

Portonovo S. Ayyaswamy

Asa Whitney Professor of Dynamical Engineering
Department of Mechanical Engineering and Applied Mechanics
School of Engineering and Applied Science
University of Pennsylvania
Philadelphia, PA 19104-6315

PERSONAL

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EDUCATION

Ph.D. (1971) University of California, Los Angeles
Thesis Title: “Natural Convection Flows in Tilted Configurations”
Advisor: Professor Ivan Catton

M.E. (1967) Columbia University, New York
Thesis Title: “A Step by Step Design for Helical Tube Multi-Start Coil
Heat Transfer Equipment: Entering Tube Side Fluid in the
Super Critical Region or Otherwise”
Advisor: Professor Harold G. Elrod, Jr.

M.S. (1965) Columbia University, New York
B.E. (1962) University of Mysore

POSITIONS HELD

Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania

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| 1996-present | Asa Whitney Professor of Dynamical Engineering |
| 1987-present | Professor |
| 2004-2006 | Chairman, Graduate Affairs |
| 1990-1996 | |
| 1984-1986 | Chairman, Undergraduate Affairs |
| 1980-1987 | Associate Professor |
| 1974-1980 | Assistant Professor |

Energy and Kinetics Department, University of California, Los Angeles

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| 1972-1974 | Postdoctoral Scholar |
| 1973-1974 | Supervisors: Professors Ivan Catton and Donald K. Edwards: Topic: Capillary flows in grooved surfaces. |
| 1972-1973 | Supervisor: Professor David Okrent: Topic: Large scale safety of nuclear reactors. |

Institute of Geophysics and Planetary Physics, University of California, Los Angeles

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| 1971-1972 | Postdoctoral Fellow |
| | Supervisor: Professor Friedrich H. Busse |
| | Topic: Bounding theories in turbulence. |

1969-1971 Post-Graduate Research Engineer
 1968-1969 Teaching Associate
 1967-1968 Research Assistant

The Lummus Company, Madison Avenue, New York
 1966-1967 Heat Exchanger Engineer

School of Engineering and Applied Sciences, The City University of New York, New York
 1964-1966 Instructor

Electronics Research Laboratories, Columbia University, New York, New York
 1963-1964 Computer Assistant

Hydro-Electric Construction Project, Government of Mysore, Bangalore
 1962-1963 Junior Engineer

HONORS/DISTINCTIONS

UCLA Engineering Alumni Professional Achievement Award: 2017
 One of the school’s highest honors

Appointed : Editor, Am.Soc. Mech .Engrs. Journal of Heat Transfer 2015

The Max Jakob Memorial Award “recognizes an eminent scholarly achievement and distinguished leadership in the field of heat transfer. Jointly awarded by the Am.Inst.Chem..Engrs and the Am.Soc. Mech. Engrs. It is the highest honor in the field of heat transfer these professional organizations bestow.” 2014

“ P. Ayyaswamy 70th Birthday Tribute” Special Sessions I & II on (I) Interfacial Fluid Dynamics and (II) Devices & Modeling Nanoparticles 2014
 7th World Congress of Biomechanics, Boston, MA

Elected to the Governing Board 2014
American Society for Gravitational and Space Research

75 th Anniversary Medal of the ASME Heat Transfer Division for service to the heat transfer community and contributions to the field 2013

ASME 2007 Worcester Reed Warner Medal for “outstanding contributions to the permanent literature of engineering” 2007

Expert Consultant, Workshop on “Meeting the workforce needs for the National Vision for Space Exploration,” **National Research Council of the National Academies Committee, Washington, DC** 2006

Invited Participant, NAE Benchmarking “Virtual Congress Exercise” to determine the “best of the best” researchers in subfields and sub-subfields of Mechanical Engineering (Areas: Fluid Mechanics and Heat Transfer). **National Research Council of the National Academies Committee, Washington, DC** 2006

