

CURRICULUM VITAE

Robert F. Richards

Professor

School of Mechanical and Materials Engineering
Washington State University
Pullman, WA 99164-2920

EDUCATION:

Ph. D.,	Engineering, 1990	University of California, Irvine
M. S.,	Engineering, 1987	University of California, Irvine
B.A.,	Physics, 1980	The University of Chicago

Areas of Interest: MEMS, Micropower, Thermodynamics, Heat and Mass Transfer

HONORS:

ASEE Postdoctoral Fellowship, 1990
Link Fellowship, 1985
Regents Fellowship, University of California, 1983

AWARDS:

ASME Best Paper Award MEMS Division, 2005
Teaching Excellence in Mechanical & Materials Engineering, WSU 2003

PROFESSIONAL EXPERIENCE:

2005 – Pres.	Professor , School of Mechanical and Materials Engineering, Washington State University, Pullman, WA
1999 – 2005,	Associate Professor , School of Mechanical and Materials Engineering, Washington State University, Pullman, WA
1992 – 1999,	Assistant Professor , School of Mechanical and Materials Engineering, Washington State University, Pullman, WA
1990 - 1992,	NIST/ASEE PostDoctoral Fellow , Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, MD
1983 - 1990,	Graduate Research Assistant , Department of Mechanical Engineering, University of California, Irvine,
1988 – 1989,	Consultant , PDA Engineering, Santa Anna, CA.
1981 – 1983,	Analyst , Vitro Laboratories, Silver Spring, MD.

PROFESSIONAL MEMBERSHIPS:

ASME, AIAA, ASEE

PROFESSIONAL SERVICE:

Reviewer for
Inverse Problems in Engineering
International Journal of Heat and Mass Transfer
ASME Journal of Fluids Engineering
ASME Journal of Heat Transfer
AIAA Journal of Thermophysics and Heat Transfer
ASME/IEEE Journal of MicroElectroMechanical Systems
Journal of Micromechanics and Microengineering
Nanotechnology
Sensors and Actuators
Journal of Micromechanics and Microengineering
Energy
Cambridge University Press
ASME National Heat Transfer Conference 1995, 1997
ASME IMECE, 1996, 2000, 2001
NSF Panel Reviewer
California Energy Innovations Small Grant Program Reviewer,
CDRF Reviewer

UNIVERSITY SERVICE:

Laboratory Equipment Committee (1994 - present)
Uncertified Major Advisor (1993 - present)
Seminar Coordinator (Fall 1995 - Spring 1996)
MERIT Coordinator (Fall 1995 - 2000)
ASME Graduate Student Conferences (Spring 1993, 1994)
Cougar Monday (1993 & 1994)
Faculty Phonathon (1994)
WSU Alive (1994)
MEP/WEP Advising (Fall 1994)
EIT Exam Review Sessions: Thermodynamics (1993 - 2006)
MME ABET Committee (1999 – 2001)
Academic Advising (1992 – 2006)
College Space Committee (2003-2006)
University Advisory Committee for Science Library (2005)
Faculty Search Committee (2005-2006)
University General Education Committee

RESEARCH GRANTS/CONTRACTS:

NIH - ***Implantable 16-256 Channel Data System for sleep in Mice***,
Co-Pi with C.D. Richards, D.F. Bahr, G. LaRue, & D. Hyoun (PI – D. Rector),
1/06 – 1/10

TPL SBIR:DARPA – ***Integrating the P3 Microengine with TPL Inc.'s Supercapacitor Technologies***,
Co-PI with C.D. Richards (PI – D.F. Bahr)
\$190K

NSF – ***Nanotube Based Structures for High Resolution Control of Thermal Transport***
Co-PI with D.F. Bahr, J. Jiao, C-S Chiang, S. Mesarovic, M. Osman (PI – CD. Richards)

\$1,079 K 8/04 – 7/08

TPL – STTR/Navy – ***Piezoelectrics for Energy Harvesting***

Co-PI with C.D. Richards (PI – D.F. Bahr)

