

## **Patrick Barry Butler**

Professor and Dean  
College of Engineering  
The University of Iowa  
Iowa City, Iowa

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### **Education**

- B.S. Aeronautical and Astronautical Engineering, University of Illinois at Urbana-Champaign, 1979
- M.S. Aeronautical and Astronautical Engineering, University of Illinois at Urbana-Champaign, 1981
- Ph.D. Mechanical Engineering, University of Illinois at Urbana-Champaign, 1984

### **Administrative Experience**

- The University of Iowa, Department of Mechanical Engineering  
Chairman, 2000
- The University of Iowa, College of Engineering, Office of the Dean  
Associate Dean of Academic Programs, 1997-99  
Interim Dean, 1999  
Dean, November 2000 - present

### **Academic and Professional Experience**

- The University of Iowa, Department of Mechanical Engineering  
Professor, 1995-present  
Associate Professor, 1989-95  
Assistant Professor, 1984-89
- NWC, China Lake, California  
Visiting Faculty Fellow, 1985 (June-August)
- NSWC, White Oak, Maryland  
Visiting Faculty Fellow, 1986 (June-August)
- Sandia National Laboratories, Albuquerque, New Mexico  
Graduate Fellow, 1980 (June-August)  
Visiting Faculty Fellow, 1987, 1988 (June-August)
- AB Research Associates, Incorporated, Iowa City, Iowa  
Vice President, 1990-02
- Sandia National Laboratories, Livermore, California  
Visiting Faculty Fellow, 1991 (June-August)
- Universite de Provence, Marseille, France  
Visiting Faculty, 1994 (June), 1997 (June)

## **Honors and Awards**

University of Illinois at Urbana-Champaign  
Graduate Student Fellow, College of Engineering, 1979-80, 1983-84  
Outstanding Alumni Award, Aeronautical and Astronautical Engineering, 2002

Pi Tau Sigma  
Honorary Faculty Member, 1987

Society of Automotive Engineers  
Ralph Teetor National Educator Award, 1991

American Society of Mechanical Engineers  
Outstanding Professor - The University of Iowa Student Branch, 1991 and 1995

American Institute of Aeronautics and Astronautics  
Associate Fellow, 1995

## **Board/Council Membership**

Iowa Space Grant Consortium, Executive Committee, 1993-present

John Pappajohn Entrepreneurial Center, 1999-present

State Science and Technology Fair of Iowa, 2002-present

Aerospace States Association, Delegate for State of Iowa, 2004-present

University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Alumni Board, 2004-present

Advanced Manufacturing Research and Collaboration Cluster, 2005-present

Rock Island Area Development Group, 2006-present

The University of Iowa Research Foundation, 2006-present

The University of Iowa Research Park, 2006-present

ACE Mentor Program, 2006-present

Iowa Department of Economic Development, Iowa Advanced Manufacturing Council, 2006-present

## **Professional Consulting**

Combustion Sciences Incorporated, Champaign, Illinois, 1980-94

Princeton Combustion Research Laboratories, Monmouth Junction, New Jersey, 1986-90

