.1016/j.bios.2005.11.020](https://doi.org/10.1016/j.bios.2005.11.020)
26. Leung, A., Rijal, K., P. Mohana Shankar and **Mutharasan, R.** 2006. Effects of Geometry on Transmission and Sensing Potential of Tapered Fiber Sensors. *Biosensors and Bioelectronics*. 21 (12): 2202-2209. [doi:10.1016/j.bios.2005.11.022](https://doi.org/10.1016/j.bios.2005.11.022)
27. Campbell GA, **Mutharasan R.** 2006. Detection of *Bacillus anthracis* spores and a model protein using PEMC sensors in a flow cell at 1 mL/min. *Biosensors & Bioelectronics* **2005**, 21, (4), 597-607. [doi:10.1016/j.bios.2005.12.002](https://doi.org/10.1016/j.bios.2005.12.002)
28. Detzel, A., Campbell GA, **Mutharasan R.** 2006. Rapid Assessment of *Escherichia coli* by Growth Rate on Millimeter-Sized Self-Excited PZT-Glass Cantilever. *Sensors and Actuators B-Chemical* 2006, 117, (1), 58-64. [doi:10.1016/j.snb.2005.10.045](https://doi.org/10.1016/j.snb.2005.10.045)
29. Leung, A., P. Mohana Shankar and **Mutharasan, R.** 2006. Antibody-immobilized Tapered Fiber Senses A Model Protein at 10 femtogram per mL at 1550 nm. *Sensors and Actuators B*, in press. [doi:10.1016/j.snb.2006.10.056](https://doi.org/10.1016/j.snb.2006.10.056)

## 2005

30. Campbell GA, **Mutharasan R.** 2005. Monitoring of the Self-Assembled Monolayer of 1-Hexadecanethiol on Gold Surface at Nanomolar Concentration Using Piezoelectric-Excited Millimeter-Sized Cantilever Sensor. *Langmuir*. 21(25):11568-11573. [doi: 10.1021/la0519960](https://doi.org/10.1021/la0519960)

31. Campbell GA, **Mutharasan R.** 2005. Sensing of liquid level at micron resolution using self-excited millimeter-sized PZT-cantilever. *Sensors and Actuators A-Physical*. 122 (2): 326-334. [doi:10.1016/j.sna.2005.05.012](https://doi.org/10.1016/j.sna.2005.05.012)
32. Huhtala A, Linko P, **Mutharasan R.** 2005. Protein response of insect cells to bioreactor environmental stresses. *Journal of Biotechnology* 118 (3): 278-289. [doi:10.1016/j.jbiotec.2005.05.009](https://doi.org/10.1016/j.jbiotec.2005.05.009)
33. Campbell GA, **Mutharasan R.** 2005. Escherichia coli O157 : H7 detection limit of millimeter-sized PZT cantilever sensors is 700 Cells/mL. *Analytical Sciences* 21 (4): 355-357. [http://www.jstage.jst.go.jp/article/analsci/21/4/355/\\_pdf](http://www.jstage.jst.go.jp/article/analsci/21/4/355/_pdf)
34. Rijal, K., Leung, A., P. Mohana Shankar and **Mutharasan, R.** 2005. Detection of Pathogen *E. coli* O157:H7 using Antibody-Immobilized Biconical Tapered Fiber Sensors at 70 cells/mL, *Biosensors and Bioelectronics*. 21(6):871-880. [doi:10.1016/j.bios.2005.02.006](https://doi.org/10.1016/j.bios.2005.02.006)
35. Campbell GA, **Mutharasan R.** 2005. Detection and quantification of proteins using self-excited PZT-glass millimeter-sized cantilever. *Biosensors and Bioelectronics*, 21(4):597-607. [doi:10.1016/j.bios.2004.12.016](https://doi.org/10.1016/j.bios.2004.12.016)

#### 2003

36. Wiejata, P., Shankar, P. M., **R. Mutharasan**, 2003. Fluorescent Sensing Using Biconical Tapers, 2003, *Biosensors and Actuators – Chemical*, B96 315-320. [doi:10.1016/S0925-4005\(03\)00548-3](https://doi.org/10.1016/S0925-4005(03)00548-3)
37. Haddock, H., Shankar, P. M., **Mutharasan, R.**, 2003. Fabrication of Biconical Tapered Optical Fibers Using Hydrofluoric Acid. *Materials Science & Engineering B*, B97(1):87-93. [doi:10.1016/S0921-5107\(02\)00434-8](https://doi.org/10.1016/S0921-5107(02)00434-8)
38. Haddock, H., Shankar, P. M., **Mutharasan, R.**, 2003. Evanescent Sensing of Biomolecules and Cells, 2003. *Biosensors and Actuators – Chemical*. B88:67-74. [doi:10.1016/S0925-4005\(02\)00310-6](https://doi.org/10.1016/S0925-4005(02)00310-6).
39. Yi, J. W., Shih, W. Y., **Mutharasan, R.**, and Shih, W.-H. 2003. *In situ* Cell detection Using Piezoelectric Lead Zirconate Titanate-Stainless Steel cantilevers. *J. Appl. Physics*. 93(1):619-625. doi: [10.1063/1.1524022](https://doi.org/10.1063/1.1524022)
40. Lall R, **Mutharasan R**, Shah YT, Dhurjati P. 2003. Decolorization of the dye, Reactive Blue 19, using ozonation, ultrasound, and ultrasound-enhanced ozonation. *Water Environment Research*. 75(2):171-9. [Pubmed Link](#)

#### 2002

41. Srinivas, S.P., **Mutharasan, R.**, and Fleiszig, S. 2002. Shear stress induced ATP release in corneal epithelial cells. *Lacrimal Gland, Tear Film & Dry Eye Syndromes 3: Basic Science and Clinical Relevance*. Editor: D.A. Sullivan, 456-470.
42. Ozkan, Pinar and **R. Mutharasan**, 2002. A Rapid Method for Measuring Intracellular pH using BCECF-AM. *Biochemica and Biophysica Acta*. 1572(1):143. [doi:10.1016/S0304-4165\(02\)00303-3](https://doi.org/10.1016/S0304-4165(02)00303-3).
43. Srinivas, S.P., **Mutharasan, R.**, and Fleiszig, S. 2002. Shear-induced ATP release by cultured rabbit corneal epithelial cells. *Adv. Exp. Med. Biol.* 506:677-85. [Pubmed Link](#)

#### 1999

44. Qian, F, Farouk, B., **Mutharasan, R.** and Macken, N. 1999. Heat Transfer from a Liquid Bath due to an Impinging Gas Jet: Effect of Liquid Prandtl Number. *J. Heat Transfer – Trans. ASME*. 121(2):333-340
45. Tatiraju, S., Soroush, M. and **Mutharasan, R.**, 1999. Multi-rate nonlinear state and parameter estimation in a bioreactor. *Biotechnology and Bioengineering*. 63(1):22-32. [Pubmed Link](#)

#### 1996

46. Qian, F., Farouk, B., and Mutharasan, R. 1996. Studies of Deformation in Liquid Bath due to Direct Impinging Gas Jet. *Metallurgical Transactions B*. 27B:911-920.