\$30 K

MURDOCK CHARITABLE TRUST – ***A Fabrication Facility for MEMS Devices Based on Novel Materials***

Co-PI with C.D. Richards (PI - D.F. Bahr)

\$402 K

Lockheed Martin Aeronautics – ***The P³ Power Generation System for Converting Kinetic to Electrical Energy,***

Co-PI with C.D. Richards (PI - D.F. Bahr)

\$50 K 5/03 - 5/04

US ARMY SMDC - ***The P³ Power Generation System for Advanced Missile Defense Applications,***

Co-PI with C.D. Richards and D.F. Bahr (PI - K.G.Lynn)

\$2,400 K 1/03 - 1/05

DARPA/MTO – ***The P3 Micro Power Generator***

Principal Investigator (with Co-PI's C.D. Richards and D.F. Bahr)

\$1,400K 10/01 – 12/04

NSF – ***MEMS Based Power Generation for Portable Systems***

Principal Investigator (with Co-PI's C.D. Richards and D.F. Bahr)

\$520 K 9/99 – 8/02

Battelle PNL - ***Assessment of IX Resin Dissolution,***

Co-PI with W.J. Thomson.

\$5K 6/94-9/94.

INEEL/AWU - ***Scientific Basis of Thermal Spray Coatings for Environmental Management***

Collaboration with J. Fincke and R. Wright at INEEL

\$75 K 2/97-12/97

NIST - ***Development of an Economical Video Based Fire Detection and Location System,***

Co-PI (PI - O.A. Plumb).

\$210 K 9/92-8/95.

PhD RESEARCH SUPERVISED:

Ho Ki Lee – PhD Expected 2010

MicroEvaporator Modeling and Design

Leland Weiss – PhD Expected 2008

Thermodynamic Cycle Characterization of a MEMS Micro Engine

Scott Whalen – PhD December, 2004

Cycle Work from a MEMS Heat Engine and Characterization of the Liquid-Vapor Phase Change Actuation Mechanism

Kishan Padakannaya – PhD August 1998

An Inverse Radiation Problem for a Non-Gray Gaseous Medium

MS RESEARCH SUPERVISED:

Tiffany Quy – MS August 2006

Optimization of a Micro-Capillary Evaporator

Kevin Crain – MS December 2005

Mechanical Characterization and Thermal Modeling of a MEMS Thermal Switch

Travis Wiser – MS August 2005

Steady-state Heat Transfer Characterization of a Liquid Metal Thermal Switch

Karl Olsen – MS December 2004

Dynamic Behavior of a Thermal Switch

Dan Carpenter – December 2004

Fabrication and Characterization of a Micro Capillary Evaporator for MEMS Based Power Generation

Aireus Christensen – August 2003

Fabrication and Characterization of a Liquid-Metal Micro-Droplet Thermal Switch

Jeana Kanyer – August 2003

Thin-Film Evaporative Heat Transfer from Micromachined Wicking Structures

Jack Skinner – December 2002

Piezoelectric Membrane Generator Characterization and Optimization

Sreekant Narumanchi – August 1999

Benchmark Heat Transfer Measurements in a Coupled Conductive-Radiative System

Jeff Hutchison – August 1996

Onset of Thermal Instability in a Radiatively Participating Medium

Darin Peterson – August 1996

Measurement of Droplet Temperature Using Thermochromic Liquid Crystals

Brian Munk – May 1994

Evaluation of a Video Fire Detection System

Post Doctoral

Seyoul Won

3-D Numerical Model of the P3 Micro Heat Engine

UNDERGRADUATE COURSES TAUGHT:

ME 125, MERIT

ME 212, Dynamics

ME 301, Fundamentals of Thermodynamics

ME 305, Thermal and Fluid Laboratory

ME 402, Thermodynamic Systems

ME 402, Thermodynamic Systems Design

ME 404, Heat Transfer

ME 406, Experimental Design

UNDERGRADUATE COURSES TAUGHT:

