#### **Robert K. Goldberg**

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## I. PROFESSIONAL EXPERIENCE

1991-present NASA Glenn Research Center, Cleveland, OH - Aerospace Engineer
2003-present University of Akron, Akron, OH – Ad Hoc Temporary Graduate Faculty
and Associate Lecturer

1990-1991 Cleveland State University, Cleveland, OH – Research Associate

# II. EDUCATIONAL BACKGROUND

- Ph.D. in Aerospace Engineering, University of Cincinnati, December 1999
- M.S. in Applied Mechanics, Rensselaer Polytechnic Institute, August 1990
- B.S. in Aeronautical and Astronautical Engineering, The Ohio State University, June 1988

# III. COURSES TAUGHT

University of Akron, Akron, OH, Civil Engineering: 4300-201, Statics, Summer 2007. Spring 2008, Spring 2009, Summer 2012, Fall, 2016, Fall, 2017, Spring, 2018. University of Akron, Akron, OH, Civil Engineering: 4300-202, Mechanics of Solids, Summer 2013, Fall 2018.

University of Akron, Akron, OH, Civil Engineering: 4300-683, Plasticity, Fall 2005, Fall 2008, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014.

University of Akron, Akron, OH, Civil Engineering: 4300-694, Advanced Methods in Plasticity Analysis, Spring 2011, Spring 2014, Spring 2016.

University of Akron, Akron, OH, Civil Engineering: 4300-694, Micromechanics of Composite Materials, Fall 2006, Fall 2009, Spring 2012, Spring 2015, Spring 2017.

University of Akron, Akron, OH, Civil Engineering: 4300-694, Time Dependent Inelastic Analysis Methods, Spring 2006.

University of Akron, Akron, OH, Civil Engineering: 4300-694, Numerical Methods in Plasticity Analysis, Spring 2007.

University of Akron, Akron, OH, Civil Engineering: 4300-710, Advanced Composite Mechanics, Fall 2007.

# IV. ACTIVITY IN RESEARCH

1. Developed the theory and led a multi-institution team which implemented and characterized a new material model for the predictive simulation of the response of composite materials under impact conditions. This material model has been implemented into the commercial transient dynamic finite element code LS-DYNA and is available to all licensed users. The newly developed composite impact model mitigates a number of deficiencies in the composite models currently present in LS-DYNA, which were identified by the LS-DYNA Aerospace Working Group. The LS-DYNA Aerospace Working Group is a consortium of key government (NASA and the Federal Aviation Administration), aerospace industry (such as General Electric Aircraft Engines, Pratt and Whitney and Boeing) and academic entities. In particular, the existing models often need to be correlated based on the results of structural scale impact tests and/or coupon level tests that are not physically meaningful. The newly developed model is designed to accurately predict the impact response of composites based primarily on input from standard coupon tests and supplemented to a limited degree by small scale impact tests. My work in this area was recognized by receiving the NASA Exceptional Scientific Achievement Medal in August, 2015. As part of this effort, I served on the PhD Dissertation committees of two graduate students who worked on this project.

I developed the theory for the deformation, damage and failure modules for the new material model. The theory was developed based on first principals of plasticity, damage mechanics and composite failure theory, and was not just an extension of previously developed theories used for composite analysis. In particular, the theories were developed to permit tabulated input, as opposed to pointwise property input, to permit a more accurate representation of the composite impact response. To implement the theory into usable computer code, to conduct the experiments required to characterize the material model and to conduct the required validation and verification studies of the developed code, I led a multi-institution team consisting of NASA Glenn, NASA Langley, the Federal Aviation Administration Technical Center, Arizona State University, George Mason University, Ohio State University, and Livermore Software Technology Corporation, the developers and distributors of LS-DYNA. I was the Contracting Officer Representative for a research contract with Arizona State and George Mason for the implementation and initial verification of the material model. However, my leadership role extended well beyond the specific role of contract monitor. I oversaw and provided guidance for the implementation effort. I led the development of the experimental program, assisting the experimentalists in deciding coupon level tests needed to be conducted to characterize the model and what larger scale impact tests needed to be conducted to verify and validate the model. I also defined and oversaw the verification and validation analysis studies that took place at NASA Glenn, Arizona State and George Mason University.

2. Spearheaded a multi-institution effort to gain detailed understanding of the complex local mechanisms which contribute to the impact response of polymer matrix composites and led the development of advanced analytical techniques to simulate

and predict these complex local mechanisms. Polymer matrix composites, particularly those with complex textile fiber architectures, display significant complex mechanisms under impact loading conditions. The composite damage often tracks along the paths of the fibers. Under impact conditions the composite response displays significant nonlinearity and strain rate dependence. In addition, significant local temperature increases and rate dependent matrix embrittlement often occur under impact. In order to develop predictive structural level analysis tools to simulate the response of composites under impact, these detailed local mechanisms need to be fully understood and simulated using high fidelity analysis methods. The high fidelity methods provide guidance to the development of, and specific input parameters for, the structural scale models. I have carried out the fundamental theoretical development of analysis methods to simulate these various local mechanisms. These methods include developing advanced constitutive equations to simulate the nonlinear, rate-dependent response of the polymer matrix including the effects of hydrostatic stresses which are significant for polymers and creating semi-analytical micromechanics methods to incorporate the details of the fiber architecture into an impact simulation in a computationally efficient manner. This effort has also involved the generation and analysis of very high fidelity analytical models, where the local microstructure of the textile composite is explicitly modeled and analyzed in order to gain detailed insight into the local response of the composite.

To carry out this effort, I have guided multiple graduate students (11) from multiple universities, including the University of Akron, Michigan State University, Drexel University and Arizona State University. Two of these students were NASA PhD Fellowship students (GSRP and Harriet Jenkins Fellowship), several of the students were LERCIP summer student interns for multiple summers, and other students participated in the effort through NASA grants and other collaborative arrangements. The student's participation in the effort, which I led and guided, involved taking the fundamental theory and implementing it into the LS-DYNA transient dynamic finite element code, and conducting the required analyses to exercise and validate the analytical methods. For all of these students, beyond guiding the specifics of the research related to this effort, I served as an overall guide and co-advisor for their PhD programs, including serving on their dissertation committees. Based on their experiences gained from their NASA research and my guidance, all of these students have gone on to work for high profile employers including NASA, General Electric Global Research, Pratt and Whitney and various academic institutions. A paper based on this work was awarded the Best Paper Award from the ASCE Journal of Aerospace Engineering in 2015.

3. Served as task lead for a ceramic matrix composite modeling effort. I led a team, which included in-house Glenn personnel and a PhD student from the University of Florida (for whom I served on her dissertation committee) which investigated the effects of irregularities and variability in the composite microstructure on the effective properties and life of woven ceramic matrix composites. This effort

identified that key geometric variables such as the arrangement of internal porosity played a key role in causing variability in the effective material properties and internal stress distributions. Previous efforts had focused on the variability of constituent material properties as playing the primary role in causing the variability of the composite, but this effort opened up a new line of inquiry which has been expanded on by other researchers in the field. The graduate student associated with this effort won the Harry Hilton Award for Best Student Paper in Structures at the 2013 American Institute of Aeronautics and Astronautics Structures, Structural Dynamics and Materials Conference.

4. Leveraged extensive experience and unique expertise in the area of high strain rate analysis of composites to aid in development of material models for use in the impact analysis of Reinforced Carbon Carbon (RCC), which is used in the Space Shuttle Wing Leading Edge, for use in the Shuttle program Return to Flight efforts. As part of an agency-wide Ballistic Impact Analysis Team, developed next generation material model for RCC which incorporated strain rate effects, which are significant for RCC, but are not accounted for in current material models. Analysis techniques were also developed to separate out effects of outer thermal coating and inner substrate, and homogenize results into the effective composite response. Analysis techniques played key role in defining damage and failure criteria which are currently being used in impact analyses for Shuttle program. NASA Silver Snoopy honor was awarded for this effort.

## V. PROFESSIONAL ORGANIZATIONAL MEMBERSHIPS

AIAA (American Institute of Aeronautics and Astronautics)-Associate Fellow ASCE (American Society of Civil Engineers)-Member

#### VI. ACADEMIC SERVICE

- 1. Served as member of PhD dissertation committee for following students:
  - a. Xiahua Zheng, University of Akron, Graduation: Spring, 2006
  - b. Jingyun Cheng, University of Akron, Graduation: Spring, 2006
  - c. Linfa Zhu, Arizona State University, Graduation: Spring, 2006
  - d. Justin Littell, University of Akron, Graduation: Fall, 2008
  - e. Xuetao Li, University of Akron, Graduation: Fall, 2010
  - f. Brina Blinzler, University of Akron, Graduation: Spring, 2012
  - g. Lee Kohlman, University of Akron, Graduation: Spring, 2012
  - h. Marlana Goldsmith, University of Florida, Graduation: Fall, 2013
  - i. Chao Zhang, University of Akron, Graduation: Fall, 2013
  - j. Walter Nie, University of Akron, Graduation: Summer, 2014
  - k. Christopher Cater, Michigan State University, Graduation: Summer 2015.
  - 1. Canio Hoffarth, Arizona State University, Graduation: Fall 2016.
  - m. Derek Quade, University of Akron, Graduation: Summer 2017.
  - n. Mingkun Sun, University of Akron, Graduation: Fall 2018.
  - o. Bilal Khaled, Arizona State University, Graduation: Summer, 2019.