#### 1995

47. Cai, Z., **Mutharasan, R.** and Steinetz, B. 1995. Development of Braided Fiber Seals: Characterization of Leakage Flow. *J. of Advanced Materials*. 25(2):29-35.
48. Hou, Q., **R. Mutharasan** and M. Koczak. 1995. Feasibility of Aluminum Nitride Formation in Aluminum Alloys. *Materials Science and Engineering*. A195:121-129.. [doi:10.1016/0921-5093\(94\)06511-X](https://doi.org/10.1016/0921-5093(94)06511-X).
49. Qian, F, Farouk, B. and **R. Mutharasan**. 1995. Modeling of Fluid Flow and Heat Transfer in the Plasma Region of a DC Electric Arc Furnace. *Metallurgical Transactions B*, 26B(5):1057-1067.

#### 1994

50. Guang-Wu Du, **R. Mutharasan**, Bruce Steinetz and Frank Ko. 1994. Development of Braided Rope Seals for Hypersonic Engine Applications. Part III: Effects of Preload and Flow Pressures. *ALAA Journal*. 10(4):476-491.
51. Shi-lu Wu and **R. Mutharasan**. 1994. Effects of Taxol and Diamide on Shear Tolerance of Hybridoma and Insect Cells. *Annals of New York Academy of Sciences*. 745:678-691.
52. Sureshkumar, G. K. and **R. Mutharasan**. 1994. Intracellular pH Response of Hybridoma and Yeast to Substrate Additions and Acid Challenges. *Annals of New York Academy of Sciences*. 745:106-121.
53. Cai, Z., **Mutharasan, R.**, Ko, F.K. and Steinetz, B. M. 1994. Development of Hypersonic Engine Seals-Flow effects of Preload and Engine Pressure. *Journal of Propulsion and Power*. 10(6):884-889.
54. Cai, Z., **Mutharasan, R.**, Ko, F.K. and Steinetz, B. M. 1994. Characterizing the Leakage Flow of Braided Fiber Seals. *Textile Research Journal*. 64(1):1-9.
55. Cai, Z., **Mutharasan, R.**, Ko, F.K. and Steinetz, B. M. 1994. Parametric Study of Leakage Flow in Braided Fiber Seals. *Textile Research Journal*. 64(5):280-290.

#### 1993

56. Sureshkumar, G. K. and **R. Mutharasan**. 1993. Intracellular pH Based Controlled Cultivation of Yeast Cells: I. Measurement Methodology. *Biotechnology and Bioengineering*. 41(1):118-128.

[doi:10.1002/bit.260410116](https://doi.org/10.1002/bit.260410116)

57. Sureshkumar, G. K. and **R. Mutharasan**. 1993. Intracellular pH Based Controlled Cultivation of Yeast Cells: II. Cultivation Methodology. *Biotechnology and Bioengineering*. 42(3):295-302. [doi:10.1002/bit.260410116](https://doi.org/10.1002/bit.260410116)
58. **Mutharasan, R.**, B. M. Steinetz, X. Tao and F. Ko. 1993. Development of Braided Rope Seals for Hypersonic Engine Applications: Flow Modeling. *ALAA Journal*. 9(3):456-461.

#### 1992

59. Brad Kent and **R. Mutharasan**. 1992. Cultivation of Animal Cells in a Reticulated Vitreous Carbon Foam. *J of Biotechnology*. 23(3):311-327. [doi:10.1016/0168-1656\(92\)90101-E](https://doi.org/10.1016/0168-1656(92)90101-E)
60. Asali, E. C., **R. Mutharasan** and A. E. Humphrey. 1992. Use of NAD(P)H-Fluorescence in Monitoring the Response of Starved Cells of *Catharanthus roseus* in suspension to Metabolic Perturbations. *Journal of Biotechnology*. 23(1):83-94. [doi:10.1016/0168-1656\(92\)90101-E](https://doi.org/10.1016/0168-1656(92)90101-E)
61. Ramirez, O. T. and **R. Mutharasan**. 1992. Effect of Serum on the Plasma Membrane Fluidity of Hybridomas: An Insight into its Shear Protective Mechanism. *Biotechnology Progress*. 8(1):40-50.

#### 1991

62. Siano, S. A. and **R. Mutharasan**. 1991. NADH Fluorescence and Oxygen Uptake Responses of Hybridoma Cultures to Substrate Pulse and Step Changes. *Biotechnology and Bioengineering*. 37(2):141- 159. [doi: 10.1002/bit.260370208](https://doi.org/10.1002/bit.260370208)
63. Eickhoff, W. M., Liversidge, G. G. and **R. Mutharasan**. 1991. Liquid Chromatographic Analysis of a Potential Polymeric-Pendant Drug Delivery System for Peptides: Application of HPESC, RP- HPLC and IC to the Evaluation of Biodegradable Poly[(chloromethoxy tri-alanine methyl ester phosphazenes)], *J. of Chromatography*. 536:255-264. [doi:10.1016/S0021-9673\(01\)89258-X](https://doi.org/10.1016/S0021-9673(01)89258-X)
64. Sureshkumar, G. K. and **R. Mutharasan**. 1991. The Influence of Temperature on a Mouse-Mouse Hybridoma Growth and Monoclonal Antibody Production. *Biotechnology and Bioengineering*. 37(3):292-295. [doi:10.1002/bit.260370313](https://doi.org/10.1002/bit.260370313)

#### 1990

65. Ramirez, O. T., G. K. Sureshkumar and **R. Mutharasan**. 1990. Bovine Colostrum or Milk as a Serum Substitute for the Cultivation of a Mouse Hybridoma. *Biotechnology and Bioengineering*. 35(9):882-889. [doi:10.1002/bit.260350905](https://doi.org/10.1002/bit.260350905)
66. Ramirez, O. T. and **R. Mutharasan**. 1990. Cell Cycle- and Growth Phase- Dependent Variations in Size Distribution, Antibody Productivity, and Oxygen Demand in Hybridoma Cultures. *Biotechnology and Bioengineering*. 36(8):839-848. [doi: 10.1002/bit.260360814](https://doi.org/10.1002/bit.260360814).
67. Ramirez, O. T. and **R. Mutharasan**. 1990. The Role of the Plasma Membrane Fluidity on the Shear Sensitivity of Hybridoma Grown under Hydrodynamic Stress. *Biotechnology and Bioengineering*. 36(9):911- 920. [doi: 10.1002/bit.260360906](https://doi.org/10.1002/bit.260360906)

#### 1989

68. Ramirez, O. T. and **R. Mutharasan**. 1989. Physical Immobilization Characteristics of a Hybridoma in a Glass Bead Packed-Bed Reactor. *Biotechnology and Bioengineering*. 33(8):1072-1079. [doi:10.1002/bit.260330816](https://doi.org/10.1002/bit.260330816).
69. Siano, S. A. and **R. Mutharasan**. 1989. NADH and Flavin Fluorescence Responses of Starved Yeast Cultures to Substrate Perturbations. *Biotechnology and Bioengineering*. 34(5):660-670. [doi: 10.1002/bit.260340510](https://doi.org/10.1002/bit.260340510).
70. Rao, G. and **R. Mutharasan**. 1989. NADH Levels and Solventogenesis in Continuous Cultures of *Clostridium acetobutylicum*: New Insights through Culture Fluorescence. *Applied Microbiology and Biotechnology*. 30:59-66.