ME 527, Macroscopic Thermodynamics

ME 526, Microscopic Thermodynamics

ME 514, Thermal Radiation Processes

ME 516, Conduction and Radiation Heat Transfer

ME 598, Graduate Seminar

MSE 514, Thermodynamics of Solids

PUBLICATIONS

S.A. Whalen, C. Richards, D. F. Bahr, and R. Richards, Characterization and Modeling of a Microcapillary Driven Liquid-Vapor Phase-Change Membrane Actuator Wick, *Sensors and Actuators: A. Physical*, vol. 134, pp. 201-212, 2007

J.H. Cho, R.F. Richards, D.F. Bahr and C.D Richards, Development of Noncontact Spring Constant Measurement and Deflection Characterization of Piezoelectric Devices, *Journal of Applied Physics*, vol. 101, 044014, 2007.

S. Dj. Mesarovic, C.M. McCarter, D.F. Bahr, H. Radhakrishnan, R.F.Richards, C.D.Richards, D. McClain, J. Jiao, Mechanical behavior of a carbon nanotube turf," *Scripta Materialia*, vol. 56, pp. 157-160, 2007.

J. Cho, T. Wiser, C. Richards, D. Bahr and R. Richards, Fabrication and Characterization of a Thermal Switch, *Sensors and Actuators: A. Physical*, vol. 133, pp. 55-63, 2007.

C.M. McCarter, R.F.Richards, S. Dj. Mesarovic, C.D.Richards, D.F. Bahr, D. McClain, J. Jiao, Mechanical compliance of photolithographically defined vertically aligned carbon nanotubes turf," *Journal of Material Science*, vol. , pp. , 2006.

M.C. Robinson, D.J. Morris, P.D. Hayenga, J.H. Cho, C.D. Richards, R.F. Richards and D.F. Bahr, Structural and Electrical Characterization of PZT on Gold for Micromachined Piezoelectric Membranes, *Applied Physics A*, vol. 85, pp. 135-140, 2006.

L.W. Weiss, J. Cho, K.E. McNeil, D.F. Bahr, C.D. Richards, and R.F. Richards, Characterization of an Dynamic Micro Heat Engine with Integrated Thermal Switch, *Journal of Micromechanics and Microengineering*, vol. 16 pp. 1-8, 2006

J.H. Cho, M.J. Anderson, R. F. Richards, D.F. Bahr, C.D. Richards, Efficiency of Energy Conversion by Piezoelectrics, *Applied Physics Letters*, In Press 2006

O. Al-Hattamleh, J. Cho, R. Richards, D. Bahr, C. Richards, The effect of design and process parameters on electromechanical coupling for a thin-film PZT membrane, *JMEMS*, In Press 2006

B. A. Hollenberg, C. D. Richards, R.F. Richards, D.F. Bahr, and D.M. Rector, Fabrication of a Flexible MEMS Electrode Array for Recording Surface Field Potentials, *J. Neuroscience Methods* (2005).

O. I. Crabtree, S. Dj. Mesarovic, R. F. Richards, D. F. Bahr, C. D. Richards, Nonlinear Vibrations of a Pre-Stressed Laminated Thin late, *International J of Mech. Sciences*, Vol 48, No. 4, 451 – 459 (2006).

J. Cho, M. Anderson, R. Richards, D. Bahr, C. Richards, Optimization of Electromechanical Coupling for a Thin Film PZT Membrane. Part I: Modeling, *Journal of Micromechanics and Microengineering*, Vol. 15 pp.1797-1803, (2005)

J. Cho, M. Anderson, R. Richards, D. Bahr, C. Richards, Optimization of Electromechanical Coupling for a Thin Film PZT Membrane. Part II: Experiment, Journal of Micromechanics and Microengineering, Vol. 15 pp. 1804-1809, (2005)

C. D. Richards, M. A. Anderson, D. F. Bahr, and R. F. Richards, Efficiency of energy conversion for devices containing a piezoelectric component, Journal of Micromechanics and Microengineering, Vol. 14, no. 5, 717 – 721 (2004).