- p. Christopher Sorini, Arizona State University, Expected Graduation: Summer 2020.
- 2. Served as member of Master's thesis committee for following students:
  - a. Charles Ruggeri, University of Akron: Graduation: Fall, 2009

# VII. PROFESSIONAL SERVICE

- 1. ASCE Committee on Technical Advancement Member, 2018-present. This organization oversees the activities and budgets of all of the technical divisions of ASCE.
- 2. Executive Committee Member, ASCE Aerospace Division, 2013-2018. Served as Chair 2016-2017. The Executive Committee oversees the activities of four technical committees of the Aerospace Division, develops the yearly budget for the division, and interacts with the Committee for Technical Advancement (CTA), the ASCE organization that oversees all of the technical divisions of ASCE. A major task of the Executive Committee is to plan and execute the biannual Earth and Space Conference, the keystone event for the division. During my term as an Executive Committee member, and particularly during my year as chair, I increased the activity and relevance of the technical committees, which had become somewhat dormant. Due to my leadership, the technical committees are active and producing products. I also worked to get younger people involved with the division to ensure the future viability of the division. In recognition of my accomplishments as a member of the Executive Committee, I received the 2017 Aerospace Division Outstanding Professional Service Award.
- 3. Conference Chair, Earth and Space 2018, 16th ASCE International Conference on Engineering, Science, Construction and Operations in Challenging Environments, Cleveland, OH April, 10-12, 2018. The conference concentrates on engineering in extreme environments, and the application of civil engineering technologies to aerospace applications. Specific areas of interest include space exploration, granular materials, robotics, in-situ resource utilization, space construction, space mining, and advanced materials and structures in advanced environments. Over 130 technical papers, several of them authored by NASA Glenn personnel, were presented at the conference in multiple concurrent sessions, including several focused special sessions on key technical issues. I determined the overall layout of the technical program, established the focused special sessions, and led a team in the solicitation and review of the technical papers, as well as overseeing the development of the specifics of the technical program. I organized the opening plenary sessions were presented each day. Several high level NASA Glenn personnel, such as the head of the Research and Engineering Directorate, served as plenary speakers. I also organized the participation of Ms. Kristina Swallow, the national President of ASCE, in the conference. I organized an opening reception at the Great Lakes Science Center, which included extensive student participation. I organized a post-conference tour of NASA Glenn Research

Center. The conference was very well received by all participants and the attendance of 165 people was the highest of the conference in several years.

- 4. Associate Editor, ASCE Journal of Aerospace Engineering, 2011-present. I have been responsible for the review and final decision for over 800 total papers (683 in the last 5 years, 507 in the last 3 years). My average time of completing the review and decision process for the papers assigned to me is the fastest of any of the current associate editors of the journal. My performance as an Associate Editor has strongly contributed to an increase in the number of issues of the journal from four to six each year, the number of papers published in a year from 100 to over 200, and an increase in the 5-year Impact Factor for the journal from below 1 to over 1.2. My performance as an Associate Editor was recognized by my receiving the ASCE Associate Editor of the Year Award in 2014.
- 5. Guest Editor, ASCE Journal of Aerospace Engineering Special Issue, "Seventy Years of Aerospace Research and Technology Excellence at NASA Glenn Research Center", Volume 26, April, 2013. To organize this special issue, I worked closely with high level center management to solicit review papers from high level personnel in the technical organizations of the center describing the key technical accomplishments of the center and the vision for the future. I coordinated the paper review process, which involved soliciting reviewers from notable personnel in industry, government and academia. The resulting issue was distributed to high level political leadership and multiple center stakeholders, and is currently among the most referenced issues of the journal.
- 6. Guest Editor, ASCE Journal of Aerospace Engineering Special Issue, "Advances in Ballistic Impact and Crashworthiness Analysis of Aerospace Structures", Volume 27, May/June 2014.
- 7. Guest Editor, Journal of Aerospace Engineering Special Issue, "Ballistic Impact and Crashworthiness Analysis of Aerospace Structures", Vol. 22, July, 2009.
- 8. Symposium Organizer, "Advanced Materials and Designs for Hydraulic, Earth, and Aerospace Structures", Earth and Space 2016, 15th ASCE International Conference on Engineering, Science, Construction and Operations in Challenging Environments, Orlando, FL, April 11-14, 2016.
- Symposium Organizer (5 sessions), "Impact & Dynamic Response", American Society for Composites 30<sup>th</sup> Technical Conference, East Lansing, MI, September 28-30, 2015.
- Symposium Organizer (three sessions) and Session Chair, "Impact and Crashworthiness Analysis of Composite Structures", 17<sup>th</sup> U.S. National Congress on Theoretical and Applied Mechanics, East Lansing, MI, June 16-20, 2014.

- 11. Symposium Organizer, "Advanced Materials and Designs for Hydraulic, Earth, and Aerospace Structures", Earth and Space 2014, 14th ASCE International Conference on Engineering, Science, Construction and Operations in Challenging Environments, St. Louis, CA, Oct. 27-29, 2014.
- 12. Symposium Organizer (four sessions), "Ballistic Impact and Crashworthiness Analysis of Advanced Aerospace Structures", Earth and Space 2012, 13<sup>th</sup> ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Pasadena, CA, April 16-18, 2012.
- Session Chair, "Design and Analysis of Textile Composites", 52<sup>nd</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Denver, CO, April 4-7, 2011.
- 14. Symposium Organizer (five sessions), "Ballistic Impact and Crashworthiness Analysis of Advanced Aerospace Structures", Earth and Space 2008, 11<sup>th</sup> ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Long Beach, CA, Mar. 3-5, 2008.
- 15. Session Chair, "Ballistic Impact of Composites", Earth and Space 2006, 10th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Houston, TX, Mar. 5-8, 2006.

# VIII. AWARDS

- 1. ASCE Aerospace Division 2017 Outstanding Professional Service Award. (April, 2018).
- 2. ASCE Journal of Aerospace Engineering 2015 Best Paper Award for paper entitled "Single Ply and Multi-Ply Braided Composite Response Predictions Using Modified Subcell Approach" (April, 2016).
- 3. Ceramic and Polymer Composites Branch Best Paper Award for paper entitled "Incorporation of Plasticity and Damage Into an Orthotropic Three-Dimensional Model With Tabulated Input Suitable for Use in Composite Impact Problems" (March, 2016).
- 4. NASA Exceptional Scientific Achievement Medal "for exceptional achievement in the development, validation, and dissemination of theoretical models and computational tools for impact analysis of composite engine structures". (August, 2015).
- 5. ASCE (American Society of Civil Engineers) 2014 Associate Editor of the Year. (September, 2014).

- 6. NASA Group Achievement Award for "NASA Glenn Special Issue Journal Team" (September 2013).
- 7. NASA Certificate of Recognition for NASA Tech Brief "A Modeling Technique and Representation of Failure in the Analysis of Triaxial Braided Carbon Fiber Composites" (June 2009).
- 8. AIAA (American Institute of Aeronautics and Astronautics) Associate Fellow (September 2007).
- 9. NASA Space Flight Awareness "Silver Snoopy" Astronauts' Personal Achievement Award (October 2006).
- 10. NASA One NASA Peer Award GRC Center Best Team Award as member of "NASA Ballistic Impact Test Team" (April 2006).
- 11. NASA Software Release Award for "Strain Rate Dependent Analysis of Polymer Matrix Composites (STRANAL-PMC) Version 2.0" software (November 2005).
- 12. NASA One NASA Peer Award Team Award as member of "Shuttle RCC Damage Threshold Team" (September 2005).
- 13. NASA Aeronautics Turning Goals Into Reality Award as member of "Jet Engine Containment Concepts and Blade-Out Simulation Team" (July 2004).
- 14. AIAA Northern Ohio Section Best Paper Award for paper "Incorporation of Mean Stress Effects into the Micromechanical Analysis of the High Strain Rate Response of Polymer Matrix Composites" (June 2003).
- 15. NASA Software Release Award for "Strain Rate Dependent Analysis of Polymer Matrix Composites (STRANAL-PMC) Version 1.0" software (June 2003).
- 16. NASA Software Release Award for "Micromechanics Analysis Code Post-Processing (MACPOST) Version 1.0" software (June 2003).
- 17. NASA Certificate of Recognition for NASA Tech Brief "Analyzing Loads and Strains in Composite Materials" (November 2002).
- 18. NASA Certificate of Recognition for NASA Tech Brief "Postprocessing Software for Micromechanics Analysis Code" (July 2001).
- 19. Branch Best Paper Award for NASA Life Prediction Branch for paper entitled "Rate Dependent Deformation and Strength Analysis of Polymer Matrix Composites" (September 1999).