#### 1988

71. Rao, G. and **R. Mutharasan**. 1988. Altered Electron Flow in a Reducing Environment in *Clostridium acetobutylicum*. *Biotechnology Letters*. 10(2):129-132.
72. Rao, G. and **R. Mutharasan**. 1988. Directed Metabolic Flow with High Butanol Yield and Selectivity in Continuous Cultures of *Clostridium acetobutylicum*. *Biotechnology Letters*. 10(4):313-318.

#### 1987

73. Rao, G. and **R. Mutharasan**. 1987. Alcohol Production by *Clostridium acetobutylicum* induced by Methyl Viologen. *Biotech.Letters*. 8(12):893-896.
74. Srinivas, S. P. and **R. Mutharasan**. 1987. Culture Fluorescence Characteristics and its Metabolic Significance in Batch Cultures of *Clostridium acetobutylicum*. *Biotechnology Letters*. 9(2):139-142.
75. Menawat, A., **R. Mutharasan** and D. R. Coughanowr. 1987. Optimal Control Strategies for Fed-Batch Bioreactor: Numerical Approaches to a Singular Control Problem. *AIChE Journal*. 33(5):776-784.
76. Luk, S., **R. Mutharasan** and D. Apelian. 1987. Experimental Observation of Wall Slip: Tube and Packed Bed Flow. *IE&EC Research*. 26:1609-1616.
77. McMichael, G., Armiger, W. B., J.F. Lee and **R. Mutharasan**. 1987. On-Line Measurement of Hybridoma Growth by Culture Fluorescence. *Biotechnology Techniques*. 1(4):213-218.
78. Rao, G., P. J. Ward and **R. Mutharasan**. 1987. Manipulation of End Product Distribution in Strict Anaerobes. *New York Academy of Sciences*. 506:76- 83.
79. Rao, G. and **R. Mutharasan**. 1987. Altered Electron Flow in Continuous Cultures of *Clostridium Acetobutylicum* induced by Methyl Viologen. *Appl. Environ. Microbiology*. 53:1232-1235.
80. Luan, Y. T., **R. Mutharasan** and W. E. Magee. 1987. Effect of various Glucose/Glutamine Ratios on Hybridoma Growth, Viability and Monoclonal Antibody Formation. *Biotechnology Letters*. 9:535-540.
81. Luan, Y. T., **R. Mutharasan** and W. E. Magee. 1987. Strategies to Extend Longevity of

Hybridomas in Culture and Promote Yield of Monoclonal Antibodies. *Biotechnology Letters*. 9:691-696.

82. Luan, Y. T., **R. Mutharasan** and W. E. Magee. 1987. Factors Governing Lactic Acid Formation in Long Term Cultivation of Hybridoma Cells. *Biotechnology Letters*. 9:751-756.
83. Ramirez, O. T., **R. Mutharasan** and W. E. Magee. 1987. A Novel Immobilized Hybridoma Reactor for the Production of Monoclonal Antibodies," *Biotechnology Techniques*. 1(4):245-250.
84. Srinivas, S. P. and **R. Mutharasan**. 1987. Inner Filter Effects and Their Interferences in the Interpretation of Culture Fluorescence. *Biotechnology and Bioengineering*. 30(6):769-774.  
[doi:10.1002/bit.260300609](https://doi.org/10.1002/bit.260300609).

#### 1986

85. Fireoved, R. L. and **R. Mutharasan**. 1986. Effect of Furfural and Ethanol on the Growth and Energetics of Yeast Under Microaerobic conditions. *Annals of N. Y. Acad. of Sciences*. 469:433-446.

#### 1985

86. Kannan, V. and **R. Mutharasan**. 1985. Ethanol Fermentation Characteristics of *Thermoanaerobacter ethanolicus*. *Enzyme & Microbial Technology*. 7:87-91.
87. Shukla, R., X.E. Verykios, **R. Mutharasan**. 1985. Isomerization and Hydrolysis of Important Disaccharides over Inorganic Heterogeneous Catalysts. *Carbohydrate Research*. 143: 97-106.
88. Apelian, D., **R. Mutharasan**, S. Ali. 1985. Removal of Inclusions from Steel Melts by Filtration. *Journal of Materials Science*. 20:3501-3514.
89. Bui, S., Verykios, X. E. and **R. Mutharasan**. 1985. In situ removal of ethanol from fermentation broths. 1. Selective adsorption characteristics. *Ind. Eng. Chem. Proc. Des. Dev.* 24(4):1209-1213.
90. Ali, S., **R. Mutharasan**, D. Apelian. 1985. Physical Refining of Steel Melts by Filtration. *Metallurgical Transactions B*, 16B:725-742.
91. Teng, K. F. and **R. Mutharasan**. 1985. Kinetics of Conversion of High-Solids Biomass Slurries to Glucose by Acid Hydrolysis. *Energy From Biomass & Wastes*, 9:873-894.
92. Ali, S., D. Apelian, **R. Mutharasan**. 1985. Refining of Aluminum and Steel Melts by the Use of Multi-Cellular Extruded Ceramic Filters. *Canadian Met. Quarterly*. 24(4):311-318.

#### 1984

93. Aldridge, G.A., X.E. Verykios and **R. Mutharasan**, 1984. Recovery of Ethanol From Fermentation Broths by Catalytic Conversion to Gasoline: II - Energy Analysis. *IE&EC (Process Design & Dev.)* 23:733-738.
94. Ullal, V.G., **R. Mutharasan** and E.D. Grossmann. 1984. New Insights Into High Solids Acid Hydrolysis of Biomass. *Biotechnology and Bioengineering*. 14:69-93..