SNPE Laboratory, Vert-le-Petit, France, 1987

Iowa Precision Corporation, Cedar Rapids, Iowa, 1989-90

Sandia National Laboratories, Livermore, California, 1989-90

Iowa Public Defenders Office, Cedar Rapids, Iowa, 1991

TRW Vehicle Safety Systems, Incorporated, Mesa, Arizona, 1991-94, 2003-06

Automotive Systems Laboratory, Farmington Hills, Michigan, 1991-93

Battelle Memorial Institute, Columbus, Ohio, 1992-94

### **Professional Consulting (continued)**

Praxair Surface Technologies, Indianapolis, Indiana, 2003-06

### **Service Activities - Professional Societies**

Society of Automotive Engineers

The University of Iowa Student Chapter, Faculty Advisor, 1985-90

Fine Particle Society

Program Subcommittee for International Symposium, 1986-88

Conference Session Chair, 1986

American Society of Mechanical Engineers

The University of Iowa Student Chapter, Faculty Advisor, 1988-90

American Institute of Aeronautics and Astronautics

Associate Editor of *AIAA Journal of Propulsion and Power*, 1994-02

Member of Propellants and Combustion Technical Committee, 1994-00

Conference Session Chair, 1996-99

The Combustion Institute

Program Subcommittee for International Symposium, 1994, 96

Conference Session Chair, 1991

Pi Tau Sigma

The University of Iowa Student Chapter, Faculty Advisor, 1994-97

Iowa Academy of Science, Engineering Section

Chair, 1992

Vice-Chair, 1991

### **Service Activities - The University of Iowa**

Presidential Scholarship Program Committee, 1986-89, 1996-98

Central Electron Microscopy Facility Advisory Board, 1987-90

Susan Hancher Award Selection Committee, 1991

Secondary Student Training Program, Selection Committee and Mentor, 1993-98

Junior Science and Humanities Symposium, Advisory Board and Judge, 1994-98

The University of Iowa Faculty Senate, 1995-98

Faculty Council, 1996-99

Committee on Committees, 1998, 1999 (Chair)

Study Abroad Advisory Committee, 1998

Women in Science and Engineering, Director Search Committee, 1998

National Advanced Driving Simulator, NADS Director Search Committee, 1999

President's Task Force on UI Foundation Funding Policy, 2003 (Chair)

Provost's Task Force on UI Tuition, 2003

Iowa State Fair, UI Volunteer, 2003-06

Tippie College of Business Dean Search Committee, Chair, 2005

### **Service Activities - The University of Iowa (continued)**

Provost's Ad Hoc Committee on Special Compensation, 2005  
Green Power Task Force, Co-Chair, 2007

### **Service Activities - College of Engineering**

Placement Committee, 1984-85  
Faculty Secretary, 1986-87  
Engineering Faculty Council, 1987-90, 1995-96, 1996-97 (Chair)  
Summer Institute for Creative Engineering, Selection Committee and Lecturer, 1991-92  
Civil and Environmental Engineering, External Review Committee, 1991-92  
Curriculum Committee, 1993-94 (Chair), 1994-95  
Lectures Committee, 1995-96

### **Service Activities – Community**

Volunteer Basketball Coach, Urbana Recreation Department, Urbana, Illinois, 1981-82  
University of Illinois at Urbana-Champaign, Rehabilitation-Education Center,  
reader/recorder of technical books and legal briefs for blind students, 1983-84  
Wesley House Free Lunch Program, Iowa City, Iowa, meal server, 1996-98  
City High School, Iowa City, Iowa, mentor for 12<sup>th</sup> grade science students, 1993-98  
Northwest Junior High, Iowa City, Iowa, mentor for 7<sup>th</sup> grade science students, 1993-95  
Cub Scouts Den Leader, Pack 252, Iowa City, Iowa, 1999-2003  
Soccer Coach, Iowa City Kickers, Iowa City, Iowa, 1999-2004  
Iowa City Eels Swim Club, Board of Directors, Trustee, 2007  
Corridor STEM (Science, Technology, Engineering and Mathematics) Initiative, 2007

### **Outreach and Presentations on Higher Education**

“National Engineers Week Annual Presentation,” joint presentation with Iowa State University's Dean of Engineering, 24 different Rotary Clubs throughout Iowa, 2000-2007.  
“Securing the Nation's Future,” presentation to Iowa Congressmen, American Society for Engineering Education, Engineering Deans Council, 2004 Public Policy Colloquium, Washington, DC, 2004  
“The Value of Science, Math and Engineering Education in Securing the State's/Nation's Future,” presentation to House Economic Growth Committee, The Iowa General Assembly, Des Moines, Iowa, 2005  
“Proactive in Driving Components of the ‘EcoSystem’ of Innovation and Economic Development,” presentation to Iowa Congressmen, American Society for Engineering Education, Engineering Deans Council, 2005 Public Policy Colloquium, Washington, DC, 2005