- 20. NASA Invention Award for development of ICAN/PART software (May 1998).
- 21. NASA Team Achievement Award for contributing towards the establishment of the NASA/GLITeC/Battelle Consortium for the Design and Analysis of Composite Materials (August 1997).
- 22. NASA Certificate of Recognition for NASA Tech Brief "Micromechanics for Particulate Reinforced Composites" (May 1997).
- 23. NASA Certificate of Recognition for NASA Tech Brief "Computing Fiber/Matrix Interfacial Effects in SiC/RBSN" (November 1996).
- 24. NASA Team Achievement Award for paper entitled "Application of the Boundary Element Method to the Micromechanical Analysis of Composite Materials", which was selected as Structural Mechanics Branch Best Paper (September 1996).
- 25. NASA Group Achievement Award for transfer and commercialization of NASA ICAN composite mechanics software (August 1996).
- 26. NASA Certificate of Recognition for NASA Tech Brief "Program Helps Generate Boundary Element Mathematical Models" (October 1995).

# IX. COMMUNITY SERVICE

- 1. Served as advisor to NASA sponsored Boy Scouts Explorers posts: 1992-1996, 1997-1998, 2000-2001, 2002-2003. Duties involved assisting in development of technical program, supervision of weekly meetings, mentoring of post officers.
- Served as mentor to summer interns for ten summers (1994, 1995, 1996, 2012, 2013, 2014, 2015, 2016, 2017, 2018) through NASA L.E.R.C.I.P. summer program for college students.
- 3. Spoke at area schools describing NASA, personal research work and engineering careers as part of NASA sponsored activities for Engineer's Week: 1995, 1996, 1999, 2000, 2001, 2003, 2005, 2010, 2011.
- 4. Served as mentor to two NASA Graduate Student Researchers program PhD students (2008-2013).
- 5. Served as mentor to NASA Faculty Fellowship Recipient (2013).
- 6. Serving as NASA Technical Advisor for NASA Harriett G. Jenkins Graduate Fellows Program (JGFP) Cohort 2015 student (2015-present).

# X. PUBLICATIONS

## A. Publications in Refereed Journals

Published or Accepted

- 1. Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "Micromechanical modeling of the effects of adiabatic heating on the high strain rate deformation of polymer matrix composites", Composite Structures, Vol. 215, pp. 377-384, 2019.
- Khaled, B.; Shyamsunder, L.; Hoffarth, C.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Damage characterization of composites to support an orthotropic plasticity material model", Journal of Composite Materials, Vol. 53, Issue 7, pp. 941-967, 2019.
- Cater, C.R.; Goldberg, R.K.; Kohlman, L.W.; and Xiao, X.: "Experimental Investigation and Numerical Analysis of the In-Plane Tensile Behavior of a Triaxially Braided Composite with Subcell Modeling Approach", Journal of Aerospace Engineering, Vol. 31, Issue 5, 10.1061/(ASCE)AS.1943-5525.0000872, 04018052, 2018.
- 4. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Implementation of a tabulated failure model into a generalized composite material model", Journal of Composite Materials, Vol. 52, Issue 25, pp. 3445-3460, 2018.
- Cater, C.R.; Xiao, X.; Goldberg, R.K.; and Gong, X.: "Multiscale investigation of micro-scale stresses at composite laminate free edge", Composites Structures, Vol. 189, pp. 545-552.
- Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Rajan, S.; and Blankenhorn, G.: "Analysis and Characterization of Damage Utilizing a Generalized Composite Material Model Suitable for Impact Problems", Journal of Aerospace Engineering, Volume 31, Issue 4, 10.1061/(ASCE)AS.1943-5525.0000854, 04018025, 2018.
- Khaled, B.; Shyamsunder, L.; Hoffarth, C.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Experimental characterization of composites to support an orthotropic plasticity material model", Journal of Composite Materials, Vol. 52, Issue 14, pp. 1847-1872, 2018.
- 8. Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; Goldberg, R.K.; Carney, K.S.; DuBois, P.; and Blankenhorn, G: "Verification and Validation of a Three-

Dimensional Orthotropic Plasticity Constitutive Model Using a Unidirectional Composite", Fibers, Vol. 5, Issue 1, Number 12, 2017.

- Harrington, J.; Hoffarth, C.; Rajan, S.; Goldberg, R.; Carney, K.; DuBois, P.; and Blankenhorn, G.: "Using Virtual Tests to Complete the Description of a Three-Dimensional Orthotropic Material", Journal of Aerospace Engineering, Volume 30, 10.1061/(ASCE)AS.1943-5525.0000737, 04017025,2017.
- Hoffarth, C.; Rajan, S.D.; Goldberg, R.K.; Revilock, D.; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Implementation and validation of a three-dimensional plasticity-based deformation model for orthotropic composites", Composites: Part A, Vol. 91, pp. 336-350, 2016.
- Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Harrington, J; Rajan, S.; and Blankenhorn, G.: "Development of an Orthotropic Elasto-Plastic Generalized Composite Material Model Suitable for Impact Problems", Journal of Aerospace Engineering, Vol. 29, no. 4, 04015083, 2016.
- Cater, C.R.; Xiao, X.; Goldberg, R.K.; and Kohlman, L.W.: "Single and Multi-ply Braided Composite Response Predictions using Modified Subcell Approach", Journal of Aerospace Engineering, Vol. 28, No. 5, 04014117, 2015.
- Zhang, C.; Binienda, W.K.; and Goldberg, R.K.: "Free-edge effect on the effective stiffness of single-layer triaxially braided composite", Composites Science and Technology, Vol. 107, pp. 145-153, 2015.
- Poulain, X.; Benzerga, A.A.; and Goldberg, R.K.: "Finite-Strain Elasto-Viscoplastic Behavior of an Epoxy Resin: Experiments and Modeling in the Glassy Regime", International Journal of Plasticity, Vol. 62, pp. 138-161, 2014.
- Goldsmith, M.B.; Sankar, B.V.; Haftka, R.T.; and Goldberg, R.K.: "Effects of microstructural variability on thermo-mechanical properties of a woven ceramicmatrix composite", Journal of Composite Materials, Vol. 49, No. 3, pp. 335-350, 2015.
- Goldberg, R.K.; and Binienda, W.K.: "Special Section on Advances in Ballistic Impact and Crashworthiness Response of Aerospace Structures" Journal of Aerospace Engineering, Vol. 27, pp. 423, 2014.
- Zhang, C.; Binienda, W.K.; Goldberg, R.K.; and Kohlman, L.K.: "Meso-scale Failure Modeling of Single layer Triaxial Braided Composite using Finite Element Method", Composites Part A: Applied Science and Manufacturing, Vol. 58, pp. 36-46, 2014.

- Mital, S.K.; Goldberg, R.K.; and Bonacuse, P.J.: "Two-Dimensional Nonlinear Finite Element Analysis of CMC Microstructures", Composites Part B: Engineering, Vol. 57, pp. 144-154, 2014.
- Poulain, X; Kohlman, L.W.; Binienda, W; Roberts, G.D.; Goldberg, R.K.; Benzerga, A.A.: "Determination of the intrinsic behavior of polymers using digital image correlation combined with video-monitored testing", International Journal of Solids and Structures, Vol. 50, pp. 1869-1878, 2013.
- 20. Lei, J.-F.; and Goldberg, R.K.: "Seventy Years of Aerospace Research and Technology Excellence at NASA Glenn Research Center", Journal of Aerospace Engineering, Vol. 26, Issue 2, pp. 197-201, 2013.
- Binienda, W.K.; and Goldberg, R.K.: "Dynamic Testing and Characterization of Woven/Braided Polymer Composites: A Review", Applied Mechanics Reviews, Vol. 64, Issue 5, 2012.
- Blinzler, B.J.; Goldberg, R.K.; and Binienda, W.K.: "Macro Scale Independently Homogenized Subcells for Modeling Braided Composites", AIAA Journal, Vol. 50, pp. 1873-1884, 2012.
- Goldberg, R.K.; Blinzler, B.J.; and Binienda, W.K.: "Modification of a Macromechanical Finite-Element Based Model for Impact Analysis of Triaxially Braided Composites", Journal of Aerospace Engineering, Vol. 25, pp. 383-394, 2012.
- Goldberg, R.K.; Blinzler, B.J.; and Binienda, W.K.: "Investigation of a Macromechanical Approach to Analyzing Triaxially-Braided Polymer Composites". AIAA Journal, Vol. 49, pp. 205-215, 2011.
- 25. Li, X.; Binienda, W.K.; and Goldberg, R.K.: "Finite Element Model for Failure Study of Two Dimensional Triaxially Braided Composite". Journal of Aerospace Engineering, Vol. 24, pp. 170-180, 2011.
- Littell, J.D.; Binienda, W.K.; Arnold, W.A.; Roberts, G.D.; and Goldberg, R.K.: "Effect of Microscopic Damage Events on Static and Ballistic Impact Strength of Triaxial Braid Composites". Composites Part A: Applied Science and Manufacturing, Vol. 40, pp. 1846-1862, 2009.
- Goldberg, R.K.; and Binienda, W.K.: "Ballistic Impact and Crashworthiness Response of Aerospace Structures", Journal of Aerospace Engineering, Vol. 11, pp. 199-200, 2009.
- Littell, J.D.; Binienda, W.K.; Roberts, G.D.; and Goldberg, R.K.: "Characterization of Damage in Triaxial Braid Composites Under Tensile Loading", Journal of Aerospace Engineering, Vol. 22, pp. 270-279, 2009.