#### 1983

95. Whitcraft, D.R., Verykios, X.E., and **R. Mutharasan**. 1983. Recovery of Ethanol from Fermentation Broths by Catalytic Conversion to Gasoline. *I&EC (Process Design & Dev.)*, 22:452-458.
96. Fireoved, R.L., **R. Mutharasan** and Y.H. Lee. 1983. Measurement of Ultra Low Gas-Phase Oxygen Concentration with Oxygen Electrode. *Biotechnology and Bioengineering*. 24:2109-2113.
97. Gencer, M.A. and **R. Mutharasan**. 1983. Ethanol Fermentation in a Yeast Immobilized Tubular Fermentor. *Biotechnology and Bioengineering*. 25(9):2243-2262. [doi: 10.1002/bit.260250910](https://doi.org/10.1002/bit.260250910).
98. Horwath, J.A., **R. Mutharasan** and E.D. Grossmann. 1983. Pentosan Hydrolysis in a Concentrated Slurry System. *Biotechnology and Bioengineering*. 25(1):19-32. [doi:10.1002/bit.260250104](https://doi.org/10.1002/bit.260250104)

#### 1982

99. Whitcraft, D.R., Verykios, X.E., and R. Mutharasan. 1983. Catalytic Conversion of Fermentation Derived Ethanol to Gasoline. *Biotechnology and Bioengineering Symp.Series*. 12:2109-2114.

#### 1981

100. Gencer, M.A., and R. Mutharasan. 1981. Ethanol Fermentation in a Yeast Immobilized Column Fermentor. *Advances in Biotechnology*, pp 627-634. Pergamon Press.
101. Gencer, M.A. and R. Mutharasan. 1981. Performance Characteristics of a Yeast Immobilized Column Fermentor. *Energy From Biomass*. Volume V, pp775-789.

#### 1980

102. Fuhrmann, J. E., R. Mutharasan, D. R. Coughanowr. 1980. Computer Control of a Distributed Parameter System. *I & EC Process Design and Dev.* 19(4):537-546.
103. Giger, G.K., R. Mutharasan, D.R. Coughanowr. 1980. Control of Temperature Peaks in Adiabatic Fixed Tubular Reactors. *I&EC Fundamentals*. 19(4):389-396. DOI: [10.1021/i160076a012](https://doi.org/10.1021/i160076a012)
104. Giger, G.K., R. Mutharasan, D.R. Coughanowr. 1980. A Novel Integral Heat Balance Approach for the Prediction of Temperature Peaks in Adiabatic Reactors. *I&EC Fundamentals*. 19(4):396-404. DOI: [10.1021/i160076a013](https://doi.org/10.1021/i160076a013)
105. Mutharasan, R., and D. Apelian. 1980. Filtration: A Melt Refining Method. *J of Metals*. 32(9):14-19.

#### 1979

106. Gencer, M. A., and **R. Mutharasan**. 1979. Determination of Biomass Concentration by Capacitance Measurement. *Biotechnology and Bioengineering*. 21(6):1097-1103. . [doi: 10.1002/bit.260210616](https://doi.org/10.1002/bit.260210616)
107. **Mutharasan, R.** 1979. An Approximate Solution to the Theoretical Model of a Submerged Biological Filter. *Biotechnology and Bioengineering*. 20(1):151-156. [doi: 10.1002/bit.260200115](https://doi.org/10.1002/bit.260200115).

#### 1978

108. Gautam, R., **R. Mutharasan**, and D. R. Coughanowr. 1978. Sampled-Data Control of a Nonlinear System. *Chemical Engineering Science*. 33:561-568. [doi:10.1016/0009-2509\(78\)80018-9](https://doi.org/10.1016/0009-2509(78)80018-9)
109. Gautam, R., and **R. Mutharasan**. 1978. General Direct Digital Control Algorithm for a Class of Linear Systems. *A. I. Ch. E. Journal*. 24(2):360-364..

#### 1976

110. **Mutharasan, R.**, and R. Luus. 1976. Linear Direct Digital Control Algorithms for a Class of Distributed Processes. *I & EC Process Design & Dev.* 15 (10):137-141..
111. **Mutharasan, R.,** and D. R. Coughanowr. 1976. Sampled-Data Proportional Control of a Flow-Forced Tubular Reactor. *I & EC Process Design & Dev.*, 15 (1):141-144..
112. **Mutharasan, R.,** and D. R. Coughanowr. 1976. Effect of Inclusion of Delayed First-Order Hold on the Stability of First-Order Sampled-Data Proportional Control System, *AICHE Journal*. 22 (1):189-190.
113. **Mutharasan, R.,** and D. R. Coughanowr. 1976. Sampled-Data Control of a Distributed-Parameter Process. *I & EC Process Design & Dev.* 15 (3):378-381.

#### 1975

114. **Mutharasan, R.,** and R. Luus. 1975. Analysis of Time-Delay Systems by Series Approximation. *AICHE Journal*. 21 (3):567-571.
115. Luus, R., and **R. Mutharasan**. 1975. Application of Series Approximation to the Analysis of a CSTR with Time-Delay. *International Journal of Control*. 21(6):967-970.

#### 1974

116. **Mutharasan, R.,** and D. R. Coughanowr. 1974. Feedback Direct Digital Control Algorithms for a Class of Distributed-Parameter Systems. *I & EC Process Design & Dev.* 13(2):168-176.
117. Luus, R., and **R. Mutharasan**. 1974. Stabilization of Linear Systems by Pole Shifting. *International Journal of Control*. 20(3):395-405.

### PATENTS

#### *Patents - issued*

- Eckert; C. E., Hornack; T. R., Lyness; G. E., Kaems; J. A., Cox; C. J. , Miller, R. E., Apelian; D., Mutharasan, R., "Multistage Rigid Media Filter for Molten Metal and Method of Filtering," US Patent No: 05114472, 1992.
- DeYoung; D. H., Apelian; D. , Mutharasan; R., "Method for Separation and Removal of Suspended Liquid Particles from Molten Metal and Associated Apparatus," US Patent No: 05336295, 1994.

#### *Patents - applied*

Mutharasan, R., Maraldo, D., and Campbell, G. A., "Self-Exciting, Self-Sensing Piezoelectric Cantilever Sensor," PCT/US2007/001835, 60/761,172 filed 01/23/2006 and 60/807,020 filed 07/11/2006.

Mutharasan, R., P. Mohana Shankar and Leung, A., "Ultra Sensitive Tapered Fiber Optic Sensor for Proteins, Pathogens and DNA," US Provisional Patent No: 60/763,529, filed 03/21/2006.

Mutharasan, R., deLesdernier, D. L., Rijal, K., "Molecular Control of Surface Coverage", PCT applied 05/10/2007 based on US Serial No: 60/746,948, filed 05/10/2006

Mutharasan, R., deLesdernier, Campbell, G. A., Maraldo, D., and Nagy, P. A. "Self-Exciting Self-Sensing Piezoelectric Cantilever Sensor for Detection of Airborne Analytes Directly in Air", PCT applied 05/11/2007 based on US Serial No: 60/746,948, filed 05/10/2006; 60/807,020 filed 07/11/2006; 60/761,172 filed 01/23/2006; 11/625,919 filed 01/23/2007.

