MECHANICAL PROPERTIES RESEARCH LABORATORY (MPRL)

1994/1995 Annual Report

Prepared by:

David L. McDowell, Director
W. Steven Johnson, Associate Director

August 1995

Telephone: (404) 894-5128
Fax: (404) 894-8336

Participating Units:

School of Aerospace Engineering
G.W. Woodruff School of Mechanical Engineering
School of Materials Science and Engineering

MPRL STATUS & SUMMARY OF 1993/1994 ACCOMPLISHMENTS

The Mechanical Properties Research Laboratory (MPRL) has been in existence for over a decade. Dr. D.L. McDowell of the Woodruff School of Mechanical Engineering has served as Director of the MPRL since October 1992, and previously served as Associate Director since 1983. He received a joint appointment with the School of Materials Science and Engineering in Spring 1995. Dr. W.S. Johnson of the School of Materials Science and Engineering, formerly of NASA Langley, was named Associate Director of the MPRL in July 1994.

The MPRL is an interdisciplinary laboratory which supports education and research programs in structural materials. Its principal activities are directed towards the measurement and modelling of the mechanical properties of engineering materials, primarily related to deformation, fatigue and fracture. The MPRL impacts very directly on educational and research programs within the academic units of the College of Engineering. In its role as an interdisciplinary umbrella organization for experimental research in mechanical properties of materials, the MPRL provides a degree of coordination of equipment usage, training and maintenance that would be much more costly to the sum of academic units in the conventional university setting of distinctly controlled single investigator equipment.

The MPRL is administered by the Director, with recommendations from a Faculty Governance Board. The Industrial Advisory Board of the School of Materials Science and Engineering also serves as the Industrial Advisory Board of the MPRL, and meets with the Director and selected MPRL faculty each fall.

Principal activities of the MPRL include:

- Fatigue and fracture studies of structural materials
- Development of constitutive equations for deformation and damage
- Characterization and quantification of microstructure and damage in engineering materials
- Development of life prediction methodologies, including effects of long term exposure and aging
- Processing and fabrication of structural materials, and development of improved

constitutive models and simulation capability for processing

Participation includes faculty and students from ME, MSE and AE (Appendix A). The number of participating MPRL faculty has increased by over 50% this past year.

MPRL staff includes:

- MPRL Director (10% time)
- MPRL Associate Director (5% time)
- Technician (40% time)
- Secretary (25% time)
- Administrative Assistant (5% time)

The following Table provides data regarding the activities of the MPRL during the past year.

No. Faculty	Published Papers	Presentations	Students Graduated M.S.	Ph.D.	Major Faculty & Student Awards
15*	89	62	6	1	14

* Several of these faculty joined the MPRL in mid-year

Approximately $1.7M was expended during the past year by MPRL faculty in externally sponsored research. This represents the highest annual funding level in the last decade and is, in fact, a conservative estimate since not all MPRL members provided information for the annual report. Appendices B and C list the publications and presentations of participating MPRL faculty from July 1, 1994 to June 30, 1995. Appendix D lists MPRL-related sponsored funding and Appendix E lists major awards bestowed upon participating MPRL faculty in 1994-95.

MPRL faculty offer a wide range of courses in fatigue, fracture, deformation and damage of

engineering materials, mechanics of solids, quantitive image analyis and nondestructive evaluation, and mechanical behavior of materials. The sequence of introductory and advanced applied fracture mechanics courses, cross-listed between ME and MSE, is among the strongest of its type offered at any U.S. university. A graduate Certificate in the Mechanical Properties of Solids is also offered through the MPRL.