## **Outreach and Presentations on Higher Education (continued)**

- “Engineering Colleges - A Key Driver for Economic Competitiveness,” presentation to Iowa Congressmen, American Society for Engineering Education, Engineering Deans Council, 2006 Public Policy Colloquium, Washington, DC, 2006
- “Can Iowa Rise Above the Gathering Storm?” Opinion article, Corridor Business Journal, Cedar Rapids, Iowa, 2006.
- “Iowa’s Engineering Colleges – Providing Solutions for the ‘Big Picture’, ” presentation to Iowa Congressmen, American Society for Engineering Education, Engineering Deans Council, 2007 Public Policy Colloquium, Washington, DC, 2007

## **Teaching Record and Accomplishments**

### Recognition and Achievement

- Ralph Teetor National Educator Award, 1991
- Outstanding Professor - The University of Iowa ASME Student Branch, 1991 and 1995
- ACE Instructor Effectiveness Rating of all classes taught at UI, 5.6/6.0
- ACE Instructor Effectiveness Rating, 4 times achieved perfect score of 6.0/6.0

### Educational Initiatives

- Initiated College of Engineering’s “Grabbing the Globe” lecture series to promote global awareness (<http://www.engineering.uiowa.edu/events/globe>), 2006
- Developed and implemented Virtual International Project Teams (VIPT) curriculum, 1997-present

### Courses Taught

- Introduction to Engineering
- Thermodynamics I, Thermodynamics II, Intermediate Thermodynamics
- Elements of Gas Flow
- Advanced Topics in Thermal and Fluid Engineering (Shock Physics)
- Combustion and Propulsion Engineering
- Elements of Rocket Propulsion
- Numerical Calculations
- Experimental Engineering
- Thermal Fluid System Design
- Mechanical Engineering Senior Design Project

## **Undergraduate Student Research Supervision**

- B. Cohen, Department of Mechanical Engineering, “A Study of Solid Propellant Combustion Modeling,” 1984.
- C. Onewokae, Department of Mechanical Engineering, “Numerical Methods in Heat Transfer,” 1984.
- T. Budan, Department of Mechanical Engineering, “Design of an Electronic Test Stand for Solid Propellant Thrust Measurements,” 1985.
- B. Mills, Department of Mechanical Engineering, “Instrumentation of Solid Propellant Thrust Stand,” 1986.
- D. Heims, Department of Mechanical Engineering, “Numerical Model for Predicting Blast Overpressure from Grain Dust Explosions,” 1986.

**Undergraduate Student Research Supervision (continued)**

- E. Van Arkel, Department of Mechanical Engineering, "Two-Cycle Engine Thrust Measurement and Analysis," 1986.
- A. Mutammara, Department of Mechanical Engineering, "Development of Thermodynamics Software," 1986.
- D. Heims, Department of Mechanical Engineering, "Modeling Interior Ballistics of High-Pressure Systems," 1986.
- J. Schlueter, Department of Mechanical Engineering, "Digital Data Acquisition on Macintosh," 1988.
- M. McNutt, Department of Mechanical Engineering (UI Presidential Scholar), "Computational Thermodynamics," 1989.
- D. Bonnett, Department of Mechanical Engineering (ISGC NASA Undergraduate Scholar), "Computational Thermodynamics – Part II," 1990.
- S. Inlow, Department of Mechanical Engineering (ISGC NASA Undergraduate Scholar), "Pyrotechnic Modeling," 1992.
- M. Eckman, Department of Mechanical Engineering (College of Engineering Honors Program), "Vehicle Airbag Research," 1993.
- A. Veit, Department of Mechanical Engineering (AASERT Undergraduate Scholar), "Thermochemical Modeling," 1993.
- R. Morrissey, Department of Mechanical Engineering (AASERT Undergraduate Scholar), "Development of Thermochemical Database for Non-Ideal Gases," 1993.
- J. Freesmeir, Department of Mechanical Engineering (College of Engineering Honors Program), "Airbag Modeling," 1994.
- D. Crosby, Department of Mechanical Engineering (AASERT Undergraduate Scholar), "Thermochemical Database," 1995.
- D. Crosby, Department of Mechanical Engineering (College of Engineering Honors Program), "Airbag Modeling in FLOW-3D," 1996.
- M. Munoz, Department of Mechanical Engineering (ISGC NASA Undergraduate Scholar), "Airbag Testing," 1997.
- Kassie Kloberdanz, Department of Mechanical Engineering (ISGC NASA Undergraduate Scholar), "Airbag Testing – Part II," 1999.
- Andrew Wehr, Department of Mechanical Engineering, "Thermochemical Software Development," 1999.
- C. Smith and P. Rasmussen, Department of Chemical and Biochemical Engineering (College of Engineering Honors Program), "Biofuels for Small Engines," 2006.
- K. Rod, Department of Chemical and Biochemical Engineering, "EcoMarathon Mileage Vehicle Engine Analysis Team," 2006.
- M. Zanker, R. Meier, and D. Richmann, Department of Mechanical and Industrial Engineering, "EcoMarathon Mileage Vehicle Engine Analysis Team," 2006.
- Matthew Zanker, Department of Mechanical and Industrial Engineering (College of Engineering Honors Program), "Modeling Non-Ideal Thermodynamics in High-Pressure Combustion," 2007.