### *Patents - in process*

Mutharasan, R. and Campbell, G. A., "Flow Cell Design for Piezoelectric-Excited Millimeter-Sized Cantilever Sensors at flow range 0 to 20 mL/min," disclosure filed (10/11/05). Docket No 05-0631D

## CONFERENCE PUBLICATIONS

Listed below are papers that were submitted and published in conference proceedings. In some conferences, they are "lightly" reviewed (ASME, for example) and in others (AIChE, for example) they are not reviewed at all.

Eckert, C. Edward; Meyer, Thomas; Kinosz, Mike; **Mutharasan, Raj**. Preventative metal treatment through advanced melting. Shape Casting, the John Campbell Symposium, Proceedings of a Symposium held at the TMS Annual Meeting, San Francisco, CA, United States, Feb. 13-17, 2005 (2005), 31-40. CODEN: 69GTO2 AN 2005:337222 CAPLUS

Shih, Wan Y.; Campbell, G.; Yi, J. W.; Luo, H.; **Mutharasan, R.**; Shih, Wei-Heng. Ultrasensitive pathogen quantification in drinking water using highly piezoelectric microcantilevers. ACS Symposium Series (2005), 890(Nanotechnology and the Environment), 179-185. CODEN: ACSMC8 ISSN:0097-6156. AN 2005:683496 CAPLUS

Campbell, Gossett A.; **Mutharasan, Raj**. Detection of group A streptococcus and model protein using self-excited PZT-glass microcantilever. AIChE Annual Meeting, Conference Proceedings, Austin, TX, United States, Nov. 7-12, 2004 (2004), 037D/1-037D/6. CODEN: 69GSKT AN 2005:953266 CAPLUS

Leung, Angela S. Y.; Rijal, Kishan; Thomas, Gregory J.; **Mutharasan, Raj**; Shankar, P. Mohana. Continuous tapered fibers as sensors for cellular growth and pathogen detection. AIChE Annual Meeting, Conference Proceedings, Austin, TX, United States, Nov. 7-12, 2004 (2004), 041C/1-041C/7. CODEN: 69GSKT CAN 143:301549 AN 2005:953279 CAPLUS

Angela Labadessa, Edwin Chuy and Mohana Shankar and **R. Mutharasan**, "Continuous Tapered Fibers as Sensors for Cellular Growth and Pathogen Detection," AICHE Symposium Series on Sensors, Presented at AICHE Conf at San Francisco, (2003).

Gossett Campbell and **R. Mutharasan**, "Detection of Pathogen E. coli 0157:H7 using Monoclonal Antibody Immobilized on Piezoelectric Glass Microcantilever", AICHE Symposium Series on Sensors, Presented at AICHE Conf at San Francisco, (2003).

**Mutharasan, R.**, "Teaching of Engineering Biotechnology," Paper No: 2613, Proceedings of the American Society for Engineering Education Annual Conference & Exposition, June 2003.

**Mutharasan, R.** and Srinivas, S. P. Transport of a Lipid Drug Analog across the cornea. *Pharmaceutical and Biotechnology: Discovery, Development in Medicine*, AICHE Symposium Series, 136:167-176(2002).

**Mutharasan, R.** Online monitoring of intracellular properties and its use in bioreactor operation. Editor(s): Galindo, Enrique; Ramirez, Octavio T. *Adv. Bioprocess Eng. Vol. II*, Invited Paper at International Biotechnology Symposium, Kluwer, Dordrecht, Netherlands. 53-66 (1998)

Weinberger, C. B. and **R. Mutharasan**, "Fundamentals of Manufacturing -- Multimedia Modules for Contextual Learning Proceedings of the 1998 Frontiers in Education Conference, ASEE/IEEE, 669-671(1998).

Sathianathan, D., Sheppard, S., Jenison, R., Bilgutay, N.M., Demel, J.T., Gavankar, P., Lockledge, J., **Mutharasan, R.**, Phillips, H., Poli, C., Richardson, J., "Freshman Design Projects: Lessons Learned in Engineering Coalitions," *Proceedings of the Frontiers in Education Conference*.(1998).

**Mutharasan, R.**, W. E. Magee, M. A. Wheatley and Y. H. Lee, "Multimedia Assisted Instruction in Upper Level Engineering Courses," Paper # 1373, Proceedings of FiE Conference, Pittsburgh, Oct 1997.

Qian, F, Farouk, B., **R. Mutharasan** and N. Macken, "Heat Transfer from a Liquid Bath due to an Impinging Gas Jet: Effect of Liquid Prandtl Number," 1996 National Heat Transfer Conference, HTD-Vol. 333, V2:181-194, August 1996

**Mutharasan, R.**, W. E. Magee, M. A. Wheatley, Y. H. Lee, "Thematic Introduction to Engineering Biotechnology: Gateway Experience," Proceedings of ASEE Conf., 1093-97(1995).

DeYoung, D. H., J. B. Morland and **R. Mutharasan**, "Closed-Loop Melt Composition Control by in-line Computer Aided Alloying," *Light Metals 1995*, published by AIME-TMS, Warrendale, PA, 841-850(1995).

Qian, F, Farouk, B. and **R. Mutharasan**, "Numerical Study of Heat Transfer from a Liquid Pool due to an Impinging Gas Jet," 1995 National Heat Transfer Conference, Portland, Oregon, HTD-Vol. 306, 51-62(1995).

**Mutharasan, R.** and A. Lawley, "Materials Processing: Science and Practice," Paper # 1697, Proceedings of 1995 ASEE Conference, Los Angeles, June 1995.