I. Demir, A.L. Olson, J. L. Skinner, C. D. Richards, R. F. Richards, D. F. Bahr, High Strain Behavior of composite thin film piezoelectric membranes, J. Microelectronics Engineering, Vol. 75,12 – 23, (2004) .

L.M.R. Eakins, B.W. Olson, C.D. Richards, R.F. Richards, and D.F. Bahr, Influence of structure and chemistry on piezoelectric properties of PZT in a MEMS power generation application, J. Mater. Res., vol. 18, pp. 2079-2086(2003).

L.M.R. Eakins, B.W. Olson, C.D Richards, R.F Richards, D.F. Bahr, Microstructural Characterization And Mechanical Reliability Of Pt/Pzt Interfaces In MEMS Applications, Thin Solid Films, vol. 441, pp. 180-186 (2003).

S. Whalen, M. Thompson, D. Bahr, C. Richards and R. Richards, Design, Fabrication and Testing of the P3 Micro Heat Engine, Sensors and Actuators, vol. 104, no.3, pp. 200-208, (2003).

J. D. Hall, N. E. Apperson, B. T. Crozier, C. Xu, R. F. Richards, D. F. Bahr, and C. D. Richards, "A facility for characterizing the dynamic mechanical behavior of thin film membranes for microelectromechanical systems devices", Review of Scientific Instruments, Vol. 73, pp. 2067-2072, 2002.

D.F. Bahr, B.T. Crozier, C.D. Richards, and R.F. Richards, "Fatigue and Fracture in Membranes for MEMS Power Generation", Mechanical Properties of Structural Films, STP No. 1413, C.L. Muhlstein and S.B. Brown, Eds., American Society for Testing and Materials, West Conshohocken, PA, (2001).

Richards, C.D., and Richards, R.F., "Convective cooling of a suspended water droplet," ASME J. Heat Trans., Vol. 119, no. 2 (1997).

Hutchison, J.E. and Richards, R.F., "Effect of Nongray Gas Radiation on Thermal Stability in Carbon Dioxide," AIAA Journal of Thermophysics and Heat Transfer, vol. 13, no. 1, pp. 25-32 (1999).

Richards, C.D. and Richards, R.F., "Transient Temperature Measurements in a Convectively Cooled Droplet," Experiments in Fluids, vol. 25, pp. 392-400 (1998).

Richards, R.F., Munk, B.N., and Plumb, O.A., "Fire Detection, Location, and Heat Release Rate through Inverse Problem Solution, Part I: Theory," Fire Safety Journal, vol. 28, no. 4, pp. 323-350 (1997).

Richards, R.F., Ribail, R.T. , Bakkom, A.B., and Plumb, O.A., *"Fire Detection, Location, and Heat Release Rate through Inverse Problem Solution, Part II: Experiment,"* Fire Safety Journal, vol. 28, no. 4, pp. 351-378 (1997).

Abou-Ziyan, H., and Richards, R.F., *"Effect of Gap Thickness on a Rectangular-Cell Compound-Honeycomb Solar Collector,"* Solar Energy, vol. 60, no. 5, pp. 271-280 (1997).

Richards, C.D., and Richards, R.F., *"Convective Cooling of a Suspended Water Droplet,"* ASME Journal of Heat Transfer, vol.119, p. 208 (1997).

Richards, R.F., *"Thermal Stability of a Diathermanous Fluid in a Multi-Layer System with Partially Transparent Radiating Boundaries,"* International Journal of Heat and Mass Transfer, v.37, pp.2101-2112 (1994).

Richards, R.F., *"Steady-Flux Measurements of Moisture Diffusivity in Unsaturated Porous Media,"* Building and Environment, v.29, pp531-535 (1994).

Richards, R.F., Burch, D.M. and Thomas, W.C., *"Water Vapor Sorption Measurements of Common Building Materials,"* ASHRAE Transactions, v.98, pp.475-485 (1992).

Edwards, D.K. and Richards, R.F., *"Optimum Heat Rejection Temperatures for Spacecraft Heat Pumps,"* AIAA Journal of Spacecraft and Rockets, v.26, pp.303-307 (1989).