## Current Research Interests

High Velocity, Multi-Component Reactive Flow: Pulsating, supersonic flow of high-temperature products of combustion serves as a unique transport mechanism for accelerating and heating micron-sized particulate matter. The gas-particle mixture eventually impinges at high velocity on a substrate where it forms thin, overlapping, lenticular-shaped particle layers. We have developed the theory and accompanying computer models for understanding the interaction between controllable process variables (e.g., chemical composition of combustible gas, particle thermal properties, injection parameters, and particle size distribution) and characteristics of the resultant coating.

Rapid Combustion of Energetic Materials at Non-Ideal States: Working closely with research engineers in the automotive industry, we have developed advanced computer codes for use in the design, development and analysis of occupant restraint gas generators. These computer codes include exact real-gas thermodynamics for several cubic equations of state and elementary combustion kinetics characteristic of the unique high-pressure environment of many gas generators used to activate passenger restraint systems.

## Graduate Student Research Supervision

- F. Jahani, Department of Mechanical Engineering, "Attenuation of Weak Shock Waves in Fibrous and Granular Materials," (M.S.) 1987.
- Y. Han, Department of Mechanical Engineering, "A Statistical Analysis of Light Blockage Sizing Techniques," (M.S.) 1987.
- A. Ndayizeye, Department of Mechanical Engineering, "The Influence of Size Distribution on Explosibility: An Experimental Investigation and Regression Analysis," (M.S.) 1987.
- M. Haworth, Department of Mechanical Engineering, "Morphological Analysis of Quasi-Static Compacted Sucrose Crystals," (M.S.) 1988.
- K. Montz, Department of Chemical and Materials Engineering, "Particulate Removal Using High-Intensity Acoustic Waves," (Ph.D., Co-Advisor) 1988.
- R. Schmitt, Department of Mechanical Engineering, "Multicomponent, Multiphase Flow Analysis," (M.S.) 1990.
- J.Z. Yao, Department of Mechanical Engineering, "Analysis of Particle-Laden Gaseous Shock Waves," (Ph.D.) 1989.
- L.J. Chen, Department of Mechanical Engineering, "Shock Propagation and Shock Initiated Reaction in Granular Energetic Materials," (Ph.D.) 1990.
- J. Kang, Department of Mechanical Engineering, "A Thermo-Mechanical Analysis of Hot-Spot Formation in Condensed-Phase, Energetic Materials," (Ph.D.) 1991.
- M. Kodumudi, Department of Mechanical Engineering, "Real Gas Equations of State in Reaction Kinetics," (M.S.) 1992.
- V. Pai, Department of Mechanical Engineering, "A Numerical Model of Supercritical H<sub>2</sub>O Oxidation in a Tubular Reactor," (M.S.) 1993.