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| Invited Member , Review of NASA Strategic Roadmaps: Space Station Panel, National Research Council of the National Academies Committee, Washington, DC | 2005 |
| ASME Heat Transfer Memorial Award in the Science Category for "many seminal contributions to such diverse fields of heat transfer as phase change, plasma, bio, and natural convection, in particular to transport processes with moving droplets and thermal design of advanced industrial equipment." | 2001 |
| Appointed Visiting Professor , Department of Mechanical Engineering, University of California, Berkeley, CA | 2000 |
| Council of Indian Organizations Award for Distinguished Contributions to Engineering Science | 1999 |
| "Aerospace Professional of the Year" award, Am. Inst. Aeronautics and Astronautics for "Outstanding contributions to the advancement of the arts and sciences of aeronautics and astronautics." | 1997 |
| Appointed Asa Whitney Professor of Dynamical Engineering: "In recognition of his outstanding achievements in heat transfer research, excellence in teaching, and distinguished service to the University and his profession." | 1996 |
| Appointed United Nations Expert and Consultant for Engineering and Technology, UNIDO, Vienna, Austria | 1991 |
| Elected Fellow , American Society of Mechanical Engineers for "significant contributions to Heat Transfer;" "His studies on droplet dynamics in the presence of phase change (condensation, evaporation, and combustion) have yielded new and important insights into mechanisms of drag and heat transfer." | 1990 |
| Outstanding Faculty Advisor Award: "For dedication to quality education and development of professional awareness through student participation." American Society of Mechanical Engineers | 1979 |
| Lindback Award for Distinguished Teaching: "For distinguished teaching, in recognition of outstanding service in stimulating and guiding the intellectual development of students at the University of Pennsylvania." | 1979 |
| Reid Warren Award for Distinguished Teaching: "In recognition of outstanding service in stimulating and guiding the intellectual development of undergraduate students at the College of Engineering and Applied Science." University of Pennsylvania, Philadelphia | 1978 |

PATENTS

1. Bioactive, degradable composite for tissue engineering, U.S. Patent #6328990.
2. Hollow bone mineral-like calcium phosphate particles, U.S. Patent #6416774.

IMPORTANT KEYNOTE, INVITED LECTURES

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| <p>“The linear and non-linear stabilities of a Plasma-arc” University of Zurich, Zurich, Switzerland</p> | 1979 |
| <p>Keynote address to Chinese Nuclear Society on “Heat and Mass Removal from Nuclear Reactor Containment by Spray Droplets,” China International Conference Center for Science and Technology, Beijing, People’s Republic of China</p> | 1985 |
| <p>Invited Distinguished Participant and Keynote Speaker, Eighth National Heat and Mass Transfer Conference, Visakha Patnam, India. Invited by the Indian Society for Heat/Mass Transfer and the Ministry of Education, India. Address on “Heat and mass transfer with condensation”</p> | 1985 |
| <p>“The theory of condensation on moving droplets” Cavendish Laboratory, University of Cambridge, England</p> | 1986 |
| <p>“Hydrodynamics of condensation on a moving drop” The Royal Institute of Technology, Stockholm, Sweden</p> | 1986 |
| <p>“Mathematics of direct-contact condensation on a moving drop” The Danish Center for Applied Mathematics & Mechanics, The Technical University of Denmark, Lyngby, Denmark</p> | 1986 |
| <p>“Direct-Contact Phase Change Processes with Moving Liquid Droplets,” International Symposium/Workshop on Boiling, Condensation and Two-Phase Flow Heat Transfer, Visakha Patnam, India</p> | 1994 |
| <p>Bio-Heat Transfer: “Effects of Micro-Wave Radiation on Biological Tissue Heating,” Bhabha Atomic Research Center, Bombay, India</p> | 1994 |
| <p>Am. Inst. Aeronautics and Astronautics award lecture: “Bone-cell growth in microgravity,” Philadelphia, PA</p> | 1997 |
| <p>Bio-Mass Transfer: “Bone-cell growth in microgravity--cell biology, fluid mechanics and mass transfer,” 14th National Heat and Mass Transfer Conference and the 3rd ISHMT/ASME Joint Heat and Mass Transfer Conference, Kanpur, India</p> | 1997 |
| <p>"Interfacial motion of a molten layer subject to plasma heating" Chia-Shun Yih Memorial Symposium, 13th U.S. National Congress of Applied Mechanics, Gainesville, FL</p> | 1998 |
| <p>“The culture of three-dimensional bone-like tissue under simulated microgravity conditions in NASA’s rotating-wall vessels: experimental and numerical studies.” Engineering foundation conference on microgravity fluid physics and heat transfer (Microgravity and fluid physics program of NASA), Oahu, Hawaii</p> | 1999 |
| <p>Bio-Mass Transfer Processes: “Composite microsphere: Effects of different filler materials on polymeric surface bioactivity.” Engineering Foundation Conference on microgravity transport processes in fluid, thermal, biological and materials sciences II, Banff, Alberta, Canada</p> | 2001 |