- 29. Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "A Failure Model for Rate Dependent Polymer Matrix Composite Laminates under High Velocity Impact", Journal of Aerospace Engineering, Vol. 21, pp. 132-139, 2008.
- 30. Littell, J.D.; Ruggeri, C.R.; Goldberg, R.K.; Roberts, G.D.; Arnold, W.A.; and Binienda, W.K.: "Measurement of Epoxy Resin Tension, Compression and Shear Stress-Strain Curves over a Wide Range of Strain Rates Using Small Test Specimens", Journal of Aerospace Engineering, Vol. 21, pp. 162-173, 2008.
- 31. Goldberg, R.K.; Roberts, G.D.; Littell, J.D.; and Binienda, W.K.: "Approximation of Nonlinear Unloading Effects In the Strain Rate Dependent Analysis of Polymer Matrix Composites Utilizing a State Variable Approach", Journal of Aerospace Engineering, Vol.21, pp. 119-131, 2008.
- 32. Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Strain Rate Sensitivity of Epoxy Resin in Tensile and Shear Loading", Journal of Aerospace Engineering, Vol. 20, pp. 75-89, 2007.
- Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "Multiscale Analysis Including Strain Rate Dependency for Transient Response of Composite Laminated Shells", Journal of Reinforced Plastics and Composites, Vol. 25, pp. 1795-1831, 2006.
- 34. Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "Nonlinear transient response of strain rate dependent composite laminated plates using multiscale simulation", International Journal of Solids and Structures, Vol. 43, pp. 2602-2630, 2006.
- Tabiei, A.; Yi, W.; and Goldberg, R.: "Non-linear strain rate dependent micromechanical composite material model for finite element impact and crashworthiness simulation", International Journal of Non-Linear Mechanics, Vol. 40, pp. 957-970, 2005.
- 36. Zhu, L.; Kim, H.S.; Chattopadhyay, A.; and Goldberg, R.K.: "Improved Transverse Shear Calculations for Rate-Dependent Analyses of Polymer Matrix Composites", AIAA Journal, Vol. 43, No. 4, 2005.
- 37. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Implementation of an Associative Flow Rule Including Hydrostatic Stress Effects Into the High Strain Rate Deformation Analysis of Polymer Matrix Composites.", Journal of Aerospace Engineering, Vol. 18, pp. 18-27, 2005.
- Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Analytical Studies of the High Strain Rate Tensile Response of a Polymer Matrix Composite" Journal of Advanced Materials, Vol. 36, pp. 14-24, 2004.
- 39. Goldberg, R.K.; and Gilat, A.: "Experimental and Computational Characterization of the High Strain Rate Tensile Response of Polymer Matrix Composites." Composite Materials, Testing and Design Fourteenth Volume,

ASTM STP 1436, C.E. Bakis, Editor, American Society for Testing and Materials, West Conshocken, PA, pp. 207-223, 2003.

- 40. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Incorporation of mean stress effects into the micromechanical analysis of the high strain rate response of polymer matrix composites." Composites Part B: Engineering, Vol. 34, pp. 151-165, 2003.
- Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Experimental Study of Strain Rate Behavior of Carbon/Epoxy Composite." Composites Science and Technology, Vol. 62, pp. 1469-1476, 2002.
- 42. Goldberg, R.K.; and Stouffer, D.C.: "Strain Rate Dependent Analysis of a Polymer Matrix Composite Utilizing a Micromechanics Approach." Journal of Composite Materials, Vol. 36, pp. 773-793, 2002.
- 43. Mital, S.K.; Murthy, P.L.N.; and Goldberg, R.K.: "Micromechanics for Particulate Reinforced Composites." Mechanics of Composite Materials and Structures, Vol. 4, pp. 251-266, 1997.
- 44. Goldberg, R.K.; and Hopkins, D.A.: "Thermal Analysis of a Functionally Graded Material Subject to a Thermal Gradient Using the Boundary Element Method." Composites Engineering, Vol. 5, pp. 793-806, 1995.
- 45. Goldberg, R.K.; and Hopkins, D.A.: "Application of the Boundary Element Method to the Micromechanical Analysis of Composite Materials." Computers and Structures, Vol. 56, pp. 721-731, 1995.

## **B. Refereed NASA Technical Publications**

- Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Incorporation of Failure Into an Orthotropic Three-Dimensional Model With Tabulated Input Suitable for Use in Composite Impact Problems", NASA TM-2017-219442, 2017.
- Sorini, C.; Chattopadhyay, A.; Goldberg, R.K.; and Kohlman, L.W.: "Development of a Subcell Based Modeling Approach for Modeling the Architecturally Dependent Impact Response of Triaxially Braided Polymer Composites", NASA TM-2016-219116, 2016.
- Goldberg, R.K.; Carney, K.; DuBois, P.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Analysis and Characterization of Damage Utilizing an Orthotropic Generalized Composite Material Model Suitable for Use in Impact Problems", NASA TM-2016-218959, 2016.
- 4. Goldberg, R.K.; Carney, K.; DuBois, P.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Incorporation of Plasticity and Damage Into an Orthotropic

Three-Dimensional Model With Tabulated Input Suitable for Use in Composite Impact Problems", NASA TM-2015-218849, 2015.

- Cater, C.; Xiao, X.; Goldberg, R.K.; and Kohlman, L.W.: "Experimental and Numerical Analysis of Triaxially Braided Composites Utilizing a Modified Subcell Modeling Approach", NASA TM-2015-218814, 2015.
- 6. Hoffarth, C.; Harrington, J.; Rajan, S.; Goldberg, R.; Carney, K.; DuBois, P.; and Blankenhorn, G.: "Verification and Validation of a Three-Dimensional Generalized Composite Material Model", NASA TM-2015-218446, 2015.
- 7. Goldberg, R.; Carney, K.; DuBois, P.; Hoffarth, C.; Harrington, J; Rajan, S.; and Blankenhorn, G.: "Theoretical Development of an Orthotropic Elasto-Plastic Generalized Composite Material Model", NASA TM-2014-218347, 2014.
- Carney, K.; Pereira, M.; Kohlman, L.; Goldberg, R.; Envia, E.; Lawrence, C.; Roberts, G.; and Emmerling, W.: "Weight Assessment for Fuselage Shielding on Aircraft With Open-Rotor Engines and Composite Blade Loss", NASA TM-2013-216582, 2013.
- 9. Goldsmith, M.B; Sankar, B.V.; Haftka, R.T.; and Goldberg, R.K.: "Quantifying Effects of Voids in Woven Ceramic Matrix Composites", NASA TM-2013-217874, 2013.
- Cater, C.R.; Xiao, X.; Goldberg, R.K.; and Kohlman, L.W.: "Improved Subcell Model for the Prediction of Braided Composite Response", NASA TM-2013-217875, 2013.
- Goldsmith, M.B.; Sankar, B.V.; Haftka, R.T.; and Goldberg, R.K.: "Effects of Microstructural Variability on Thermo-Mechanical Properties of a Woven Ceramic Matrix Composite", NASA TM-2013-217817, 2013.
- 12. Goldberg, R.K.: "Utilization of the Generalized Method of Cells to Analyze the Deformation Response of Laminated Ceramic Matrix Composites", NASA TM-2012-217737, 2012.
- 13. Blinzler, B.J.; Goldberg, R.K.; and Binienda, W.K.: "Macro Scale Independently Homogenized Subcells for Modeling Braided Composites", NASA TM-2012-217621, 2012.
- Mital, S.K.; Goldberg, R.K.; and Bonacuse, P.J.: "Two-Dimensional Nonlinear Finite Element Analysis of CMC Microstructures", NASA TM-2012-217297, 2012.
- 15. Goldberg, R.K.; Bonacuse, P.J.; and Mital, Subodh, K.: "Investigation of Effects of Material Architecture on the Elastic Response of a Woven Ceramic Matrix Composite", NASA TM-2012-217269, 2012.