**Graduate Student Research Supervision (continued)**

- C. Greenlee, Department of Mechanical Engineering, "Influence of Product Species on Thermochemical Equilibrium Calculations for Energetic Materials," (M.S.) 1993.
- R.G. Schmitt, Department of Mechanical Engineering, "Analysis of Gas-Phase Detonation Wave Structure at Elevated Initial Pressures," (Ph.D.) 1994.
- D. Bonnett, Department of Mechanical Engineering, "A Thermochemical Transport Model for Hotspot Formation in Energetic Materials," (M.S.) 1995.
- M.K. Alkam, Department of Mechanical Engineering, Ignition of Solid Energetic Materials by Hot Gas Impingement," (Ph.D.) 1995.
- J. Clay, Department of Mechanical Engineering, "Design of a Small Spacecraft Thermal Analysis," (M.S., Co-Advisor) 1995.
- M. Schneider, Department of Mechanical Engineering, "Modeling Shock-Induced Hot Spot Formation and Ignition in Condensed-Phase Energetic Materials," (M.S.) 1996.
- P. Green, Department of Mechanical Engineering, "Ignition Temperature Prediction of Stoichiometric Methane-Air and Oxygen Mixtures up to 100 Bar," (M.S.) 1997.
- J. Freesmeier, Department of Mechanical Engineering, "Analysis of a Dual Combustion Chamber Gas Generator Used in Automotive Airbag Systems," (M.S.) 1997.
- D. Crosby, Department of Mechanical Engineering, "Numerical Analysis of a High-Velocity Oxygen-Fuel Thermal Spray Torch," (M.S.) 1998.
- Z. Xiong, Department of Mechanical Engineering, "Study of Aspiration Effects in Model Airbag Modules," (M.S., Co-Advisor) 2001.
- P. Green, Department of Mechanical Engineering, "Flow Aspiration During Airbag Deployment," (Ph.D.) 2001.
- K. Ramadan, Department of Mechanical Engineering, "A Computational Study of Pulsed Thermal Spraying," (Ph.D.) 2002.
- J. Cannon, Department of Mechanical and Industrial Engineering, "Thermal Efficiency Delivery of a Detonation Induced Pulse Jet," (M.S.) 2007.

**Publications (Archived Journal Articles and Select Conference Proceedings)**

- Butler, P.B., Lembeck, M.F., and Krier, H., "Modeling of Shock Development and Transition to Detonation Initiated by Burning in Porous Propellant Beds," *Combustion and Flame*, Vol. 46, March 1982, pp. 75-93.
- Coyne, D.W., Butler, P.B., and Krier, H., "Shock Development from Compression Waves Due to Confined Burning in Porous Solid Propellants and Explosives," AIAA Aerospace Sciences Meeting, Paper No. 83-0480, Reno, NV, January, 1983, pp. 1-12.
- Butler, P.B. and Krier, H., "DDT Analysis for Porous High Energy Propellants, Proceedings of 1983 JANNAF Propulsion Systems Hazards Meeting, Los Alamos, NM, CPIA Publications, 1983, pp. 145-153.