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| “Electric field effects on flames.” Fifth ISHMT ASME Heat and Mass Transfer Conference, Science City, Kolkata, India | 2002 |
| “Low energy plasma heat transfer as applied to microelectronic manufacturing.” International Symposium on Recent Trends in Heat and Mass Transfer, Indian Institute of Technology, Guwahati, India | 2002 |
| "Three-dimensional bone-like tissue generation in rotating-wall bioreactors" The 6th Am. Soc. Mech. Engrs/Japanese Soc. Mech. Engrs. Thermal Engineering Joint Conference, Hawaii Island, Hawaii | 2003 |
| “Oscillating Flow and Heat Transfer in Porous Media” NASA Glenn Research Center, Cleveland, Ohio | 2004 |
| “Loop Heat Pipe (LHP) for Spacecraft Thermal Control” NASA Glenn Research Center, Cleveland, Ohio | 2004 |
| Plenary Speaker, 2004 ASME Heat Transfer/Fluids Engineering Summer Conference, Charlotte, NC. “Surfactant Transport to an Intravascular Bubble” | 2004 |
| Sir G.I. Taylor Memorial lecture in Fluid Mechanics, 53 rd Congress of the Indian Society for Theoretical and Applied Mechanics, Hyderabad, India. “Motion Of A Finite-Sized Gas Bubble In A Blood Vessel: Non-Newtonian Effects.” | 2008 |
| Keynote address in Am. Soc. Mech. Engrs/Indian Soc. Heat & Mass Transfer Conference, Mumbai, India. “Effect of a soluble surfactant on a finite-sized bubble motion in a blood vessel” | 2010 |
| Keynote address in Am. Soc. Mech. Engrs/Indian Soc. Heat & Mass Transfer Conference, IIT, Kharagpur, India. “Modeling the Effects of Multibody Interactions on Nanoparticle Hydrodynamics in an Incompressible Newtonian Fluid.” | 2013 |
| Keynote address in 7 th World Congress of Biomechanics, Boston, MA, “Functionalized Nanocarrier Binding to Cell Surface in Targeted Drug Delivery: Hydrodynamic and Adhesive Interactions.” | 2014 |
| Max Jakob Memorial Award lecture, Int. Mech.Eng. Congress & Exposition, Houston, Texas, “Modeling of a nanoparticle in a cylindrical vessel flow: Particle shape and wall effects” | 2015 |

JOURNAL EDITORSHIP

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| Editor , ASME Journal of Heat Transfer | 2016-Present |
| Editorial Panel Member , Expert Review of Medical Devices, London, UK | 2013-Present |
| Associate Technical Editor , Journal of Heat Transfer, Trans. ASME | 1997-2000, 2001-2004 |