- Goldberg, R.K.; Blinzler, B.J.; and Binienda, W.K.: "Modification of a Macromechanical Finite-Element Based Model for Impact Analysis of Triaxially-Braided Composites", NASA TM-2010-216922, 2010.
- 17. Li, X.; Binienda, W.K.; and Goldberg, R.K.: "Finite Element Model for Failure Study of Two-Dimensionally Triaxially Braided Composite". NASA TM-2010-216372, 2010.
- Goldberg, R.K.; Blinzler, B.J.; and Binienda, W.K.: "Investigation of a Macromechanical Approach to Analyzing Triaxially-Braided Polymer Composites". NASA TM-2010-216371, 2010.
- Littell, J.D.; Binienda, W.K.; Arnold, W.A.; Roberts, G.D.; and Goldberg, R.K.: "Effect of Microscopic Damage Events on Static and Ballistic Impact Strength of Triaxial Braid Composites". NASA TM-2010-216095, 2010.
- Arnold, S.M.; Goldberg, R.K.; Lerch, B.A.; and Saleeb, A.F.: "An Overview of Prognosis Health Management at Glenn Research Center for Gas Turbine Engine Structures With Special Emphasis on Deformation and Damage Modeling", NASA TM-2009-215827, 2009.
- Roberts, G.D.; Goldberg, R.K.; Binienda, W.K.; Arnold, W.A.; Littell, J.D.; and Kohlman, L.W.: "Characterization of Triaxial Braided Composite Material Properties for Impact Simulation", NASA TM-2009-215660, 2009.
- Littell, J.D.; Binienda, W.K.; Roberts, G.D.; and Goldberg, R.K.: "Characterization of Damage in Triaxial Braid Composites Under Tensile Loading", NASA TM-2009-215645, 2009.
- Littell, J.D.; Binienda, W.K.; Goldberg, R.K.; and Roberts, G.D.: "Full-Field Strain Methods for Investigating Failure Mechanisms in Triaxial Braided Composites." NASA TM-2008-215197, 2008.
- 24. Littell, J.D.; Binienda, W.K.; Goldberg, R.K.; and Roberts, G.D.: "A Modeling Technique and Representation of Failure in the Analysis of Triaxial Braided Carbon Fiber Composites", NASA TM-2008-215245, 2008.
- 25. Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Strain Rate Sensitivity of Epoxy Resin in Tensile and Shear Loading." NASA TM-2005-213595, 2005.
- 26. Zhu, L.; Kim, H.S.; Chattopadhyay, A.; and Goldberg, R.K.: "Implementation of Improved Transverse Shear Calculations and Higher Order Laminate Theory into Strain Rate Dependent Analyses of Polymer Matrix Composites." NASA TM-2004-213420, 2004.

- 27. Goldberg, R.K.; and Carney, K.S.: "Modeling the Nonlinear, Strain Rate Dependent Deformation of Woven Ceramic Matrix Composites With Hydrostatic Stress Effects Included." NASA TM-2004-213125, 2004.
- Zheng, X.; Goldberg, R.K.; Binienda, W.K.; and Roberts, G.D.: "LS-DYNA Implementation of Polymer Matrix Composite Model Under High Strain Rate Impact." NASA TM-2003-212583, 2003.
- 29. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Implementation of an Associative Flow Rule Including Hydrostatic Stress Effects Into the High Strain Rate Deformation Analysis of Polymer Matrix Composites." NASA TM-2003-212382, 2003.
- 30. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Incorporation of Mean Stress Effects Into the Micromechanical Analysis of the High Strain Rate Response of Polymer Matrix Composites." NASA TM-2002-211702, 2002.
- 31. Goldberg, R.K.: "Computational Simulation of the High Strain Rate Tensile Response of Polymer Matrix Composites." NASA TM-2002-211489, 2002.
- 32. Goldberg, R.K.: "Implementation of Fiber Substructuring Into Strain Rate Dependent Micromechanics Analysis of Polymer Matrix Composites." NASA TM-2001-210822, 2001.
- Goldberg, R.K.: "Implementation of Laminate Theory Into Strain Rate Dependent Micromechanics Analysis of Polymer Matrix Composites." NASA TM-2000-210351, 2000.
- 34. Goldberg, R.K.; and Arnold, S.M.: "A Study of Influencing Factors on the Tensile Response of a Titanium Matrix Composite With Weak Interfacial Bonding." NASA TM-2000-209758, 2000.
- Goldberg, R.K.: "Strain Rate Dependent Deformation and Strength Modeling of a Polymer Matrix Composite Utilizing a Micromechanics Approach." NASA TM-1999-209768, 1999.
- 36. Goldberg, R.K.; and Stouffer, D.C.: "Strain Rate Dependent Modeling of Polymer Matrix Composites." NASA TM-1999-209433, 1999.
- Goldberg, R.K.; Comiskey, M.D.; and Bednarcyk, B.A.: "Micromechanics Analysis Code Post-Processing (MACPOST) User Guide Version 1.0." NASA TM-1999-209062, 1999.
- 38. Goldberg, R.K.; and Stouffer, D.C.: "Rate Dependent Deformation and Strength Analysis of Polymer Matrix Composites." NASA TM-1999-209060, 1999.

- Goldberg, R.K.; and Stouffer, D.C.: "High Strain Rate Deformation Modeling of a Polymer Matrix Composite Part II-Composite Micromechanical Model." NASA TM-1998-208664, 1998.
- Goldberg, R.K.; and Stouffer, D.C.: "High Strain Rate Deformation Modeling of a Polymer Matrix Composite Part I-Matrix Constitutive Equations." NASA TM-1998-206969, 1998.
- Goldberg, R.K.; Murthy, P.L.N.; and Mital, S.K.: "ICAN/PART: Particulate Composite Analyzer, User's Manual and Verification Studies." NASA TM-107297, 1996.
- 42. Mital, S.K.; Murthy, P.L.N.; and Goldberg, R.K.: "Micromechanics for Particulate Reinforced Composites." NASA TM-107276, 1996.
- 43. Goldberg, R.K.; and Hopkins, D.A.: "Thermal analysis of a functionally graded material subject to a thermal gradient using the boundary element method." NASA TM-106801, 1994.
- 44. Goldberg, R.K.; and Hopkins, D.A.: "Micromechanical modeling of laminated composites with interfaces and woven composites using the boundary element method." NASA TM-106280, 1993.
- 45. Goldberg, R.K.; and Hopkins, D.A.: "Composite micromechanical modeling using the boundary element method." NASA TM-106127, 1993.
- 46. Goldberg, R.K.: "COMGEN-BEM: Boundary element model generation for composite materials micromechanical analysis." NASA TM-105548, 1992.

## **C. Unrefereed Conference Proceedings and Presentations**

- 1. Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "An Improved Unified Viscoplastic Polymer Constitutive Formulation for Multiscale Analysis of Polymer Matrix Composites Under High Strain Rate Loading", AIAA SciTech Forum 2019, San Diego, CA, Jan. 7-11, 2019.
- Goldberg, R.K.; Ricks, T.M.; Carney, K.S.; DuBois, P.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Verification and Validation of a Three-Dimensional Composite Impact Model With Tabulated Input", AIAA SciTech Forum 2019, San Diego, CA, Jan. 7-11, 2019.
- 3. Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "Multiscale Modeling of the Impact Response of Triaxially Braided Polymer Matrix Composites, Including Effects of Adiabatic Heating", American Society for Composites 33rd Annual Technical Conference, Seattle, WA, Sept. 24-26, 2018.

- 4. Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "Computational Modeling of Adiabatic Heating in Triaxially Braided Polymer Matrix Composites Subjected to Impact Loading via a Subcell Based Approach", 15th LS-DYNA International Users Conference, Dearborn, MI, June 11-12, 2018.
- Shyamsunder, L.; Khaled, B.; Hoffarth, C.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Using MAT213 for Simulation of High-Speed Impacts of Composite Structures", 15th LS-DYNA International Users Conference, Dearborn, MI, June 11-12, 2018.
- Khaled, B.; Holt, N.; Shyamsunder, L.; Hoffarth, C.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Generating Experimental Data for a Three-Dimensional Generalized Composite Material Model", 15th LS-DYNA International Users Conference, Dearborn, MI, June 11-12, 2018.
- Goldberg, R.K.; Carney, K.; DuBois, P.; Khaled, B.; Shyamsunder, L.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Development and Verification of an Orthotropic Elasto-Plastic Three-Dimensional Model with Tabulated Input Suitable for Use in Composite Impact Problems", 15th LS-DYNA International Users Conference, Dearborn, MI, June 11-12, 2018.
- Goldberg, R.K.; Carney, K.; DuBois, P.; Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Development and Verification of an Orthotropic Three-Dimensional Model with Tabulated Input Suitable for Use in Composite Impact Problems", Earth and Space 2018, 16th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Cleveland, OH, April 10-12, 2018.
- Khaled, B.; Hoffarth, C.; Shyamsunder, L.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Experimental Techniques for Material Characterization of Composites for Modeling Impact Analysis", Earth and Space 2018, 16th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Cleveland, OH, April 10-12, 2018.
- Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "Effects of Adiabatic Heating on the High Strain Rate Deformation Response of Triaxially Braided Polymer Matrix Composites", Earth and Space 2018, 16th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Cleveland, OH, April 10-12, 2018.
- Cater, C.R.; Xiao, X.; Goldberg, R.K.; and Gong, X.: "Multiscale Investigation of Micro-Cracking at Composite Laminate Free Edge", American Society for Composites 32nd Annual Technical Conference, West Lafayette, IN, Oct. 23-25, 2017.