**Publications (continued)**

- Simpson, J.A., Krier, H., and Butler, P.B., "Launch Dynamics of Advanced Indirect Fire System (AIFS)," Proceedings of the Seventh International Symposium on Ballistics, The Hague, The Netherlands, 1983, pp. 1-7.
- Butler, P.B., and Krier, H., "Analysis of Deflagration to Shock to Detonation Transition (DSDT) in Porous Energetic Solid Propellants," Proceedings of AGARD Conference on Energetic Propellants, Conference Proceedings No. 367, Lisse, The Netherlands, May 1984, pp. 5-10.
- Cudak, C.A., Krier, H., and Butler, P.B., "Transition to Detonation from Rapid-Compression (Ramp-Waves) Generated in a Burning Porous Bed," Proceedings of JANNAF Propulsion Hazards Subcommittee Meeting, CPIA Publication, 1984, pp. 1-9.
- Wang, S.Y., Butler, P.B., and Krier, H., "Non-ideal Equations of State for Combusting and Detonating Explosives," *Progress in Energy and Combustion Sciences*, Vol. 11, Dec. 1985, pp. 311-332.
- Krier, H., Cudak, C.A., Stewart, J.R., and Butler, P.B., "A Model for Shock Initiation of Porous Propellants by Ramp-Induced Compression Processes," Proceedings of the 8th Symposium (International) on Detonation, July, 1985, pp. 1-10.
- Butler, P.B., and Krier, H., "Analysis of Deflagration to Detonation Transition in High-Energy Solid Propellants," *Combustion and Flame*, Vol. 63, Jan., 1986, pp. 31-48.
- Panczak, T.D., Butler, P.B., and Krier, H., "Shock Propagation and Blast Attenuation Through Aqueous Foams," *Journal of Hazardous Materials*, Vol. 14, 1987, pp. 321-336.
- Raspet, R., Butler, P.B., and Jahani, F., "The Reduction of Blast Overpressures from Aqueous Foam in a Rigid Confinement," *Journal of Applied Acoustics*, Vol. 22, 1987, pp. 35-45.
- Raspet, R., Butler, P.B., and Jahani, F., "The Effect of Material Properties on Reducing Intermediate Blast Noise," *Journal of Applied Acoustics*, Vol. 22, 1987, pp. 243-259.
- Butler, P.B., Haworth, M.E., Elban, W.L., and Coyne, P.J., "Morphological Analysis of Crystals During Quasi-Static Compaction," JANNAF Propulsion Hazards Subcommittee Meeting, CPIA Publication, 1987, pp. 1-10.
- Montz, K.W., Butler, P.B., and Beddow, J.K., "Adhesion and Removal of Particulate Contaminants in a High Decibel Acoustic Field," *Powder Technology*, Vol. 55, 1988, pp. 133-140.
- Han, J.S. and Butler, P.B., "Reliability of Minimum Sample Size for Irregularly Shaped Fine Particles," *Particulate Science and Technology*, Vol. 6, No. 3, 1988, pp. 305-315.
- Ah Chin, A.D., Butler, P.B., and Luerkens, D.W., "Influence of Particle Shape on Size Measured by the Light Blockage Technique," *Powder Technology*, Vol. 54, 1988, pp. 99-105.
- Ogle, R.A., Chen, L-D., Butler, P.B., and Beddow, J.K., "An Investigation of Aluminum Dust Explosions," *Combustion Science and Technology*, Vol. 61, 1988, pp. 75-99.

**Publications (continued)**

- Montz, K.W., Butler, P.B., and Beddow, J.K., "Acoustic Interactions with Surface-Adhered Fine Particles," *Journal of Applied Acoustics*, Vol. 28, 1988, pp. 9-19.
- Butler, A.A., Butler, P.B., and Luerkens, D.W., "Single Particle Statistics Derived From Light Blockage Instruments," *Powder Technology*, Vol. 57, 1989, pp. 143-149.
- Butler, P.B., Haworth, M.E., Elban, W.L., and Coyne, P.J., "Particle Morphology Characterization of Quasi-Static Compacted Sucrose Powder," *Powder Technology*, Vol. 62, 1990, pp. 171-181.
- Butler, P.B., and Schmitt, R.G., "Shock Propagation through a Perfect Gas Entrained with a Normal Distribution of Fine Particles," *Powder Technology*, Vol. 63, 1991, pp. 229-240.
- Bergan, N.E., Butler, P.B., and Dwyer, H.A., "High-Pressure Thermodynamics in Supercritical Oxidation Processes," Proceedings of 2nd Conference (International) on Supercritical Fluids, May, Boston, MA, 1991.
- Butler, P.B., Bergan, N.E., Bramlette, T.T., Pitz, W.J., and Westbrook, C.K., "Oxidation of Hazardous Waste in Supercritical Water: A Comparison of Modeling and Experimental Results for Methanol Destruction," The Combustion Institute Western States Meeting, March 18, 1991, Boulder, CO.
- Schmitt, R.G., Butler, P.B., Bergan, N.E., Pitz, W.J., and Westbrook, C.K., "Destruction of Hazardous Waste in a Supercritical Water. Part II: A Study of High Pressure Methanol Oxidation Kinetics," The Combustion Institute Western States Meeting, October 13, 1991, Los Angeles, CA.
- Haferman, J.L., Schmitt, R.G., Smith, T.F., and Butler, P.B., "Thermal Radiation Effects on a Shocked Particle-Laden Gas," *AIAA Journal of Thermophysics and Heat Transfer*, Vol. 6, 1992, pp. 467-475.
- Schmitt, R.G., and Butler, P.B., "Influence of Particle Melting on a Shocked Particle-Laden Gas," *Powder Technology*, Vol. 70, 1992, pp. 163-173.
- Kang, J., Butler, P.B., and Baer, M.R., "A Thermomechanical Analysis of Hot Spot Formation in Condensed-Phase Energetic Materials," *Combustion and Flame*, Vol. 89, 1992, pp. 117-139.
- Kang, J., and Butler, P.B., "Hot Spot Formation and Growth to Ignition in Nitramine-Based Energetic Materials," The Combustion Institute Central States Meeting, April 26, 1992, Columbus, OH.
- Butler, P.B., Kang, J., and Krier, H., "Modeling Pyrotechnic Combustion in an Automotive Airbag Inflator," 5th International Congress of the Groupe de Travail de Pyrotechnie, June, 1993, France.
- Butler, P.B., Kang, J., and Krier, H., "Numerical Simulation of a Pre-Pressurized Pyrotechnic Automotive Airbag Inflator," 5th International Congress of the Groupe de Travail de Pyrotechnie, June, 1993, France.