PROGRAM DEVELOPMENT

Over the past few years, the MPRL has played a leading role, in cooperation with the Composites Education and Research Center (CERC) and several GTRI faculty, in developing proposals in response to University Research Initiatives in high temperature structural materials sponsored by ARPA and AFOSR. The momentum of these development efforts, along with an internally funded Focused Research Program (FRP) in the subject of mechanics and processing of high temperature materials, have drawn together an excellent core group of faculty from different disciplines with common goals. This FRP involves faculty from both academic units and GTRI, predominately composed of MPRL and CERC faculty. Currently, the FRP actively supports collaboration of faculty and graduate students working in mechanics and processing of CMCs with the goal of enhancing co-authored interdisciplinary journal papers and conference presentations, co-advised theses, and proposal development through frequent meetings of various team sub-groups during the academic year. MPRL/FRP faculty hosted an NSF Workshop on **Mechanics and Processing of Advanced Engineered Materials** held October 24-26, 1994 at Lake Lanier Islands; this workshop featured prominent researchers from academia, government and industry and considered future directions in research and education.

The MPRL has been actively involved in developing a program on durability models for the NASA initiative on the High Speed Civil Transport.

A major new research thrust involving MPRL faculty is the development of high cycle fatigue models and integration with real-time inspection techniques for critical rotorcraft components. Sponsored by ONR at an overall exceeding $1.5M/yr, this 3-5 year M-URI in "Integrated Diagnostics" (PI/PD W.O. Winer) involves four MPRL faculty (McDowell, Johnson, Neu and Saxena) and two other universities (Northwestern and the University of Minnesota). The annual MPRL-related component is approximately $230K.

MPRL faculty are also vitally involved in the formulation of a new AFOSR initiative to address basic mechanics and materials issues in high cycle fatigue of polycrystalline and single crystal Ni-base superalloys used in jet engine components. Drs. McDowell and Johnson were invited to attend an AFOSR workshop held June 7, 1995 in Dayton, Ohio in which basic research issues were discussed in order to formulate Air Force research initiatives in high cycle fatigue. Dr. McDowell was an invited lecturer at the workshop in the area of mechanics issues in high cycle fatigue, and upon AFOSR request has drafted a white paper based on this workshop that will serve as a basis for future AFOSR initiatives. The MPRL expects to play a leading role among U.S. universities in this area in the coming years.

As a result of the recent hiring of Drs. Johnson (MSE) and Neu (ME) and addition of several new Georgia Tech faculty during the past year, the MPRL has risen to an unprecedented level of research activity. Other new faculty include:

1. T.L. Starr - A longtime researcher at GTRI prior to joining MSE in summer 1994, Dr. Starr is internationally recognized for his contributions to measurement of the mechanical and transport properties of ceramic matrix composites, and modeling of the chemical vapor infiltration (CVI) process and development of ceramic composites.
2. N. Thadhani - Dr. Thadhani is well-known for his contributions to materials aspects of dynamic deformation, including fracture and flow behavior of solid and porous materials, synthesis of intermetallics and ceramics materials utilizing effects of high-strain-rate loading.
3. J. Hampikian - Dr. Hampikian joined the MPRL in Winter 1995. Her work focuses on microstructural and analytical characterization of materials through transmission electron microscopy, high temperature oxidation kinetics, and thermal barrier coatings.
4. K.V. Logan - Dr. Logan joined the MPRL in Spring 1995. Her research involves effects of processing on microstructure, and effects of microstructure on mechanical properties of high performance ceramics.

In addition, the MPRL will add two new faculty in the next academic year with high potential for involvement in and development of its programs and facilities:

1. C. Lynch - Dr. Lynch received his doctorate from the University of California at Santa Barbara

and will join the Mechanical Engineering faculty in August 1995. He is developing a strong reputation in the mechanics of coupled electromagnetic-mechanical effects in fracture of ferroelectric materials, and has a strong background in dynamic testing of materials.

2. M. Zhou - Dr. Zhou received his doctorate from Brown University and will conclude post-doctoral work at Cal Tech before joining the Mechanical Engineering faculty in Fall 1995. He has made fundamental contributions to the understanding of dynamic inelastic behavior of single and multiphase materials, including fracture and shear localization, from both experimental and computational modelling perspectives.