- Goldberg, R.K.; Carney, K.; DuBois, P.; Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Implementation of a Tabulated Failure Model into a Generalized Composite Material Model Suitable for Use in Impact Problems", American Society for Composites 32nd Annual Technical Conference, West Lafayette, IN, Oct. 23-25, 2017.
- Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Development of an Input Suite for an Orthotropic Composite Material Model", American Society for Composites 32nd Annual Technical Conference, West Lafayette, IN, Oct. 23-25, 2017.
- Sorini, C.; Chattopadhyay, A.; and Goldberg, R.K.: "Effects of Adiabatic Heating on the High Strain Rate Deformation of Polymer Matrix Composites", American Society for Composites 32nd Annual Technical Conference, West Lafayette, IN, Oct. 23-25, 2017.
- 15. Goldberg, R.K.; Carney, K.; DuBois, P.; Khaled, B.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Analysis and Characterization of Damage and Failure Utilizing a Generalized Composite Material Model Suitable for Use in Impact Problems", American Society for Composites 31th Annual Technical Conference, Williamsburg, VA, Sept. 19-21, 2016.
- Sorini, C.; Chattopadhyay, A.; Goldberg, R.K.; and Kohlman, L.W.: "Development of a Subcell Based Modeling Approach for Modeling the Architecturally Dependent Impact Response of Triaxially Braided Polymer Composites", 14th International LS-DYNA Users Conference, Dearborn, MI, June 12-14, 2016.
- Hoffarth, C.; Khaled, B.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Using Tabulated Experimental Data to Drive an Orthotropic Elasto-Plastic Three Dimensional Model for Impact Analysis", 14th International LS-DYNA Users Conference, Dearborn, MI, June 12-14, 2016.
- Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Rajan, S.; and Blankenhorn, G.: "Incorporation of Damage and Failure Into an Orthotropic Elasto-Plastic Three-Dimensional Model with Tabulated Input Suitable for Use in Composite Impact Problems", 14th International LS-DYNA Users Conference, Dearborn, MI, June 12-14, 2016.
- Cater, C.; Goldberg, R.K.; and Xiao, X.: "Multiscale Analysis of Micro-Scale Stresses At The Laminate Free Edge", NAFEMS Americas 2016 Conference, Seattle, WA, June 7-9, 2016.
- 20. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Analysis and Characterization of Damage Utilizing an Orthotropic Generalized Composite Material Model Suitable for Use in Impact Problems", Earth and Space 2016, 15th ASCE Aerospace Division Conference on

Engineering, Construction and Operations in Challenging Environments, Orlando, FL, April 12-15, 2016.

- 21. Cater, C.; Xiao, X.; Goldberg, R.K.; and Kohlman, L.W.: "Experimental and Numerical Analysis of Triaxially Braided Composites Utilizing a Modified Subcell Modeling Approach", American Society for Composites 30th Annual Technical Conference, East Lansing, MI, Sept. 28-30, 2015.
- 22. Goldberg, R.K.; Carney, K.; DuBois, P.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Incorporation of Plasticity and Damage Into an Orthotropic Three-Dimensional Model With Tabulated Input Suitable for Use in Composite Impact Problems", American Society for Composites 30th Annual Technical Conference, East Lansing, MI, Sept. 28-30, 2015.
- 23. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Rajan, S.; and Blankenhorn, G.: "Development and Characterization of a Rate-Dependent Three-Dimensional Macroscopic Plasticity Model Suitable for Use in Composite Impact Problems", SAE 2015 World Congress and Exhibition, Detroit, MI, April 21-23, 2015.
- 24. Zhang, C.; Binienda, W.K; and Goldberg, R.K.: "Free-Edge Effect on the Mechanical Properties of Single-Layer Triaxially Braided Composite", 17th U.S. National Congress on Theoretical and Applied Mechanics, East Lansing, MI, June 16-20, 2014.
- 25. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Harrington, J; Rajan, S.; and Blankenhorn, G.: "Development and Characterization of an Orthotropic Three-Dimensional Macroscopic Plasticity Model Suitable for Use in Composite Impact Problems", 17th U.S. National Congress on Theoretical and Applied Mechanics, East Lansing, MI, June 16-20, 2014.
- 26. Cater, C.; Xiao, X.; Khademi, V.; Goldberg, R.K.; and Kohlman, L.W.: "Modeling Meso Structure of Triaxially Braided Composites with a Subcell Approach", 17th U.S. National Congress on Theoretical and Applied Mechanics, East Lansing, MI, June 16-20, 2014.
- Hoffarth, C.; Harrington, J.; Rajan, S.D.; Goldberg, R.K; Carney, K.S.; DuBois, P.; and Blankenhorn, G.: "Verification and Validation of a Three-Dimensional Generalized Composite Material Model", 13th International LS-DYNA Users Conference, Dearborn, MI, June 8-10, 2014.
- Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Harrington, J; Rajan, S.; and Blankenhorn, G.: "Theoretical Development of an Orthotropic Elasto-Plastic Generalized Composite Material Model", 13th International LS-DYNA Users Conference, Dearborn, MI, June 8-10, 2014.

- 29. Cater, C.R.; Xiao, X.; Goldberg, R.K.; and Kohlman, L.K.: "Improved Subcell Model for the Prediction of Braided Composite Response", AIAA/ASME/ASCE/AHS/ASC 54rd Structures, Structural Dynamics and Materials (SDM) Conference, Boston, MA, April 8-11, 2013.
- Goldsmith, M.; Sankar, B.; Haftka, R.; and Goldberg, R.: "Quantifying Effects of Voids in Woven Ceramic Matrix Composites", AIAA/ASME/ASCE/AHS/ASC 54rd Structures, Structural Dynamics and Materials (SDM) Conference, Boston, MA, April 8-11, 2013.
- 31. Goldberg, R.K.; Roberts, G.D.; Kohlman, L.W.; Pereira, J.M.; and Cater, C.R.: "Composite Materials Characterization Methods for More Reliable Simulation of Blade Containment in Jet Engines", NIAR Aerospace Structural Impact Dynamics International Conference, Wichita, KS, November 6-7, 2012. – Keynote address
- 32. Goldsmith, M.; Sankar, B.; Haftka, R; and Goldberg, R: "Overview of Probabilistic Modeling of Woven Ceramic Matrix Composites", Proceedings of the American Society for Composites 27th Technical Conference, Arlington, Texas, October 1-3, 2012.
- 33. Goldberg, R.K.: "Utilization of the Generalized Method of Cells to Analyze the Deformation Response of Laminated Ceramic Matrix Composites", Proceedings of the American Society for Composites 27th Technical Conference, Arlington, Texas, October 1-3, 2012.
- 34. Mital, S.; Goldberg, R.; and Bonacuse, P.: "Modeling of Damage Initiation and Progression in a SiC/SiC Woven Ceramic Matrix Composite", AIAA/ASME/ASCE/AHS/ASC 53rd Structures, Structural Dynamics and Materials (SDM) Conference, Honolulu, Hawaii, April 23-26, 2012.
- 35. Janapala, N.; Maier, P.; Chang, F.-K.; Goldberg, R.; Roberts, G.; and Jackson, K.: "Energy Absorption of Hybrid Textile Composite Structures Using DyCrash", Earth and Space 2012, 13th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Pasadena, CA, April 16-18, 2012.
- 36. Li, X.; Kohlman, L.W.; Hu, Z; Binienda, W.K.; and Goldberg, R.K.: "Progressive Damage and Delamination Studies of 2D Tri-axially Braided Composites in Short Beam Shear Test", Earth and Space 2012, 13th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Pasadena, CA, April 16-18, 2012.
- 37. Goldberg, R.K.; Roberts, G.D; Blinzler, B.J.; Kohlman, L.W.; and Binienda, W.K.: "Characterization and Analysis of Triaxially Braided Polymer Composites Under Static and Impact Loads", Earth and Space 2012, 13th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Pasadena, CA, April 16-18, 2012.