MEMBERSHIP IN IMPORTANT PANELS, DELEGATION

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| Member, Review Panel, Division of CBET Systems, U.S. National Science Foundation | 2012, 2013 |
| Member, Review Panel, National Space Biomedical Research Institute, NASA, Washington, D.C. | 2007, 2008, 2009, 2010,2011,2012 |
| Invited Participant, NASA Workshop on Porous Media, NASA Glenn Research Center, Ohio | 2004 |
| Member, Requirements Definition Review Panel for Micro-Gravity Studies in Nucleate Boiling Heat Transfer, NASA Glenn, Ohio | 2002 |
| Member, NASA Bioreactor/Biosensor Research Review Panel, Washington D.C. | 2002 |
| Invited Participant, Workshop on research needs in space thermal systems and processes for human exploration of space, NASA Glenn, Ohio | 2000 |
| Member, Science Concept Review Panel for Micro-Gravity Experiments in Space, NASA, Lewis Research Center, Cleveland, Ohio | 1998, 1990 |
| Member, Review Panel for Micro-Gravity Studies in Heat Transfer and Fluid Mechanics, NASA, Washington, D.C. | 1997, 1993 |
| Invited Panelist, NSF/DOE Workshop on Advanced Thermal Manufacturing and Materials Processing: Future Needs for Research, Leesburg, Virginia | 1995 |
| United Nations Expert on Micro-Electronics: Lectured and Conducted a workshop on “Thermal Design/Analysis/Optimization in Microelectronics”, Society for Applied Microwave Electronics Engineering and Research - Center for Electromagnetics, Madras, India | 1992 |
| Invited Panelist, NSF Workshop on “Thermal Engineering: Emerging Technologies and Critical Phenomena: Future needs for thermal engineering research,” Chicago, Illinois | 1991 |
| Invited Panelist, National Workshop on Mass, Momentum, and Energy Exchange in Combusting Sprays: Droplet Studies, Sandia National Laboratories, Livermore, California | 1988 |
| Member, Evaluation Panel for Engineering Initiation Awards, U.S. NSF | 1987 |
| Member, Delegation on Nuclear Reactor Safety to the People's Republic of China at the invitation of the Chinese Nuclear Society and the Chinese Association for Science and Technology (Delegation leader: Professor Richard T. Lahey, Jr.) | 1985 |

CONSULTING ACTIVITIES

Battelle, NC;
Boeing Satellite Systems, CA;
Combustion Unlimited Incorporated, PA;
General Electric Co, Valley Forge, PA;
General Motors Corporation MI;
Hughes Space and Communications, CA;
IBM Corporation, NY;
National Air Oil Burner Co., Inc., PA;
NASA, Glenn Research Center, OH;
Pathway Technology, Inc., PA;
Thermacore, Inc., PA;
United Nations Industrial Development Organization, Vienna, Austria

MASTER'S, DOCTORAL AND POST-DOCTORAL RESEARCH SUPERVISION

1. L.J. Huang, Laminar Condensation on a Moving Drop: Effects of Transients, M.S. Thesis (1986).
2. S.G. Klemick, Heat Transfer in Tissue Subject to Microwave Heating, M. S. Thesis (1988).
3. T.R. Stauffer, Multi Foil Insulation Systems for Hypersonic Vehicles, M.S. Thesis (1992).
4. J. Weiner, Thermal Stress Analysis of Multilayered Materials of Finite Thickness, M.S. Thesis (1994).
5. A. Chau, Bubble motion in a Casson fluid flowing through a vessel, M.S. Thesis (In Progress).
6. J.N. Chung, Laminar Condensation Phenomenon Associated with a Moving Droplet, Ph.D. Thesis (1979).
(At present: Andrew H. Hines Jr./Florida Progress Eminent Scholar Chair Professor, U. of Florida, Gainesville.)
7. T. Sundararajan, Laminar Condensation Heat and Mass Transfer to a Drop Moving at Intermediate or High Reynolds Number, Ph.D Thesis (1983).
(At present: Professor, Dept. of Mech. Eng., IIT, Madras, India)
8. J.M. Hogan, Wave Phenomena on the Interface Separating Fluids of Different Viscosities, Ph.D. Thesis (1984).
(At present: Manager of Engineering, GE, Seton Center, PA)
9. G. Gogos, Evaporation and Combustion of a Moving Liquid Drop, Ph.D Thesis (1986).
(At present: Associate Professor, Dept. of Mech. Eng., Univ. of Nebraska, Lincoln, Nebraska)
10. J.W. Baish, Convective Heat Transport Due to Blood Perfusion in Volumetrically Heated Biological Tissue, Ph.D. Thesis (1986). (Presidential Young Investigator Award Recipient)
(At present: Professor, Dept. of Mech. Eng., Bucknell Univ., PA)