Richards, R.F. and Edwards, D.K., *"Effect of Boundary Radiation on Thermal Stability in Horizontal Layers"* International Journal of Heat and Mass Transfer, v.32, pp.81-86 (1989).

Richards, R.F., Young, M.F. and Haiad, J.C., *"Turbulent Forced Convection Heat Transfer From a Bottom Heated Open Surface Cavity,"* International Journal of Heat and Mass Transfer, v.30, pp.2281-2287 (1987).

REFEREED CONFERENCE PROCEEDINGS

H-K Lee, T.A. Quy, C.D.Richards, D.F. Bahr, R.F. Richards, *Experimental and Numerical Study of Evaporative Heat Transfer from Ten-Micron Microchannels*, ASME IMECE, Paper No. IMECE-15587, Chicago, IL, Nov. 5-10, 2006

J.H. Cho, C.D.Richards, D.F. Bahr, R.F. Richards, *Dynamic Operation of a MEMS Thermal Switch*, ASME IMECE, Paper No. IMECE-15286, Chicago, IL, Nov. 5-10, 2006

L.W. Weiss, J.H. Cho, D.J. Morris, D.F. Bahr, C.D.Richards, R.F. Richards, *A MEMS-Based Micro Heat Engine with Integrated Thermal Switch*, ASME IMECE, Paper No. IMECE-15042, Chicago, IL, Nov. 5-10, 2006

J.H. Cho, L.W. Weiss, C.D. Richards, D.F. Bahr, and R.F. Richards, *Power Production by a Dynamic Micro Heat Engine with Integrated Thermal Switch*, PowerMEMS 06, Technical Digest, pp. , Berkeley, CA, Dec. , 2006

J.H. Cho, C.D.Richards, J. Jiao, D.F. Bahr, R.F. Richards, *Design, and characterization of a MEMS Thermal Switch*, Hilton Head 2006, Solid State Sensor, Actuator and Microsystem Workshop, June 4-8, 2006

D. McClain, M. DeRoss, N. Tavan, J. Jiao, C. McCarter, R. Richards, S. Mesarovic, C. Richards, D. Bahr, *Effect of Diameter on Electron Field Emissions of Carbon Nanotube Bundles*, Mater. Res. Soc. Symp. Proc., vol. 901E. 2006

L.W. Weiss, K.E. McNeil, D.F. Bahr, C.D. Richards, and R.F. Richards, *Characterization of an External Combustion Dynamic Micro Heat Engine*, PowerMEMS 05, Technical Digest, pp.29-32, Tokyo, Nov. 29-30, 2005

M.C. Robinson, P.D. Hayenga, J.H. Cho, C.D. Richards, R.F. Richards, and D.F. Bahr, *Fabrication Methods For Improved Electromechanical Behavior In Piezoelectric Membranes* Proceedings of the Materials Research Society, **872**, pp. J18.26 (2005)

T.A. Quy, D.A. Carpenter, C.D. Richards, D.F. Bahr and R.F. Richards, *Evaporative Heat Transfer from Ten-Micron Channels*, ASME IMECE, Paper No. IMECE-81460, Orlando, FL, Nov. 5-11, 2005

J. Cho, M. Anderson, R. Richards, D. Bahr, C. Richards, A Comparison of Piezoelectric and Electrostatic Electromechanical Coupling for Ultrasonic Transduction and Power Generation, 2005 IEEE Ultrasonics Symposium, September 2005, Rotterdam, The Netherlands.

S. Whalen, S. Y. Wan, C. Richards, D. Bahr, and R. Richards, *Characterization of a Model Liquid-Vapor Phase-Change Membrane Actuator*, Proceedings of ASME IMECE, Paper No. IMECE2005-82564, Orlando, Nov. (2005). Best Paper MEMS Division.