- Bonacuse, P.J.; Goldberg, R.K.; and Mital, S.K.: "The Effect of Local Geometric Variability on the Local Stress Distribution in Woven Ceramic Matrix Composites", NASA Fundamental Aeronautics Program Technical Conference, Cleveland, OH, March 13-15, 2012.
- Goldsmith, M.; Sankar, B.; Haftka, R; and Goldberg, R.: "Effects of Architectural Variability on the Thermal-Mechanical Properties of Ceramic Matrix Composites", USACA 36th Annual Conference on Composites, Materials and Structures, Cocoa Beach, FL, January 23-26, 2012.
- 40. Bonacuse, P.J.; Goldberg, R.K; and Mital, S.K.: "On the Correlation between Local Geometry and Stress State in Woven Ceramic Matrix Composites", USACA 36th Annual Conference on Composites, Materials and Structures, Cocoa Beach, FL, January 23-26, 2012.
- 41. Goldsmith, M.; Sankar, B.; Haftka, R; and Goldberg, R.: "Effects of Microstructural Variability on the Mechanical Properties of Ceramic Matrix Composites", Proceedings of the American Society for Composites Twenty-Sixth Technical Conference, Montreal, Canada, Sept. 26-28, 2011.
- 42. Mital, S.K.; Goldberg, R.K.; and Bonacuse, P.J.: "Two-Dimensional Nonlinear Finite Element Analysis of CMC Microstructures", ASME Turbo Expo 2011, Vancouver, BC, Canada, June 6-10, 2011.
- 43. Bonacuse, P.J.; Goldberg, R.K.; and Mital, S.K.: "Characterization of the As-Manufactured Variability in a CVI SiC/SiC Woven Composite", ASME Turbo Expo 2011, Vancouver, BC, Canada, June 6-10, 2011.
- 44. Janapala, N.R.; Chang, F.-K., Goldberg, R.K.; Roberts, G.D.; and Jackson, K.E.: "Crashworthiness of Advanced Textile Composites Structures", 2011 Aircraft Airworthiness and Sustainment Conference, San Diego, CA, April 18-21, 2011.
- 45. Blinzler, B.J.; Goldberg, R.K.; and Binienda, W.K.: "Macro Scale Independently Homogenized Subcells for Modeling Braided Composites", AIAA/ASME/ASCE/AHS/ASC 52nd Structures, Structural Dynamics and Materials (SDM) Conference, Denver, Colorado, April 4-7, 2011.
- 46. Goldberg, R.K.; Bonacuse, P.J.; Mital, S.K.; and Calomino, A.C.: "High Fidelity Meso-scale Modeling for CMC Life Prediction", NASA Fundamental Aeronautics Program Technical Conference, Cleveland, OH, March 15-17, 2011.
- 47. Goldberg, R.K.; Mital, S.K.; Bonacuse, P.J.; and Lang, J: "Effects of Material Microstructure on Elastic Response of Woven Ceramic Matrix Composites", USACA 35th Annual Conference on Composites, Materials and Structures, Cocoa Beach, FL, January 24-27, 2011.

- 48. Goldberg, R.K.; Blinzler, B.J.; and Binienda, W.K.: "Modification of a Macromechanical Finite-Element Based Model for Impact Analysis of Triaxially Braided Composites", Proceedings of the American Society for Composites Twenty-Fifth Technical Conference, Dayton, OH, Sept. 20-22, 2010, J.B. Lantz, N. Takeda, B.M. Doudican, G.A. Shoeppner, and S.L. Donaldson, editors, DEStech Publications, Inc., 2010.
- 49. Janapala, N.R.; Chang, F.-K.; Goldberg, R.K.; Roberts, G.D.; and Jackson, K.E.: "Crashworthiness of Composite Structures with Various Fiber Architectures", 11th International LS-DYNA User's Conference, Dearborn, MI, June 7-8, 2010.
- 50. Blinzler, B.J.; Goldberg, R.K.; and Binienda, W.K.: "Investigation of \*MAT\_58 for Modeling Braided Composites", 11th International LS-DYNA User's Conference, Dearborn, MI, June 7-8, 2010.
- 51. Poulain, X.; De Castro, A; Roberts, G.; Goldberg, R.; and Benzerga, A.: "Towards Physics-based Multiscale Modeling of The Ballistic Impact of Carbon/Epoxy Composites", 2010 Aircraft Airworthiness and Sustainment Conference, Austin, Texas, May 10-12, 2010.
- 52. Goldberg, R.K.; Blinzler, B.J.; Binienda, W.K.: "Characterization of a Macromechanical Finite-Element Based Model for Impact Analysis of Triaxially Braided Composites", 2010 Aircraft Airworthiness and Sustainment Conference, Austin, Texas, May 10-12, 2010.
- 53. Goldberg, R.K.; Blinzler, B.J.; Binienda, W.K.: "Investigation of a Macromechanical Approach to Analyzing Triaxially Braided Polymer Composites", AIAA/ASME/ASCE/AHS/ASC 51st Structures, Structural Dynamics and Materials (SDM) Conference, Orlando, Florida, April 12-15, 2010.
- 54. Goldberg, R.K.; Bednarcyk, B.A.; Blinzler, B.J.; Li, X.; Binienda, W.K.; Liu, K.C.; and Chattopadhyay, A.: "Multiscale Modeling of Triaxial Braided Composites", NASA Aviation Safety Conference, Mclean, Virginia, Nov. 17-19, 2009.
- 55. Goldberg, R.K.; Roberts, G.D.; Blinzler, B.J.; Binienda, W.K.; and Littell, J.D.: "Development of a Macroscopic, Non-homogeneous, Finite Element Based Approach to Analyze the Impact Response of Triaxially Braided Polymer Composites", American Helicopter Society National Technical Specialists' Meeting on Rotorcraft Structures and Survivability, Williamsburg, Virginia, Oct. 27-29, 2009.
- 56. Arnold, S.M.; Goldberg, R.K.; Lerch, B.A.; and Saleeb, A.F.: "An Overview of Prognosis Health Management at Glenn Research Center for Gas Turbine Engine Structures With Special Emphasis on Deformation and Damage Modeling",

Annual Conference of the Prognostics and Health Management Society 2009, San Diego, California, Sept. 27-Oct. 1, 2009.

- 57. Poulain, X.; Goldberg, R.K.; Talreja, R.; and Benzerga, A.A.: "A multiscale modeling methodology for damage progression in polymer-based composites", 12th International Conference on Fracture, Ottawa, Canada, July 12-17, 2009.
- 58. Roberts, G.D.; Goldberg, R.K.; Littell, J.D.; Kohlman, L.W.; and Binienda, W.K.: "Characterization of Triaxial Braided Composite Material Properties for Impact Simulation", American Helicopter Society 65th Annual Forum, Grapevine, Texas, May 27-29, 2009.
- Littell, J.D.; Binienda, W.K.; Arnold, W.A.; Roberts, G.D.; and Goldberg, R.K.: "Effect of microscopic damage events on static and ballistic impact strength of triaxial braid composites", CompTest 2008 4th International Conference on Composites Testing and Model Identification, Dayton, OH, October 20-22, 2008.
- 60. Carney, K.S.; Goldberg, R.K.; Pereira, J.M.; Lee, R.S.; and Albert, J.J.: "A Heterogeneous Constitutive Model for Carbon-Carbon Using LS-DYNA." Proceedings of 10th International LS-DYNA Users Conference, Dearborn, MI, June 8-10, 2008.
- 61. Littell, J.D.; Binienda, W.K.; Goldberg, R.K.; and Roberts, G.D.: "A modeling technique and representation of failure in the analysis of triaxial braided carbon fiber composites." Aging Aircraft 2008, 11th Joint NASA/FAA/DoD Conference on Aging Aircraft, Phoenix, AZ, April 21-24, 2008.
- 62. Littell, J.D.; Braley, M.; Goldberg, R.K.; Roberts, G.D.; and Binienda, W.K.: "Characterization of Triaxial Braided Composites using Optical Measurement Techniques." Earth and Space 2008, 11th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Long Beach, CA, Mar. 3-5, 2008.
- 63. Carney, K.S.; Goldberg, R.K.; Lee, R.S.; and Santhanam, S.: "A Heterogeneous Constitutive Model for Reinforced Carbon Carbon." SAMPE Fall Technical Conference 2007, Cincinnati, OH, October 29-November 1, 2007.
- 64. Littell, J.D.; Ruggeri, C.R.; Goldberg, R.K.; Roberts, G.D.; Arnold, W.A.; and Binienda, W.K.: "An Optical Measurement Technique for Measuring Mechanical Properties of Polymer Resins." 2007 Society of Experimental Mechanics Annual Conference and Exposition, Springfield, MA, June 3-6 2007.
- 65. Zhu, L; Chattopadhyay, A.; and Goldberg, R.K.: "A failure model for rate dependent polymer matrix composite laminates under high velocity impact." ACUN-5: International Composites Conference, Developments in Composites: Advanced, Infrastructural, Natural and Nano-composites, Sydney, Australia, July 11-14, 2006.