11. L.J. Huang, Fundamental Problems in Heat Transfer and Fluid Mechanics of Phase-Change Processes with Liquid Drops, Ph.D. Thesis (1989).
(At present: Senior Engineer, R&D, GM, Lockport, NY)
12. M. Jog, Asymptotic and Numerical Studies of Plasma Arc Heat Transfer and Phase-Change Heat Transfer, Ph.D. Thesis (1993). (Engineering Initiation Award Recipient; NSF Career Award Recipient)
(At present: Associate Professor, Dept. of Mech., Ind., and Nucl. Eng., University of Cincinnati, OH)
13. K. Zwick, The Fluid Mechanics of Bonding With Yield Stress Epoxies, Ph.D. Thesis (1996).
(At Present: Research Engineer, Kimberly-Clark, Inc., WI)
14. W. Qin, Numerical and Experimental Studies of Heat Transfer Phenomena in Microelectronic Packaging, Ph.D. Thesis (1997).
(At Present: Supervisor Engineer, Kulicke & Soffa Industries, PA)
15. S. Sripada, Fundamental Studies in Plasma-Arc and Phase-Change Heat Transfer, Ph.D. Thesis (1999).
(At Present: Applications Engineer, i2 Technologies, Irving, TX)
16. H. Gao. Numerical studies of microcarrier particle dynamics and associated mass transfer in rotating wall vessels, Ph.D. Thesis (2000).
(At Present: Engineering Specialist, Kimberly-Clark, Inc., WI)
17. M. Parker, Modeling of Looped heat pipes with applications to spacecraft thermal control (2000)
(At Present: Thermal Engineering Specialist, Boeing Satellite Division, CA)
18. K. Mukundakrishnan, Fluid mechanics and mass transfer in rotating cylindrical vessels: A numerical and experimental study, Ph.D. Thesis (2005).
(At Present: Engineer, Dassault Systemes Simulia, RI)
19. Josh Lampe, Interfacial characteristics of a gas bubble immersed in a surfactant and protein laden fluid: Experiments and Modeling, Ph.D. Thesis (2007) (Joint advisor: Prof. David Eckmann)
(At Present: Research Associate, Dept. of Emergency Medicine, Univ. of Pennsylvania)
20. Dr. G.C. Das, Indian Institute of Plasma Physics, Bangalore, India, Research on the Thermal and Electrical Characteristics of Plasma Arcs (1976-77).
21. Dr. T. Sundararajan, University of Pennsylvania, Research in Hydrodynamics and Heat/Mass Transfer Associated with Condensation on Moving Spray Drops (1983-1985).
22. Dr. L.J. Huang, University of Pennsylvania, Research in Thermal and Resultant Stresses in Microelectronic Packaging (1989-1990).
23. Dr. M. Lavy, University of Cambridge, England, Research on Non-Equilibrium Wet Steam Flow in Turbine Cascades (1990-1991).
24. Dr. Q.Q. Qiu, University of Toronto, Canada, Research on the Use of Bioactive Glass Particles as Microcarriers in Microgravity Environment (supervision jointly with Professor P. Ducheyne), (1995-1999).