D. McClain, L.F. Dong, C.C. Pan, J. Jiao, C. McCarter, D. Bahr, C. Richards, R. Richards, "Synthesis and Microanalysis of Aligned Carbon Nanotube Arrays," Proceedings of Microscopy and Microanalysis 2005, Vol. 11, Supplement 2, 1920-1921 (2005).

S.A Whalen, S.Y. Won, R. F. Richards, D. F. Bahr, and C.D. Richards, *Characterization and Modeling of a Liquid-Vapor Phase-Change Membrane Actuator with an Integrated SU-8 Micro Capillary Wicking Structure*, Transducers '05, Paper No. AM837, Seoul, Korea, June 5-9, 2005

D. McClain, L.F. Dong, C.C. Pan, J. Jiao, C. McCarter, D. Bahr, C. Richards, R. Richards, "Fabrication of Patterned Carbon Nanotube Arrays and Study of Their Electron Field Emission," Proceedings of the 2005 Materials Research Society Fall Meeting.

C. M. McCarter, D.F. Bahr, R.F. Richards, C.D. Richards, D. McClain, and J. Jiao, "Integration of Carbon Nanotubes with MEMS through Standard Photolithographic Techniques," Proceedings of Materials Science and Technology 2005 Conference, Symposium on Nanomaterials, pp. 45-52 (2005).

M.C. Robinson, P.D. Hayenga, J.H. Cho, C.D. Richards, R.F. Richards, and D.F. Bahr, *Fabrication Methods For Improved Electromechanical Behavior In Piezoelectric Membranes*, Proceedings of the Materials Research Society, **872**, pp. J18.26 (2005)

E.K. Herzog, D.F. Bahr, C.D. Richards, R.F. Richards, and D.M. Rector, Spatially Dependent Mechanical Properties of Rat Whiskers for Tactile Sensing, Proceedings of the Materials Research Society. 841, pp. R3.6/Y3.6 (2005).

J.H. Cho, J.C. Raupp, P. Hayenga, R.F. Richards, D.F. Bahr, M.J. Anderson, C.D. Richards, "Efficiency characterization of piezoelectrics for power," Proceedings of ASME IMECE, Paper No. IMECE2004-61739, Anaheim, Nov. (2004).

O. Crabtree, S. Mesarovic, I. Demir, R. Richards, D. Bahr, C. Richards, "Numerical Modeling of a Geometrically Nonlinear PZT MEMS Membrane," Proceedings of ASME IMECE, Paper No. IMECE2004-61760, Anaheim, Nov. (2004).

D.F. Bahr, M.S. Kennedy, M.C. Robinson, K.E. Shafer, C.D. Richards, R.F. Richards Fracture and Residual Stress in Piezoelectric Thin Films for MEMS, Advanced Materials for Energy Conversion II, TMS, Warrendale PA, pp. 393-400 (2004)

D.F. Bahr, C.D. Richards, R.F. Richards, J.V. Martinez, and T.M. Sullivan, Piezoelectric Thin Films for Energy Conversion in MEMS, TMS Annual Meeting, February (2004)

J.H. Cho, M.J. Anderson, R.F. Richards, D.F. Bahr, and C.D. Richards, "Analysis of micromachined PZT membranes for MEMS power, Nanotech 2004, Boston, March 2004.

M.S. Kennedy, M. Zosel, C.D. Richards, R.F. Richards, D.F. Bahr, and K.W. Hipps, Optimization of Film Stresses in Composite Piezoelectric Membrane Microgenerators, Proceedings of the Materials Research Society, Thin Films: Stresses and Mechanical Properties X, vol. 795, pp. 503-508 (2004).

W. Song, B. Q. Li, C. Xu and C. Richards, "A two-phase flow model for particle-gas flows and comparison with experimental measurements," Multiphase phenomena and CFD modeling and simulation in materials processing (Ed. L. Nastec and B. Q. Li), TMS, 2004, pp. 23-30.

R.M. Beiu, C.D. Richards, R.F. Richards, M.D. Fuller, D.F. Bahr, D.M. Rector, A Flexible 64 Channel Electrode Array for Chronic Local Field Potential Recording and Mapping, Neurosciences Meeting, New Orleans, November, 2003.