- 66. Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "A 3D Micromechanics Model for Strain Rate Dependent Inelastic Polymer Matrix Composites." Paper AIAA-2006-1689, 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, Newport, RI, May 1-4, 2006.
- 67. Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "Multiscale Numerical Simulation of High-Velocity Impact on Polymer Matrix Composite Laminates." Earth and Space 2006, 10th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Houston, TX, Mar. 5-8, 2006.
- 68. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Incorporation of the Effects of Temperature and Unloading Into the Strain Rate Dependent Analysis of Polymer Matrix Materials Utilizing a State Variable Approach." Earth and Space 2006, 10th ASCE Aerospace Division Conference on Engineering, Construction and Operations in Challenging Environments, Houston, TX, Mar. 5-8, 2006.
- 69. Ramachandran, S.; Chattopadhyay, A.; Goldberg, R.K.; Seaver, M; and Zhu, L.: "Development of Localized Constitutive Relations for Fiber Optic Sensors Using a Unit Cell Based Slicing Approach." SPIE Smart Structures and Materials and NDE for Health Monitoring and Diagnostics Conference, San Diego, CA, Feb. 26-Mar. 2, 2006.
- 70. Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Testing Epoxy Resin with the Tensile and Torsional Split Hopkison Bar Techniques." 2nd JSME/ASME International Conference on Materials and Processing 2005, Seattle, WA, June 19-22, 2005.
- 71. Zheng, X.; Binienda, W.K.; Goldberg, R.K.; and Roberts, G.D.: "Rate Dependent Shell Element Composite Material Model Implementation in LS-DYNA." Paper AIAA 2005-2242, 46th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, Austin, TX, April 18-21, 2005.
- Zhu, L.; Chattopadhyay, A.; and Goldberg, R.K.: "Transient Response of Strain Rate Dependent Polymer Matrix Composite Laminates." Paper AIAA 2005-1828, 46th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, Austin, TX, April 18-21, 2005.
- 73. Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "The Effects of Strain Rate and Temperature on the Response of Epoxy in Shear Loading." International Symposium on Plasticity 2005, Kauai, HI, Jan. 3-8, 2005.
- 74. Goldberg, R.K.; and Carney, K.S.: "Modeling the Nonlinear, Strain Rate Dependent Deformation of Shuttle Leading Edge Materials with Hydrostatic Stress Effects Included." Proceedings of 8th International LS-DYNA Users Conference, Dearborn, MI, May 2-4, 2004.

- 75. Zhu, L.; Kim, H.S.; Chattopadhyay, A.; and Goldberg, R.K.: "Implementation of Higher Order Laminate Theory into Strain Rate Dependent Micromechanics Analysis of Polymer Matrix Composites." Paper AIAA 2004-1638, 45th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, Palm Springs, CA, April 19-22, 2004.
- 76. Zheng, X.; Goldberg, R.K.; Binienda, W.K.; and Roberts, G.D.: "Development and Implementation of Rate Dependent Composite Material Model for Shell Element Application in LS-DYNA." Earth & Space 2004, 9th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments, Houston, Texas, March 7-10, 2004.
- 77. Zheng, X.; Goldberg, R.K.; Binienda, W.K.; and Roberts, G.D.: "LS-DYNA Implementation of Polymer Matrix Composite Model Under High Strain Rate Impact." 35th SAMPE International Conference, Dayton, OH, Sept. 28-Oct. 3, 2003.
- 78. Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Strain Rate Sensitivity of Epoxy in Tensile and Shear Loading." 2003 ASME Mechanics and Materials Conference, Scottsdale, AZ, June 17-20, 2003.
- 79. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Analytical Modeling of the High Strain Rate Deformation of Polymer Matrix Composites." Paper AIAA-2003-1754, 44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics, and Materials Conference, Norfolk, VA, April 7-10, 2003.
- Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Incorporation of Mean Stress Effects into the Micromechanical Analysis of the High Strain Rate Response of Polymer Matrix Composites." Proceedings of ICCE/9, Ninth International Conference on Composites Engineering, San Diego, CA, July 1-6, 2002, D. Hui, editor, pp. 245-246, 2002.
- 81. Goldberg, R.K.; Roberts, G.D.; and Gilat, A.: "Constitutive Modeling of the Strain Rate Tensile Response of Polymer Matrix Composites." TMS Fall Meeting 2001, Indianapolis, IN, Nov. 4-8, 2001.
- 82. Goldberg, R.K.: "Implementation of Fiber Substructuring Into Strain Rate Dependent Micromechanics Analysis of Polymer Matrix Composites." Proceedings of the American Society for Composites Sixteenth Technical Conference, Blacksburg, VA, Sept. 10-12, 2001, M.W. Hyer and A.C. Loos, editors, CRC Press, 2001.
- Gilat, A.; Goldberg, R.K.; and Roberts, G.D.: "Experimental Study of Strain Rate Sensitivity of Carbon Fiber/Epoxy Composite." ICCM 13 Conference, Beijing, China, June, 2001.

- 84. Goldberg, R.K.; Roberts, G.D.; Gilat, A.; and Stouffer, D.C.: "Experimental and Analytical Studies of the High Strain Rate Tensile Response of a Polymer Matrix Composite Utilizing a Micromechanics Approach." ASME International Mechanical Engineering Congress and Exposition, Orlando, FL, Nov. 11-16, 2000.
- Goldberg, R.K.; and Murthy, P.L.N.: "Strain Rate Dependent Analysis of Polymer Matrix Composite Laminates Utilizing a Micromechanics Approach." Proceedings of the American Society for Composites Fifteenth Technical Conference, College Station, TX, Sept. 25-27, 2000, O.O. Ochoa, T.K. O'Brien, D. Lagoudas, H.J. Sue, editors, Technomic Publishing Company, pp. 631-638, 2001.
- Goldberg, R.K.; and Stouffer, D.C.: "Strain Rate Dependent Deformation and Strength Analysis of Polymer Matrix Composites." Proceedings of the American Society for Composites Fourteenth Technical Conference, Dayton, OH, Sept. 27-29, 1999, J.M. Whitney, editor, Technomic Publishing Company, pp. 551-560, 1999.
- 87. Goldberg, R.K.; and Stouffer, D.C.: "High Strain Rate Characterization of a Polymer Matrix Composite Utilizing a Micromechanics Approach." Modeling and Simulation Based Engineering, Proceedings of the International Conference on Computational Engineering, Atlanta, GA, Oct. 6-9, 1998, S.N. Atluri and P.E. O'Donoghue, editors, pp. 1090-1095, 1998.
- 88. Wilt, T.E.; Arnold, S.M.; and Goldberg, R.: "Micromechanics Analysis Code, MAC: Features and Applications." Proceedings of the Annual HITEMP Review, Westlake, OH, Apr. 29-30, 1997, NASA CP-10192, 1997.
- Goldberg, R.K.; and Hopkins, D.A.: "Further Applications of the Boundary Element Method in the Micromechanical Modeling of Woven Composites." Proceedings of the Annual HITEMP Review, Westlake, OH, Oct. 23-23, 1995, NASA CP-10178, 1995.
- 90. Goldberg, R.K.; and Comiskey, M.D.: "COMGEN-BEM: Boundary Element Model Generation for Composite Materials Micromechanical Analysis." MSC 1995 World Users' Conference Proceedings, Universal City, CA, May 8-12, 1995, The MacNeal-Schwendler Corporation, 1995.
- 91. Goldberg, R.K.; and Hopkins, D.A.: "Utilization of the Boundary Element Method in Modeling the Thermoelastic Behavior of SiC/RBSN and Functionally Graded SiC/Ti-15-3 Composites." Proceedings of the 7th Annual HITEMP Review, Westlake, OH, Oct. 24-26, 1994, NASA CP-10146, 1994.

- 92. Goldberg, R.K.; and Hopkins, D.A.: "Micromechanical Analysis of Functionally Graded Materials Using the Boundary Element Method." Proceedings of ICCE/1, First International Conference on Composites Engineering, New Orleans, LA, Aug. 28-31, 1994, D. Hui, editor, pp. 167-168, 1994.
- 93. Goldberg, R.K.; and Hopkins, D.A.: "Utilization of Boundary Element Method in Modeling Interface Effects in SiC/RBSN Composites." Proceedings of the 6th Annual HITEMP Review, Westlake, OH, Oct. 25-27, 1993, NASA CP-19117, 1993.
- 94. Goldberg, R.K.; and Hopkins, D.A.: "Micromechanical Modeling of Laminated Composites with Interfaces and Woven Composites Using the Boundary Element Method." Proceedings of the American Society for Composites Eighth Technical Conference, Cleveland, OH, Oct. 19-21, 1993, G.M. Newaz, editor, Technomic Publishing Company, pp. 1035-1044, 1993.
- 95. Lerch, B.A.; Melis, M.E.; Goldberg, R.K.; and Tong, M.: "Experimental and Numerical Studies of Inelastic Deformation in SiC/Ti Laminates." Proceedings of Meet'n'93-First Joint ASCE/ASME/SES Meeting, Charlottesville, VA, June 6-9, 1993, C.T. Herakovich and J.M. Duva, editors, 1993.
- 96. Goldberg, R.K.; and Hopkins, D.A.: "Micro Mechanical Modeling of Laminated and Woven Composites Using the Boundary Element Method." Proceedings of the 5th Annual HITEMP Review, Westlake, OH, Oct. 27-28, 1992, NASA CP-10104, 1992.
- 97. Goldberg, R.K.; and Hopkins, D.A.: "Composite Micromechanical Modeling Using the Boundary Element Method." Proceedings of the American Society for Composites Seventh Technical Conference, University Park, PA, Oct. 13-15, 1992, H.T. Hahn, editor, Technomic Publishing Company, pp. 349-358, 1992.