25. Dr. S. Radin, All-National Research Institute for Aircraft Materials, Russia, Research on Surface transformation of reactive glass in a microgravity environment (supervision jointly with Professor P. Ducheyne, 1998-2002)
26. Dr. J. Zhang, Northwestern University, Research in Fluid Mechanics/Mass Transfer associated with gas embolism, (2002-2005).
27. Dr. S. Quan, University of Massachusetts, Macromolecule Adsorption and Bubble Adhesion to Model Endothelial Surface, (2005-2007).
28. Dr. K. Mukundakrishnan, University of Pennsylvania, Numerical Studies of Intravascular Bubble Motion, (2005-2008).
29. Dr. A.J. Calderon, University of Michigan, Ann Arbor, MI, Fluid Mechanics and Mass transfer of Targeted Drug delivery, (2006-2009).
30. Dr. T.N. Swaminathan, University of Pennsylvania, Numerical Studies of Intravascular Bubble Motion, (2008-2011).
31. Dr. S. Dasgupta, Washington State University, Pullman, WA, Experimental and modeling studies of gas embolism, (2008-2009).
32. Dr. U. Balakrishnan, Indian Institute of Technology, Madras, India, Numerical modeling of gas bubble/targeted drug delivery microcarrier motion in a blood vessel, (2009-present)
33. Dr. J. Liu, Johns Hopkins University, Baltimore, MD, Numerical modeling of targeted drug delivery microcarriers, (2009-2011).
34. Dr. P. Sobolewski, University of California, San Diego, La Jolla, CA, Cellular Mechanotransduction in Gas Embolism, (2009-2012).
35. Dr. A.L. Klinger, University of Virginia, Charlottesville, Virginia, Cellular Mechanotransduction in Gas Embolism, (2009-2012).
36. Dr. Hsiu-Yu Yu, Cornell University, Ithaca, New York, Multi-scale modeling of nanocarrier thermal motion and attachment., (2012-present).
37. Dr. N. Ramakrishnan, IIT, Madras, India, Multi-scale modeling of the nanocarrier-cell adhesion interface in targeted drug delivery, (2012-present).
38. Dr. A. Sarkar, IIT, Bombay, India, Multi-scale modeling of mass transfer by nanocarriers in targeted drug delivery, (2013-2015).
39. Dr. H. Vitoshkin, Tel-Aviv University, Tel-Aviv, Israel, Multi-scale modeling of the motion and mass transport associated with nanocarriers in targeted drug delivery, (2013-2015).
40. Dr. Y. Wang, Florida State University, Tallahassee, FL, Multi-scale modeling of the motion and mass transport associated with nanocarriers in targeted drug delivery, (2014-2016).

41. Dr. Z. Jabeen, IIT, Madras, India, Bridging Multiple Scales in Modeling Targeted Drug Nanocarrier Delivery, (2016-present).
42. Dr. S. Farokhirad, CCNY, New York, Multiscale model development and application in targeted drug delivery using Hydrodynamics and Statistical Mechanical models, (2016-present).

FUNDED RESEARCH ACTIVITIES

(Only grants where Ayyaswamy is the PI or a Co-PI are listed)

1. Grant Number: UO1 EB016027-01A1
 Sponsor: NIH
 Title: Bridging Multiple Scales in Modeling Targeted Drug Nanocarrier Delivery
 Award Amount: \$2,702,120
 Period of Award: 6/1/2013 - 5/30/2018
2. Grant Number: 2RO1 EB006818-05A1
 Sponsor: NIH
 Title: Targeted Microcarrier Design and Optimization
 Award Amount: \$1,955,247
 Period of Award: 6/1/2013 - 5/30/2017
3. Grant Number: CBET-1236514
 Sponsor: NSF
 Title: Multiscale Modeling of the Nanocarrier-Cell Adhesion Interface in Targeted Drug Delivery
 Award Amount: \$360,000
 Period of Award: 9/1/2012 - 8/31/2015
4. Grant Number: RO1 HL067986
 Sponsor: NIH
 Title: Activation of Clotting and Cell Adhesion in Response to Gas embolism
 Award Amount: \$910,587
 Period of Award: 7/01/2009 - 12/31/2011
5. Grant Number: RO1 EB06818
 Sponsor: NIH/NIBIB and NIGMS
 Title: Targeted microcarrier design and optimization
 Award Amount: \$1,575,000
 Period of Award: 7/1/2008 - 9/30/2012
6. Grant Number: N00014-08-1-0436
 Sponsor: ONR
 Title: Molecular Basis of Injury and Treatment of Arterial Gas Embolism
 Award Amount: \$1,006,274
 Period of Award: 3/01/2008 - 8/24/2011