**Mutharasan, R.**, W. E. Magee, M. A. Wheatley and Y. H. Lee, "Engineering Biotechnology:

- Gateway Experience,” Paper # 2209, Proceedings of 1995 ASEE Conference, Los Angeles, June 1995.
- Qian, F, Farouk, B. and **R. Mutharasan**, “Heat Transfer from a Liquid Pool due to an Impinging Gas Jet, ” 2nd ISHMT-ASME Heat and Mass Transfer Conference, Suratkal, India, 575-580, December 1995
- DeYoung, D. H., J.B. Moreland, and **R. Mutharasan**, "Closed Loop Melt Composition Control by In-line Computer-Aided Alloying," Light Metal 1995, Ed. J. Evans, Published by TMS, Warrendale, PA, 840-850(1995).
- Mutharasan, Raj**, Wayne Magee, Margaret Wheatley and Young Lee, "Thematic Introduction to Engineering Biotechnology: Gateway Experiences" Proc. Ann. Conf. ASEE. Anaheim, California, June 25-28 1995.
- Qian, F., B. Farouk, **R. Mutharasan** and N. Macken, “Heat Transfer from a Liquid Pool due to an Impinging Gas Jet “ with, 2nd ISHMT-ASME Heat and Mass Transfer Conference, Surathkhal, India, 575-580, December 1995
- Qian, F., B. Farouk and **R. Mutharasan**, “Impinging Gas Jet on a Liquid Surface: Numerical and Experimental Studies”, with, 1995 EPD Congress, 127-141, February, 1995, Las Vegas, Nevada
- Smith, R. W., **R. Mutharasan**, R. Knight, D. Luu, K. Malladi, J. Serino, J. Persoon, S. Garrison, and J. S. Vavruska, “Plasma Energy Recycle and Conversion (PERC) of Hazardous Waste Materials”, Proc. 3rd European Congress on Thermal Plasma Processes (TPP-3), VDI, Aachen, Germany, September, 1994.
- Qian, F, Farouk, B. and **R. Mutharasan**, “Modeling of Fluid Flow and Heat Transfer in the Plasma Region of the Electric Arc Furnace”, National Heat Transfer Conference, Atlanta, Georgia, HTD-248:53-64(1993)
- Qian, F., **R. Mutharasan** and B. Farouk, “Interface Deformation in a Liquid Bath due to Direct Impinging Gas Jet,” ECPD Congress 1994, , Editor: Garry Warren, TMS, Warrendale, PA, 1147 -1162(1994).
- Cai, Z., **Mutharasan, R.**, Ko, F.K., Du, G.W. and Steinetz, B.M. Development of braided fiber seals for engine applications. FIBER-TEX 1992: The Sixth Conference on Advanced Engineering Fibers and Textile Structures for Composites, p 203-214(1993).
- Eickhoff, W. M., G. G. Liversidge and **R. Mutharasan**, “Synthesis Characterization *and in vitro* Evaluation of a Water Soluble and Biodegradable Phosphazene Polymer with Peptide Pendants,” Proceedings of Intern. Symp. Control. Rel. Bioact. Mater., 17:160-162(1990)
- Luk, S., **R. Mutharasan** and D. Apelian, " Surface Effects in Filtration of Liquid Inclusions,” Proc of 4th Int'l Conf. on Continuous Casting, CRM & VDEh, Liege, Belgium, 560 - 578(1988).
- Apelian, D., C. E. Eckert, **R. Mutharasan** and R. E. Miller, "Refining of Molten Aluminum by Filtration Technology,” in Refining and Alloying of Liquid Aluminum, Editors: T. A. Engh, S. Lyng and H. A. Oye, Aluminium-Verlag Dusseldorf, Trondheim, Norway, 123-143(1986).

Apelian, D., **R. Mutharasan**, S. Luk and L. Wang, "Fundamentals of Molten Metal Refining by Filtration," Proc. of the Beijing Int'l Foundry Conf., Foundry Inst. of the Chinese Mech. Eng. Society, 1075-1116(1986).

Piccone, T. S. Luk, D. Apelian and **R. Mutharasan**, "Removal of Liquid and Solid Inclusions from Steel Melts," Proc. of 69th Steelmaking Conf., AIME-ISS, Warrendale, PA, 69:957-968 (1986).

Apelian, D., C.E. Eckert, **R. Mutharasan**, R.E. Miller, "Refining of Molten Aluminum by Filtration Technology," in Refining and Alloying of Liquid Aluminum and Ferro-Alloys, published by Aluminum-Verlag, Dusseldorf, Germany, 123-143(1985).

Eckert, C.E., R.E. Miller, D. Apelian and **R. Mutharasan**, "Molten Aluminum Clarification: Fundamentals and Models," Light Metals 1984, Editor: J.P. McGeer, published by AIME-TMS, Warrendale, PA, 1281-1304(1984).

Mutharasan, R., Apelian, D. and McGuiness, M., "Flow Behavior of Liquid Inclusions in Packed Beds," Light Metals 1983, Editor: E.M. Adkins, AIME-TMS, Warrendale, PA, 963-990(1983).

Apelian, D., R. Mutharasan, C. Romanowski, E. Eckert and R. Miller, "Commercially Available Filters for Molten Metal Treatment: A Critical Evaluation," Light Metals, Editor: J.E. Anderson, published by AIME-TMS, 935-969(1982).

Geleta, P., R. Mutharasan and D. Apelian, "Mechanisms of Tundish Nozzle Blockage in the Continuous Casting of Aluminum-Killed Steels," Modeling of Casting and Welding Processes, Editors: H. Brody and D. Apelian, Published by AIME-TMS, Warrendale, PA, 361-375(1981).

Mutharasan, R., D. Apelian and C.A. Romanowski, "A Laboratory Investigation of Aluminum Filtration Through Deep Bed and Ceramic Open-Pore Filters," Light Metals, Editor: R. Miller, Published by AIME-TMS, Warrendale, PA, 735-750(1981).

Giger, G. K., R. Mutharasan, and D. R. Coughanowr, "Control of Temperature Peaks and Adiabatic Fixed-Bed Tubular Reactors," Proceedings of the 12th Symp. on Computer Applications in Chemical Engineering, Vol. II, 1185-1202, (1979).

Apelian, D., and R. Mutharasan, "Depth Filtration of Liquid Metals," Phys. Chem. Sider., C-R Congr., 258-263 (1979).

Mutharasan, R., and D. Apelian, "Filtration as a Refining Process Fundamentals and Applications," in Proceedings of Innovative Steelmaking Technologies, Office of Technology Assessment, U. S. Congress, Washington, D. C. Editor: J. Hirschhorn, (1979).

Mutharasan, R., and D. R. Coughanowr, "Feedback Direct Digital Control Algorithms for Tubular Chemical reactors," Chemische Rundschau, 27 (10):19 (1974).

Mutharasan, R. and D. R. Coughanowr, "Time Delay Simulation Using Analog Memory Units," Proceedings of the Joint Automatic Control Conference, 632-641, (1972).

***Conference Presentations – Last two years [not updated]***

Each year my group presents two – ten papers at national and regional conferences. A full list is far too large to include here. I have included presentations during last three years to give a flavor on the conferences and paper titles. Presenter is in **bold**.

**Angela Leung**, P. Mohana Shankar, Raj Mutharasan. “Tapered Fiber Optic Biosensor Detects 10 fg/mL BSA At 1310 nm and 1550 nm In A Flow Cell Configuration”. May 10-12, Biosensors 2006, Toronto, Canada. [Poster]

**David deLesdernier**, Gossett Campbell and Raj Mutharasan. “Direct Detection of Airborne *Bacillus Anthracis* using Millimeter-Sized Cantilever (PEMC) Sensors”. May 10-12, Biosensors 2006, Toronto, Canada. [Poster]

David Maraldo and **Ra. Mutharasan**. “Femtogram detection of a model protein using a novel PEMC (Piezoelectric Excited Millimeter Sized Cantilever) Sensor”. May 10-12, Biosensors 2006, Toronto, Canada

Gossett Campbell and **R. Mutharasan**. Selectivity of Piezoelectric-Excited Millimeter-Sized Cantilever (PEMC) Sensors to *Bacillus anthracis* Spores in the Presence of *Bacillus thuringiensis* and *Bacillus cereus* Spores in a Flow Cell. May 10-12, Biosensors 2006, Toronto, Canada

Kishan Rijal and **R. Mutharasan**. “Piezoelectric Excited Millimeter-Sized Cantilever Sensor Monitors Alkanethiol Self Assembled Monolayer at 1 Femtomolar”. May 10-12, Biosensors 2006, Toronto, Canada

Raul Jackson and **R. Mutharasan**, “Millimeter-Sized Magneto-Elastic Sensors(MeRS) for Pathogen Detection”, Paper 481-b, Annual AIChE Meeting, Cincinnati, OH, Nov 3, 2005.