It is expected that both of these new faculty members will make significant contributions to development of new MPRL facilities in these critical research areas. It is projected that the annual MPRL funding for will exceed $2M in the coming year for the first time as a result of its expansion.

PROGRESS TOWARDS LONG RANGE PLAN GOALS

Development of a Leading Position in Mechanical Properties Research

The major Center weaknesses which were identified in the 1994 MPRL strategic plan included, in order of priority, lack of equipment and electronic upgrades in the last five years, the lack of block funding, a high percentage of external funding from DoD sources (50%), and lack of breadth of faculty participation. These weaknesses have been addressed on a systematic basis, as discussed next.

Lack of equipment/electronic upgrades:

MPRL faculty have been responding aggressively to proposal development opportunities for sponsored funding of new equipment. Drs. McDowell and Johnson have co-authored two proposals for major external funding to the AFOSR and the NSF. Through discussions with the AFOSR, it was felt that prospects were excellent for $500K in new funds to enhance the MPRL's high temperature environment testing capability; regrettably, the proposal received the wrong zip code from OCA and reached the AFOSR five hours late for consideration. The NSF has indicated that they will fund the second proposal, which will result in $205K of NSF money for electronic and supporting equipment upgrades with an additional $138K in GT matching funds.

In addition, the ONR M-URI and new faculty start-up funds are providing some funding for acquisition of electronic upgrades and small equipment items. The Office of Interdisciplinary Programs provided $45K of year end funding in June 1995 which was used to purchase a state-of-the-art digital test control and data acquisition unit.

It would appear that with the equipment proposal development efforts, program development of energetic new faculty, the block-funded ONR program, and the assistance of OIP, the MPRL is well on its way to achieving state-of-the-art status in control and instrumentation, a dramatic improvement relative to the situation 18-24 months ago.

Lack of block funding:

The MPRL has taken strong steps towards block funded program development to supplement its solid base of single investigator grants. As previously mentioned, four MPRL faculty (McDowell, Johnson,

Neu and Saxena) are involved in the 3-5 year ONR M-URI in "Integrated Diagnostics" (PI/PD W.O. Winer). This program provides on the order of $230K/yr to the MPRL in support of basic research.

The MPRL expects to play a leading role among U.S. universities in this area in the coming years in a future AFOSR initiative which will address basic mechanics and materials issues in high cycle fatigue of polycrystalline and single crystal Ni-base superalloys used in jet engine components. Drs. McDowell and Johnson were invited to attend an AFOSR workshop held June 7, 1995 in Dayton, Ohio in which basic research issues were discussed. Dr. McDowell led the effort to draft a white paper based on this workshop that will serve as input for AFOSR initiatives in mechanics of high cycle fatigue. Potentially, competition for one or more URIs may emerge from these initiatives.

Another initiative capturing the attention of a number of MPRL faculty is the current round of competition for NSF Materials Research Science and Engineering Centers (MRSEC). Coordinated with the Materials Council, a number of MPRL faculty are involved in one of two Georgia Tech pre-proposals which are under development for submission to the NSF in September 1995, each at a proposed NSF funding level on the order of $1M/yr.

In conjunction with an internally funded Focused Research Program in Mechanics and Processing of High Temperature Composites, MPRL faculty are also involved in preliminary discussions with faculty at the Virginia Polytechnic Institute and State University and Clark Atlanta University to collaborate on a possible proposal for an NSF Engineering Research Center (ERC) in long term durability of composite materials. This effort, led by MPRL faculty Drs. W.S. Johnson and R. Talreja, is in very early stages of development (i.e. feasibility). The combined potential of these three universities in this subject is considered to be outstanding, following an exploratory meeting at VPI in early July 1995.