N. Stoddard, C. Richards, C. Crowe, and T. Troutt, Turbulence modulation in an initially quiescent two-phase flow at high volume fraction using stereoscopic PIV, ASME FEDSM2003-45212.

A.O. Christensen, J.P. Jacob, C.D. Richards, D.F. Bahr and R.F. Richards, Fabrication and Characterization of a Liquid-Metal Micro-Droplet Array for Use as a Thermal Switch, Proceedings of HT2003, Paper No. HT2003-40317, Las Vegas, July, 2003

A.O. Christensen, J.P. Jacob, C.D. Richards, D.F. Bahr and R.F. Richards, Fabrication and Characterization of a Liquid-Metal Micro-Droplet Thermal Switch, Proceedings of Transducers'03, Paper No. AM069, Boston, June, 2003.

S. Whalen, R. Richards, D. Bahr, C. Richards, "Operation and testing of a micro heat engine," NanoTech 2003, San Francisco, CA, Feb. 2003.

M. Thompson, S. Whalen, C. Richards, D. Bahr, R. Richards, Low-Frequency Operation of the P³ Micro Heat Engine, ASME IMECE 2002, MEMS Symposium, New Orleans, LA, Nov. 2002.

J. Skinner, A. Olson, R. Richards, D. Bahr, & C. Richards, A Piezoelectric Membrane Generator for MEMS Power, AIAA Nanotech 2002, Houston, Texas, Sept. 2002.

M. Thompson, S. Whalen, C. Richards, D. Bahr, R. Richards, Design, Fabrication, and Testing of A Micro Heat Engine, AIAA Nanotech 2002, Houston, Texas, Sept. 2002.

Skinner, J., Thompson, M., Whalen, S., Richards, R., Bahr, D. & Richards, C., Design, Fabrication, and Testing of the P³ Micro Heat Engine, Hilton Head 2002, Solid State Sensor, Actuator and Microsystem Workshop, June 2-6, 2002

D.F. Bahr, K.R. Bruce, B.W. Olson, L.M. Eakins, C.D. Richards, and R.F. Richards, Electro-Mechanical Coupling And Power Generation In A PZT Micro-Engine Proceedings of the Materials Research Society, Materials Science of Microelectromechanical Systems (MEMS) Devices IV, vol. 687, pp. 4.3.1-6 (2002)

B.W. Olson, J.L. Skinner, C.D. Richards, R.F. Richards, and D.F. Bahr,"Optimization of Thermal Processing and Chemistry in the Fabrication of a PZT Based MEMS Power Generator", Proceedings of the Materials Research Society, Perovskite Materials, vol. 718, pp. D10.25.1-7 (2002)

A.L. Olson, L.M. Eakins, B.W. Olson, D.F. Bahr, C.D. Richards, R.F. Richards ,PZT And Electrode Enhancements Of Mems Based Micro Heat Engine For Power Generation, Proceedings of the Materials Research Society, Materials for Energy Storage, Generation, and Transport, vol. 730, pp. V5.19.1-6 (2002)

K. Bruce, R. Richards, D. Bahr, & C. Richards, Characterization of a Piezoelectric Membrane for MEMS Power, Proceedings ASME IMECE 2001– vol. 2, MEMS Symposium, Paper No. MEMS-23803, New York, New York, November 2001.

C.D. Richards, D.F. Bahr, C-G Xu and R.F. Richards, The P³ Micro Power Generation System, Proceedings ASME IMECE 2001 – vol. 1, Microscale Thermal Phenomena in Energy Systems, Paper No. HTD-24283, New York, New York, November 2001.

D.F. Bahr, B.T. Crozier, C.D. Richards, and R.F. Richards, Defects and Failure Modes in PZT Films for a MEMS Microengine, in Proceedings of the Materials Research Society, Materials Science of MEMS Devices III, vol. 657, pp. EE4.4.1-6 (2001)

C.D. Richards, D.F. Bahr, C-G Xu & R.F. Richards, MEMS Power: The P³ System, Proceedings of IECEC 2001, 36th Intersociety Energy Conversion Engineering Conference, Savannah, Georgia, July - August, 2001.