Gossett Campbell and **R. Mutharasan**, “*In Situ* Measurement of Low Concentration of *Bacillus anthracis* spores,” paper 37-d, Annual AIChE Meeting, Nov 3, 2005.

Angela Leung, P. Mohana Shankar, **Raj Mutharasan**. Detection of Proteins and Pathogens Using Antibody-Immobilized Biconical Tapered Fiber Sensors at 1550 nm. Annual AIChE Meeting, Nov 3, 2005.

Maraldo, D. and **R. Mutharasan**, “Piezoelectric-excited millimeter-sized cantilever (PEMC) sensors for model protein detection,” NJTC Meeting, Princeton, April 25, 2005. [POSTER]

Gossett Campbell and R. Mutharasan, “Anthrax Detector,” NJTC Meeting, Princeton, April 25, 2005. [POSTER]

Kishan Rijal and **R. Mutharasan**, “DNA detection using PEMC sensors,” NJTC Meeting, Princeton, April 25, 2005. [POSTER]

Kishan Rijal, Angela Leung, P. Mohana Shankar, and **R. Mutharasan**, “[Biconical Tapered Fiber Optic Sensors for Pathogen Detection in Aqueous Samples](#)”, Paper 41-c, Annual AIChE Meeting, Austin, TX, Nov 7-12, 2004.

**Gossett Campbell** and R. Mutharasan, “[Detection of Group A Streptococcus and Proteins using Monoclonal Antibody Immobilized Self-Excited Macrocantilever](#),” paper 37-d, Annual AIChE Meeting, Austin, TX, Nov 7-12, 2004.

Gossett Campbell, Angela Leung, Andrew Detzel, Kishan Rijal, P. Mohana Shankar, Rick Rest and **R. Mutharasan**, “Evanescence Field Sensors and Piezoelectric Glass Cantilever Sensors for Pathogen Detection,” presented at the Spore Conference organized by DHS at Argonne National Lab, Nov 11, 2005.

- Eckert, C.** Edward; Meyer, Thomas; Kinosz, Mike; **Mutharasan**, Raj. "Preventative Metal Treatment Through Advanced Melting", Shape Casting, The John Campbell Symposium; 2005 TMS Annual Meeting, San Francisco, CA; February 2005.
- R. Mutharasan.** "Sensing Platforms for Bioterrorism Agents," BIO 2005, June 20-24, 2005. Philadelphia, PA
- R. Mutharasan** , M. Satpathy and S. P. Srinivas, "Phosphorylation of Myosin Light Chain In Cultured Bovine Corneal Epithelial Cells ," paper #256b, presented at ARVO meeting, Ft. Lauderdale, April 2004.
- Kishan Rijal, Angela Leung, P. Mohana Shankar, and **R. Mutharasan**, "Tapered Fiber Sensors for pathogen detection in Aqueous Samples", 3<sup>rd</sup> Microsensor Workshop organized by DHS-TSA and ATF-DoJ, Scottsdale, Az. April 19-21, 2004.
- Gossett Campbell and **R. Mutharasan**, "Antibody-immobilized Self-Excited Piezoelectric Glass Microcantilevers," 3<sup>rd</sup> Microsensor Workshop organized by DHS-TSA and ATF-DoJ, Scottsdale, Az. April 19-21, 2004.
- W. Y. Shih**, W-H. Shih, G. Campbell, and R. Mutharasan, "Miniaturized highly piezoelectric cantilevers for rapid direct pathogen quantification," 227<sup>th</sup> ACS National Meeting, Anaheim, CA, March 28-April 1, 2004.
- Srinivas S.P.**, and R. Mutharasan, Measurement of pO<sub>2</sub> by Phase Fluorimetry, In: Conference on Oxygen in Wound Healing; (Dorothy Heart and Lungs Institute), Columbus, OH; October 2003.
- R. Mutharasan** , M. Satpathy and S. P. Srinivas, "Phosphorylation of Myosin Light Chain In Cultured Bovine Corneal Epithelial Cells ," paper #256b, presented at ARVO meeting, Ft. Lauderdale, April 2004.
- Gossett Campbell** and R. Mutharasan, "Detection of Pathogen E. coli 0157:H7 using Monoclonal Antibody Immobilized Piezoelectric Glass Cantilever," Paper 194c, Annual AIChE Meeting, San Francisco, Nov 17, 2004.
- R. Mutharasan**, "How to include Advanced Biotechnology Developments in Elective Courses," Paper 194c, Annual AIChE Meeting, San Francisco, Nov 17, 2004.
- E. Chuy, Kishan Rijal, P. Mohana Shankar and **R. Mutharasan**, "Continuous Tapered Fibers as Sensors for Cellular Growth and Pathogen Detection," Paper 198f, Annual AIChE Meeting, San Francisco, Nov 19, 2004.
- Srinivas S.P.**, and R. Mutharasan, Measurement of pO<sub>2</sub> by Phase Fluorimetry, In: Conference on Oxygen in Wound Healing; (Dorothy Heart and Lungs Institute), Columbus, OH; October 2002.
- R. Mutharasan** and S. P. Srinivas, "Biavailability of Topical Drugs to the Eye: Analysis Using a Distributed Parameter Model, ," paper #304c, presented at AIChE meeting, Indianapolis, IN, Nov 2002.
- Dan Luu , **S.P. Srinivas**, R. Mutharasan, "Resistance to Aqueous Humor Outflow Facility in Bovine Eyes: Measurement by a Pressure-Clamp Technique," paper #336k, presented at AIChE meeting, Indianapolis, IN, Nov 2002

J. Yi, Wan Shih, **R. Mutharasan**, Wei Shih, "Piezoelectric-based Microcantilever Mass Detection in Biomedical and Biochemical Applications," paper #30e, presented at AIChE meeting, Indianapolis, IN, Nov 2002

**Raj Mutharasan** and P. Mohana Shankar, "Upper Level Interdisciplinary Courses: Drexel Experiment," paper #169f, presented at AIChE meeting, Indianapolis, IN, Nov 2002

S.P. Srinivas, **R. Mutharasan**, "Diffusion Coefficient of Oxygen in Soft Contact Lenses," paper #192b, presented at AIChE meeting, Indianapolis, IN, Nov 2002

Hong S. Haddock, P. Mohana Shankar, **Raj Mutharasan**, "Evanescent Sensing of Cell Concentration in Microvolumes," paper #334e, presented at AIChE meeting, Indianapolis, IN, Nov 2002

**Raj Mutharasan**, Teaching of Engineering Biotechnology, at ASEE Annual Meeting, Knoxville, TN, June 2003.

**W. Y. Shih**, G. Campbell, J. W. Yi, R. Mutharasan, and W.-H. Shih, "Miniaturized highly piezoelectric unimorph cantilevers for rapid in situ pathogen quantification," Nanotechnology and the Environment Symposium, American Chemical Society Annual Meeting, New Orleans, LA, March 2003.