High percentage of external funding from DoD sources (50%):

In our view, this earlier perceived weakness has not materialized as such. The MPRL continues to enjoy strong support from both industrial and defense sectors. If anything, its ties to the defense sector have been strengthened with the ONR M-URI program, involvement of MPRL faculty in strategic planning for both the Army and Air Force, and hiring of new faculty with strong research ties to this sector.

This is no longer a concern in the most recent MPRL strategic plan.

Lack of breadth of faculty participation:

Through publicity and recruitment of potential faculty, the MPRL is in the midst of its greatest historical expansion of faculty involvement. The number of participating faculty increased by over 50% this past year, with another two faculty joining in Fall 1995. These faculty are drawn from several disciplines and each brings a different set of skills to the MPRL. This is no longer perceived as a weakness, as we must now deal with the pleasant issues of how to accommodate and assist this wide range of research activity. Increasingly, it is clear that the MPRL must focus on its primary mission in structural materials in order to balance resources amongst a broadened pool of active faculty.

Diversity

The faculty of the MPRL have worked consistently to ensure that students in the MPRL represent the diversity of the larger student body, including underrepresented groups. Presently, four female students and five minority students are conducting graduate research in the MPRL.

Graduate Degree Productivity

In view of the nominal size of the MPRL faculty, the Ph.D. production might be expected to exhibit significant variation from year to year, and must be viewed in a time-averaged sense. This year, it dropped to one student from nine in the previous year. It is expected that this number will increase substantially towards the goal of 10 per year with the MPRL faculty expansion and associated increase of research funding and will suffer from less cyclical variation as well. Several MPRL students are receiving doctorates in August 1995, for example. M.S. degree production is roughly at half the target level of 15 per year; this too will be positively affected by the faculty expansion.

Development of recruiting publicity materials has been delayed pending allocation of requested resources. We are presently in the process of completing an updated MPRL publicity brochure, living within the limits of available resources.

Service and Economic Development

Since additional funds necessary to develop topical lectures and short courses in fatigue and fracture were not allocated this past budget cycle, activities in this area were somewhat limited in scope.

Dr. R. Talreja of AE offered a new short course in fatigue of composite materials through the Office of Continuing Education. We anticipate that 1-2 more new short courses may be added during 1994-1995, pending availability of participant time. With the internationally acknowledged expertise of core MPRL faculty in experimental fracture mechanics, Georgia Tech has an unique opportunity to capitalize on development of such short courses for video/satellite presentation.

APPENDIX A

List of MPRL Faculty

Name	Affiliation
E.A. Armanios	AE
A. Gokhale	MSE
J. Hampikian	MSE
W.C. Hutton	EMORY/ME (adjunct)
W.S. Johnson	MSE
K.V. Logan	MSE
D.L. McDowell	ME/MSE
R.W. Neu	ME
B. Park	MSE
T.H. Sanders	MSE
A. Saxena	MSE
T.L. Starr	MSE
S.R. Stock	MSE
R. Talreja	AE
N. Thadhani	MSE

APPENDIX B

List of Published Papers

A. Gokhale

1. A.M. Gokhale and W.J. Drury: "Efficient Measurement of Microstructural Surface Area Using Trisector", **Metallurgical and Materials Transactions**, Vol. 25A, PP. 919-928, 1994.

2. Pascal LOUIS and A.M. Gokhale: "Application of Image Analysis for Characterization of Spatial Arrangement of Features in Microstructures", **Metallurgical and Materials Transactions**, in press (will appear in June/July, 1995).

3. W.J. Drury, A.M. Gokhale, and S.D. Antolovich: "Effect of Crack Surface Geometry on Fatigue Crack Closure", **Metallurgical and Materials Transactions**, in press.

4. Pascal LOUIS and A.M. Gokhale: "Can Average Particle Section Size in Metallographic Plane be Larger than True Average Particle Size in Three-Dimensional Microstructure?", **Metallurgical and Materials Transactions**, in press.