**Publications (continued)**

- Kang, J., and Butler, P.B., "Shock Initiation of Hydrogen/Oxygen/Argon Bubbles in a Nonreactive Liquid Media," *Combustion Science and Technology*, Vol. 90, 1993, pp. 173-192.
- Butler, P.B., Krier, H.K., Faigle, E.M., Semchena, J.H., and Thompson, R., "Numerical Simulation of Passenger-Side Automotive Airbag Inflators," *Transactions of SAE: Journal of Passenger Cars*, Vol. 101, 1993, pp. 1110-1115.
- Butler, P.B., Kang, J., and Krier, H., "Modeling and Numerical Simulation of the Internal Thermochemistry of an Automotive Airbag Inflator," *Progress in Energy and Combustion Science*, Vol. 19, 1993, pp. 365-382.
- Alkam, M.K., and Butler, P.B., "Transient Conjugate Heat Transfer Between an Impinging Jet and a Solid Disk," *AIAA Journal of Thermophysics and Heat Transfer*, Vol. 8, No. 4, 1994, pp. 664-669.
- Berger, J.M., and Butler, P.B., "Equilibrium Analysis of Three Classes of Automotive Airbag Inflator Propellants," *Combustion Science and Technology*, Vol. 104, No. 1-3, 1995, pp. 93-114.
- Schmitt, R.G., and Butler, P.B., "Detonation Properties of Gases at Elevated Initial Pressures," *Combustion Science and Technology*, Vol. 106, No. 1-3, 1995, pp. 167-193.
- Schmitt, R.G., and Butler, P.B., "Detonation Wave Structure of Gases at Elevated Initial Pressures," *Combustion Science and Technology*, Vol. 107, No. 4-6, 1995, pp. 355-386.
- Mazel, P., Saurel, R., Loraud, J.C., and Butler, P.B., "A Numerical Study of Weak Shock Wave Propagation in a Reactive Bubbly Liquid," Vol. 6, No. 3-4, *Shock Waves*, 1996, pp. 287-300.
- Alkam, M.K., Pai, V.M., Butler, P.B., and Pitz, W.J., "Methanol and Hydrogen Oxidation Kinetics in Water at Supercritical States, Vol. 106, *Combustion and Flame*, 1996, pp. 110-130.
- Bonnett, D.L., and Butler, P.B., "Hot Spot Ignition of Condensed Phase Energetic Materials," *AIAA Journal of Propulsion and Power*, Vol. 12, No. 4, 1996, pp. 680-690.
- Parra, T., Butler, P.B., Castro, F., and Rodriguez, M.A., "Numerical Simulation of Deflagration to Detonation Transition," International Congress of Finite Volumes for Complex Applications, Problems and Perspectives, July, 1996, France.
- Blomquist, H., Freesmeier, J.J., Green, P.W., Butler, P.B., and Krier, H., "Current Issues in Airbag Inflator Modeling," Proceedings of Airbag 2000 Congress, November, 1996, Germany.
- Blomquist, H., Freesmeier, J.J., Green, P.W., Butler, P.B., and Krier, H., "Heated-Gas Inflator Airbag Inflator Modeling," Proceedings of Airbag 2000 Congress, November, 1996, Germany.
- Greenlee, C.L., and Butler, P.B., "Influence of Product Species Selection on Thermochemical Equilibrium Calculations, Part I: Energetic Materials," *Propellants, Explosives and Pyrotechnics*, Vol. 22, 1997, pp. 15-22.