B.W. Olson, L.M. Randall, C.D. Richards, R.F. Richards, and D.F. Bahr, Relationships Between Microstructure and Reliability in PZT MEMS, in Proceedings of the Materials Research Society, Transport and Microstructural Phenomena in Oxide Electronics, vol. 666, pp. F6.1.1-9 (2001).

C. Xu, J. Hall, C. Richards, D.Bahr, R.Richards, Design of a Micro Heat Engine, ASME IMECE, Nov., 2000

D.F. Bahr, B.T. Crozier, C.D. Richard, R.F.Richards, Fatigue and Fracture in Membranes for MEMS Power Generation, ASTM Committee E8 on Fatigue and Fracture, Symposium on Mechanical Properties of Structural Films, (2000)

Richards, C.D. and Richards, R.F., "*Transient Temperature Measurements in a Suspended Droplet,*" Proceedings of the 32nd National Heat Transfer Conference, ASME HTD-Vol. 342, pp. 131-139, Baltimore, MD, Aug., 1997

Padakannaya, K. and Richards, R.F., "*Determining the Temperature Profile in a One-Dimensional Slab of Non-Gray Gas by Inverse Analysis,*" Proceedings of the 32nd National Heat Transfer Conference, ASME HTD-Vol. 345, pp. 31-40, Baltimore, MD , Aug., 1997.

Richards, R.F. and Plumb, O.A., "*Fire Detection and Location Through Inverse Problem Solution,*" Proceedings of the International Conference on Fire Research and Engineering, pp. 312-317, Orlando, Florida, Sept., 1995.

Padakannaya, K., Richards, R.F., and Plumb, O.A., "*Estimating the Temperature Profile in a Participating Cylindrical Medium by Inverse Analysis,*" Proceedings of 30th National Heat Transfer Conference, ASME HTD-Vol. 312 , pp. 63-69, Portland, Oregon, Aug., 1995.

Peterson, D., Hu, S.H., Richards, C.D., and Richards, R.F., "*The Measurement of Droplet Temperature Using Thermochromic Liquid Crystals,*" Proceedings of 30th National Heat Transfer Conference, ASME HTD-Vol. 308, pp. 39-46, Portland, Oregon, Aug., 1995.

Richards, R.F., Munk, B.N., Plumb, O.A., and Grosshandler, W.L., "*Fire Detection and Location through Inverse Problem Solution,*" Proceedings of the 10th International Conference on Automatic Fire Detection: AUBE '95, Duisburg, Germany, April, 1995.

Richards, R.F., "*Measurements of Liquid Diffusivity in Porous Building Materials,*" Proceedings of the Conference on the Thermal Performance of the Exterior Envelopes of Buildings V, pp. 501-511, Clearwater Beach, Florida, Dec., 1992

Richards, R.F. and Edwards, D.K., "*Investigation of Natural Convection and Film Radiation Interactions,*" Proceedings of the 2nd Annual Link Energy Conference, vol.1, pp.188-232, Rochester, New York, June, 1986.

Young, M.F., Richards, R.F. and Haiad, J.C., "*Turbulent Forced Convection Heat Transfer From a Bottom-Heated Open Cavity,*" Proceedings of the 23rd National Heat Transfer Conference, ASME HTD-vol. 42, pp. 61-64, Denver, Colorado, August, 1985.

NONREFEREED TECHNICAL PRESENTATIONS

R. Richards, D. Bahr, & C. Richards, *The P3 Micro Power Generator*, Proceedings DARPA/MTO MEMS/MPG/NMASP Principal Investigators' Meeting, Savannah, GA, January, 2006.

R. Richards, D. Bahr, & C. Richards, *The P3 Micro Power Generator*, Proceedings DARPA/MTO MEMS/MPG/NMASP Principal Investigators' Meeting, Portland, OR July, 2005.

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