**W. Y. Shih**, G. Campbell, R. Mutharasan, and W.-H. Shih, "In-situ Detection of E. Coli 0157:H7 Using Piezoelectric Unimorph Cantilever Biosensor," presented at 105th Annual American Ceramic Society meeting, April 2003.

**W.-H. Shih**, Z. Shen, W. Y. Shih, and R. Mutharasan, "Mass Detection Sensitivity of Piezoelectric Unimorph Cantilevers with a Nonpiezoelectric Tip," presented at 105th Annual American Ceramic Society meeting, April 2003.

**Tejas Patil**, Qiang Zhong, W.-H. Shih, W. Y. Shih, and R. Mutharasan, "Microporous Silica Modified with Alumina as CO<sub>2</sub>/N<sub>2</sub>," presented at 105th Annual American Ceramic Society meeting, April 2003.

### *Technical Reports*

**The following reports are fairly comprehensive studies to the extent they may even be termed as monographs. They are available through NTIS.**

**Mutharasan, R.** and E. D. Grossmann, "Novel reactor schemes for pentosan and hexosan hydrolysis," SERI - DE-FG02-79ET00087. 1981

Luu, D. V. and **Mutharasan, R.** "Heterogeneous Kinetic Model for Aspen Wood Hydrolysis," Report No: SERI/SP-231-3126. NTIS, Order No. DE87012278. 1987.

**Mutharasan, R.**, Steinetz, B.M., Tao, X., and Ko, F., "Development of Braided Rope Seals for Hypersonic Engine Applications Part II: Flow Modeling," NASA TM 104371, 1991.

Steinetz, B.M., **Mutharasan, R.**, Du, G-W., Miller, J.H., and Ko, F., "Engine Panel Seals for Hypersonic Engine Applications: High Temperature Leakage Assessments and Flow Modeling," NASA TM-105260, 1992.

Steinetz, B.M., DellaCorte, C., Machinchick, M., **Mutharasan, R.**, Du, G., Ko, F., Sirocky, P.J., and Miller, J.H., "High temperature Dynamic Engine Seal Technology Development," NASA TM-105641, 1992.

**Mutharasan, R.**, Steinetz, B.M., Tao, X., Du, G., and Ko, F., "Development of Braided Rope Seals for Hypersonic Engine Applications: Flow Modeling," NASA TM-105942, 1992.

Cai, Z., **Mutharasan, R.**, Steinetz, B., Ko, F., and Du, G., "Development of Braided Rope Seals for Hypersonic Engine Applications Part IV: Flow and Durability Screening Tests," NASA TM-106082, 1993.

### INVITED ADDRESSES - LAST TEN YEARS

"Sensor Technologies for Biothreat Agents," New Jersey Technology Council, Princeton, NJ. April 25, 2006.

"Detection of Femtogram Concentrations of Proteins and Pathogens", invited seminar at Department of Chemical Engineering, Columbia University, New York, NY. October 18, 2005.

"Detection of Ultra Low Concentrations of Proteins and Pathogens ," Invited talk at Research Retreat organized by AJ Drexel Protein Institute of Pure and Applied Protein Science, DU College of Medicine, June 2, 2005, Philadelphia.

"Piezoelectric-Excited Millimeter-Sized Cantilever Sensors for Pathogens and Proteins in Flow Cells," invited speaker at the 2<sup>nd</sup> Nanomechanics Workshop, Organized by ASME Nanotechnology Institute, May 15-18, 2005, Knoxville, TN.

"In situ measurement of Ultra Low concentrations of pathogens and proteins," invited seminar, April 21, 2005, Oak Ridge National Lab, Knoxville, TN.

"Fiber optic and Cantilever sensors for E coli 0157:H7 detection," seminar at USDA Regional Research Labs, Wyndmoor, PA, March 2005.

"Detection of Ultra Low Concentrations of Proteins and Pathogens", invited seminar at Department of Chemical Engineering, Lehigh University, Bethlehem, PA. November 17, 2004.

"Influence of Gas-Liquid Interface in Mammalian Cell Bioreactors," Seminar at Centacor, March 2004.

"Strategies for improving bioreactor productivity," Seminar at Schering-Plough, May 2001.

"Curricular Reforms: Drexel's Case Study," Invited Speaker, Workshop on Engineering Curriculum Innovations, Carnegie Mellon University, Pittsburgh, July 1997.

"Shear-Fragility of Mammalian Cells: Problems and Solutions," Keynote Address, 7th International Biotechnology Conference, Mazatlan, Mexico, September, 1997.

"Mechanism of Gas-Liquid Interface Interaction with Cells in Culture," University of Colorado, Boulder, CO, February 1995.

"Role of Plasma Membrane Fluidity on Cell Fragility," University of Maryland (Baltimore County), MD, March 1996.

"Influence of Bioreactor Conditions on Cell Productivity," Aberdeen Proving Grounds, 1996.

"Factors Governing Monoclonal Antibody Productivity," Smith, Kline and Beechum, August, 1995.

"Cultivation of Yeast Based on Intracellular Properties," University of Maryland (College Park), MD, September 1995

"Strategies for Large Scale Cultivation of Mammalian Cells," University of Akron, Akron, Ohio, March 1995

## TEACHING

Over the past 30 years, I have taught nearly all core undergraduate courses in Chemical Engineering, developed an entire sequence of four biochemical engineering courses at graduate level, and have taught specialized courses for non-chemical engineering students. Since course numbers have gone through revisions, only the course titles are given.

### **Undergraduate courses**

Chemical Engineering Thermodynamics  
Fluid Mechanics  
Process Heat Transfer  
Mass Transfer  
Unit Operations Lab  
Thermodynamics Lab  
Principles of Biochemical Engineering  
Engineering Biotechnology (team taught)  
Reaction Kinetics and Reactor Design  
Process Systems and Control  
Transport Phenomena for Non-Chemical  
Engineers

Transport Phenomena in Materials  
Processing

### **Graduate Courses**

Mathematical Methods in Chemical  
Engineering  
Chemical Engineering Thermodynamics  
Process Systems Analysis and Control  
Advanced Process Control  
Transport Phenomena in Bioprocess Systems  
Bioreactor Engineering  
Bioseparations  
Optimal Control