**Publications (continued)**

- Schmitt, R.G., Butler, P.B., and Freesmeier, J.J., "Performance and CO Production of a Non-Azide Airbag Propellant in a Pre-Pressurized Gas Generator," *Combustion Science and Technology*, Vol. 122, 1997, pp. 305-350.
- Lee, Y.G., Yu, C.S., Chen, L.D., and Butler, P.B., "A Study of Aspiration Effects in Reduced-Scale Model Airbag Modules," SAE - International Body Engineering Conference, Detroit, Michigan, 1998.
- Blomquist, H., Freesmeier, J.J., Green, P.W., and Butler, P.B., "Inflator Modeling Requirements for the Next Generation Airbags," ISATA, Germany, 1998.
- Green, P.W., Yu, C.S., Chen, L.D., Butler, P.B., Wang, J.T., and Lee, Y.G., "Experimental Analysis of Aspirating Airbag Units," SAE - International Congress, SAE Transactions - Journal of Passenger Cars, Detroit, Michigan, 1999.
- Saurel, R., Cocchi, J.P., and Butler, P.B., "A Numerical Study of Cavitation in the Wake of a Hypervelocity Underwater Projectile," *AIAA Journal of Propulsion and Power*, Vol. 15, No. 4, 1999, pp. 513-522.
- Freesmeier, J.J., and P.B. Butler "Analysis of a Hybrid Dual-Combustion-Chamber Solid Propellant Gas Generator," *AIAA Journal of Propulsion and Power*, Vol. 15, No. 4, 1999, pp. 552-561.
- Alkam, M.K., and Butler, P.B., "Impingement Heating and Ignition of Condensed-Phase Energetic Material," *AIAA Journal of Propulsion and Power*, Vol. 16, No. 6, 2000, pp. 1075-1082.
- Alkam, M.K., and Butler, P.B., "Analysis of a Pulsed Detonation Thermal Spray Device," *Combustion Science and Technology*, Vol. 159, 2000, pp. 17-37.
- Rahman, S., Smith, T.F., and P.B. Butler, "Overview and Expansion of Program for Enhanced Design Experience in 1998-88," 2000 ASEE Annual Conference and Exhibition, 2000, St. Louis, MO.
- Ramadan, K., and P. B. Butler, "A Two-Dimensional Axisymmetric Flow Model for the Analysis of Pulsed Detonation Thermal Spraying," *Combustion Science and Technology*, Vol. 175, No. 9, 2003, pp. 1649-1677.
- Ramadan, K., and P. B. Butler, "Analysis of Particle Dynamics and Heat Transfer in Detonation Thermal Spraying Systems," *Journal of Thermal Spray Technology*, Vol. 13, No. 2, 2004, pp. 248-257.
- Ramadan, K., and P. B. Butler, "Analysis of Gas Flow Evolution and Shock Wave Decay in Detonation Thermal Spraying Systems," *Journal of Thermal Spray Technology*, Vol. 13, No.2, 2004, pp. 239-247.
- Ramadan, K., and P. B. Butler, "A Numerical Study of Detonation Wave Attenuation and Its Effects in Detonation Thermal Spraying," submitted to, *Combustion Science and Technology*.
- Cannon, J.E., Alkam, M.K., and P. B. Butler, "Efficiency of Pulsed Detonation Thermal Spraying," Submitted to *Journal of Thermal Spray Technology*, December, 2007.

**Technical Reviewer (Journals and Research Funding Agencies)**

American Institute of Aeronautics and Astronautics

Journal of Propulsion and Power

Journal of Thermophysics and Heat Transfer

Journal of Acoustical Society of America

Journal of Fluid Mechanics

International Journal of Multiphase Flow

Computers and Fluids

Mechanics of Materials

Research Funding Agencies

U.S. Army Research Office

National Science Foundation

Israel Science Foundation