7. Grant Number: RO1 HL60230-S1
 Sponsor: NIH
 Title: Interfacial Mechanics in Intravascular Gas Embolism
 (Supplemental to support a minority Post Doc)
 Award Amount:
 Period of Award: 7/1/2008 - 1/8/2010
8. Grant Number: NNC05GA30G
 Sponsor: NASA
 Title: Macromolecule Adsorption and Bubble Adhesion to Model Endothelial
 Surface
 Award Amount: \$602,245
 Period of Award: 2004-2006
9. Grant Number: RO1 HL67986-01A1
 Sponsor: NIH
 Title: Activation of clotting and cell adhesion in Response to gas embolism
 Award Amount: \$1,460,000
 Period of Award: 2002-2007
10. Grant Number: NAG 9-1357
 Sponsor: NASA
 Title: Impact of microgravity on human osteoblast life history: Experimental
 investigation and Numerical study
 Award Amount: \$745,000
 Period of Award: 2001-2004
11. Grant Number: 536689
 Sponsor: Kulicke & Soffa Co., PA
 Title: Design Improvements on wire bonding machinery
 Award Amount: \$101,912
 Period of Award: 9/1/00 - 8/31/01
12. Grant Number: 5-35816
 Sponsor: NSF & Pathway Technologies, Inc.
 Title: A feasibility study on Electro-thermal compliant wheel and a micro
 accelerometer
 Award Amount: \$106,000
 Period of Award: 6/1/00 - 5/31/01
13. Grant Number: 5-08727
 Sponsor: Thermacore, Inc., PA
 Title: Transport Phenomena in wick structures
 Award Amount: \$24,303
 Period of Award: 6/1/00 - 5/31/01
14. Grant Number: NAG8-1483
 Sponsor: NASA
 Title: Surface Transformation of Reactive Glass in a Microgravity
 Environment

- Award Amount: \$403,300
 Period of Award: 2/1/98 - 1/31/02
15. Grant Number: 5-01963
 Sponsor: Delaware River Port Authority
 Title: Recirculating Aquaculture System
 Award Amount: \$450,000 + \$350,000
 Period of Award: 7/1/97 - 6/30/99, renewal to 6/30/01
16. Grant Number: KS-95
 Sponsor: Kulicke and Soffa Industries, Inc.
 Title: Die Attach Adhesive Characterization Study
 Award Amount: \$35,263
 Period of Award: 7/1/95-9/1/96
17. Grant Number: CTS-9421598 & REU
 Sponsor: National Science Foundation
 Title: Low energy arc heat transfer with applications in microelectronic packaging technology
 Award Amount: \$259,931
 Period of Award: 5/95 -4/97
18. Grant Number: NAG 9-817
 Sponsor: NASA
 Title: The use of bioactive glass particles as microcarriers in microgravity environment
 Award Amount: \$730,000
 Period of Award: 7/95- 6/99
19. Grant Number: DDM 90-005732 & REU
 Sponsor: National Science Foundation
 Title: Advances in Design of Automated Wire and Die Bonding Machinery in Microelectronic Manufacturing
 Award Amount: \$274,250
 Period of Award: 6/1/90 - 8/31/94
20. Grant Number: BFP #90S.5055R-01 and #89S.5055R-01
 Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
 Title: Design of Automated Packaging Machinery in Microelectronic Manufacturing
 Award Amount: \$60,000
 Period of Award: 6/30/90- 8/31/93
21. Sponsor: Kulicke & Soffa Industries, Inc.
 Title: Advances in Wire Bonding
 Award Amount: \$53,000
 Period of Award: 6/30/90 -8/31/94
22. Grant Number: 3-71747
 Sponsor: University of Pennsylvania Research Foundation
 Title: Numerical Simulation of Process Problems in the Design of Automated