5. A.M. Gokhale: "Estimation of Bivariate Size and Orientation Distribution of Microcracks", **Acta Metallurgica et. Mater.,** Submitted.

6. Pascal LOUIS and A.M. Gokhale: "Computer Simulation of Spatial Connectivity of Particles in 3D Microstructure: Application to Model Electrical Conductivity of Polymer Matrix Composite", **Acta Metallurgica et. Materiallia**, submitted.

7. A.M. Gokhale and N.U. Deshpande: "Stereology of Anisotropic Microstructures", in Quantitative Microscopy and Image Analysis, David J. Diaz, ed., ASM International, Materials Park, OH, 1994, pp. 73-82.

8. W.J. Drury and A.M. Gokhale: "Feature Specific Digital Profilometry of Fracture Surfaces", in Quantitative Microscopy and Image Analysis, David J. Diaz, ed., ASM International, Materials Park, OH, 1994, pp. 83-87.

9. N.U. Deshpande, A.M. Gokhale, and D.K. Denzer: "Relationship Between Fracture Surface Path and Microstructure of Aluminum Alloy 7050", in Proceedings of 4th International Conference on Aluminum Alloys, T.H. Sanders, Jr., ed., Georgia Institute of Technology, Atlanta, GA., 1994, Vol. 1, pp. 685-692.

10. W.T. Whited, A.M. Gokhale, and N.U. Deshpande: "Characterization of Thermally Induced Microcracks in a Metal Matrix Composite", in Proceedings of Annual Technical Meeting of IMS,

in Microstructural Science, 1994, Vol. 21, pp. 107-120.

J. Hampikian

1. "High Temperature Coatings I", Proceedings of the First Symposium on High Temperature Coatings, Materials Week, Oct. 6-9, 1994, edited by N. Dahotre, J.M. Hampikian and J. Stiglich.

2. American Vacuum Society, 41st National Symposium, "Preparation and Characterization of Thiol Copped Silver Nanocrystals, M.M. Alvarez, S. Murthy, R.L. Whetten, J.M. Hampikian, Denver, Colorado October 24-28, 1994.

3. J.M. Hampikian, D.I. Potter, "The Effects of Al^{+} Ion Implantation on the Oxidation of Niobium and Vanadium", manuscript submitted to Metallurgical Transactions A, May 1995.

4. "Surface Modification of Co-12Cr and Ni-12Cr Alloys by Yttrium Ion Implantation", J.M. Hampikian, M.R. Hendrick and E.M. Hunt, *High Temperature Coatings I*, Materials Week, Oct. 6-9, 1994.

5. W. B. Carter, J.M. Hampikian, S. Godfrey, and T.A. Polley, "Thermal Cycling Behavior of Combustion Chemical Vapor Deposited Oxide Coatings", February 14, 1995, TMS Annual Meeting, Las Vegas, Nevada.

W.C. Hutton

1. Daftari, T.K., Horton, W.C. and Hutton, W.C. (1994): Correlations Between Torque of Insertion, Pullout Strength and Screw Hole Preparation for Spinal Screws. Journal of Spinal Disorder 7(2): 139-145.

2. York, M.J. and Hutton, W.C.: The Treatment of Screw Hole Defects Using Bone Graft Mterials - A Histological and Biomechanical Study. Journal of the Southern Orthopaedic Association (in press).

3. Matava, M.J. and Hutton, W.C.: A Biomechanical Comparison Between the Central One-Third Patellar Tendon and the Residual Tendon. British Journal of Sports Medicine (in press).

4. Boden, S.D., Schimandle, J.H. and Hutton, W.C. (1995): A Rabbit Lumbar Spine Intertransverse Process Spine Fusion Model: Radiographic, and Biomechanic Healing Characteristics. Spine 20(4): 412-420.

5. Silcox, D.H., Daftari, T., Boden, S.D., Schimandle, J.H., Hutton, S.C., Whitesides, T.E.: The Effect of Nicotine on Spinal Fusion. Spine (in press).