- Award Amount: Machinery for Assembly of Semiconductor Integrated Circuit Chip
\$15,925
Period of Award: 1/7/92-12/31/92
23. Grant Number: 5-21201
Sponsor: IBM Corporation
Title: Analysis and Simulation of Thermal Transients and Resultant Stresses in Microelectronic Equipment
Award Amount: \$29,975
Period of Award: 7/1/90 - 6/30/91
24. Grant Number: DMC 87-09537 & REU
Sponsor: National Science Foundation
Title: Ball Formation Processes in Wire Bonding Apparatus
Award Amount: \$261,654
Period of Award: 6/1/88 - 5/31/90
25. Grant Number: BFP #07,510 RU
Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
Title: Ball Formation Processes in Wire Bonding Apparatus
Award Amount: \$19,669
Period of Award: 9/1/88 - 8/31/89
26. Grant Number: BFP #06,500 NU
Sponsor: Benjamin Franklin Partnership/State of Pennsylvania
Title: Ball Formation Processes in Wire Bonding Apparatus
Award Amount: \$23,000
Period of Award: 9/1/87 - 8/31/88
27. Grant Number: DMC 85-13128 & REU
Sponsor: National Science Foundation
Title: Ball Formation Processes in Wire Bonding Apparatus
Award Amount: \$220,365
Period of Award: 9/1/85 - 1/30/88
28. Grant Number: 5-R01-CA-36624-03 Sub 01
Sponsor: National Institute of Health
Title: Dynamic Phantom Models for Hyperthermia Research
Award Amount: \$40,008
Period of Award: 6/1/85 - 5/31/86
29. Grant Number: 5-RO1-CA-36624-02 SUB 01
Sponsor: National Institute of Health
Title: Dynamic Tissue Models for Hyperthermia Research
Award Amount: \$105,830
Period of Award: 6/1/83 - 5/31/85
30. Grant Number: MEA82-17097
Sponsor: National Science Foundation
Title: Laminar Film Condensation on Drops Translating in Steam-Air Mixture

- Award Amount: \$61,743
 Period of Award: 7/1/83 - 12/31/84
31. Grant Number: MEA80-23861
 Sponsor: National Science Foundation
 Title: Laminar Film Condensation on a Droplet Translating in Steam-Air Mixture
 Award Amount: \$60,770
 Period of Award: 7/1/81 - 4/30/83
32. Grant Number: 5-RO1-CA-26046
 Sponsor: National Institute of Health
 Title: Microwave Dielectric Properties of Tumor and Normal Tissue
 Award Amount: \$53,516
 Period of Award: 7/1/81 - 6/30/82
33. Grant Number: ENG78-25899
 Sponsor: National Science Foundation
 Title: Electrostatic Sheath Stability in Magnetohydrodynamic Flows
 Award Amount: \$93,033
 Period of Award: 4/1/79 - 9/30/81
34. Grant Number: ENG77-23137
 Sponsor: National Science Foundation
 Title: Laminar Film Condensation on a Spherical Droplet Translating in a Steam-air Mixture
 Award Amount: \$80,147
 Period of Award: 4/15/78 - 3/31/81
35. Grant Number: FAC. Grant & Award Project #0060
 Sponsor: University of Pennsylvania Faculty Grants and Awards
 Title: Turbulent Couette Motion
 Award Amount: \$1,000
 Period of Award: 7/1/76 - 6/30/77
36. Grant Number: RP-378-1
 Sponsor: Electric Power Research Institute
 Title: Arc Discharges
 Award Amount: \$166,000
 Period of Award: 12/1/74 - 6/30/77

FUNDED GRANTS FOR ACADEMIC ACTIVITIES

1. Grant Number: PO94B30032
 Sponsor: U.S. Department of Education
 Title: Patricia Roberts Harris Doctoral Fellowships
 Co-Authors of Proposal: D. Graves, W. Shieh and M. Steedman
 Award Amount: For MEAM Department: 2 Fellowships @ \$28,000 per year, per student, for a total of three years.
 Period of Award: 1993-1998

2. Sponsor: National Science Foundation and Advanced Research Project Agency (NSF-ARPA)
Title: A Program for Manufacturing Management in Support of the Technology Reinvestment Program
Principal Investigators: G. Anandalingam and J. Adler
Co-Faculty Contributors: I.M. Cohen, N. Dorny, V. Kumar and W. Seider
Award Amount: \$600,000
Period of Award: 1994-1997

PENDING GRANT APPLICATIONS

1. Title : None at Present
Submitted to
Funds requested:
Period (expected):

PUBLICATIONS

a). REVIEW ARTICLES BY INVITATION

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