6. Butler, J.C., Branch, T.P. and Hutton, W.C. (1994): Optimal Graft Fixation - The Effect of Gap

Size and Screw Size on Bone Plug Fixation in ACL Reconstruction, Arthroscopy 10(5): 524-529.

7. Schimandle, J.H., Boden, S.D., Hutton, W.C., (1995): Experimental Spinal Fusion with Recombinant Human Bone Morphogenetic Protein-2 (rhBMP-2). Spine 20: 1326-1337.

8. Boden, S.D., Schimandle, J.H., Hutton, W.C.: Lumbar Intertransverse Process Spine Arthrodesis with a Bovine-Derived Osteoinductive Bone Protein. Journal of Bone and Joint Surgery (in press).

9. Horton, W.C., Blackstock, S.F., Norman, J.T., Hill, C.S., Feiertag, M.A., Hutton, W.C. (1995). The strength of fixation of anterior vertebral screws. Spine (in press).

W.S. Johnson

1. Johnson, W.S., Mirdamadi, M., Bakuckas, J.G., Jr., "Damage Accumulation in Titanium Matrix Composites Under Generic Hypersonic Vehicle Flight Simulation and Sustained Loads," to appear in Thermo-Mechanical Fatigue of Materials, Second Volume, Eds. Verrilli and Castelli, ASTM STPXXXX, 1995.

2. Johnson, W.S., Miller, J.L., Mirdamadi, M., "Fractographic Interpretation of Failure Mechanisms in Titanium Matrix Composites", Journal of Materials Science and Engineering, (accepted) 1995.

3. Dillard, D.A., St. Clair, T.L., and Johnson, W.S. "Environmentally Enduced Spiral Fractures in LaRC TPI", Journal of Adhesion, 1994, Vol. 44, pp. 51-67.

4. Miller, J.L., Portanova, M.A. and Johnson, W.S., "Impact Damage Resistance and Residual Property Assessment of $[0/\pm45/90]_S$ SCS-6/Timetal 21S" NASA Technical Memorandum 110178, May 1995, To appear in Composites: Fatigue and Fracture 6th Symposium, ASTM STP XXXX.

5. Johnson, W.S., Lee, E., and Miller, J.L., "High Temperature Titanium Composite Laminates: An Early Analytical Assessment," Proceeding of ICCM-10, 1995.

6. Miller, J.L., Newman, J.C. Jr., and Johnson, W.S., "Fatigue Response of Perforated Titanium for Application in Laminar Flow Control," 27th National Symposium on Fatigue and Fracture Mechanics, ASTM STP XXXX, 1996.

7. Calcaterra, J.R., and Johnson, W.S., "A Comparison of Damage Mechanisms for SCS-6/Timetal 21-S Subjected to Various Thermomechanical Fatigue Cycles," 10th American Society of Composites Technical Conference, 1995.

D.L. McDowell

1. McDowell, D.L., "Description of Nonproportional Cyclic Ratchetting Behavior," European Journal of Mechanics, A/Solids, Vol. 13, No. 5, 1994, pp. 593-604.

2. McDowell, D.L., "Stress State Dependence of the Cyclic Ratchetting Behavior of Two Rail Steels," International Journal of Plasticity, Vol. 11, No. 4, 1995, pp. 397-421.

3. McDowell, D.L., Miller, M.P. and Brooks, D.C., "A Unified Creep-Plasticity Theory for Pb-Sn Solder,"*Fatigue of Electronic Materials*, ASTM STP 1153, S.A. Schroeder and M.R. Mitchell, eds., Amer. Society for Testing and Materials, Philadelphia, 1994, pp. 42-59.

4. Miller, M.P. and McDowell, D.L., "The Effect of Stress-State on the Large Strain Inelastic Deformation Behavior of 304L Stainless Steel," ASME J. Engng. Mater. Techn., in press, 1995.

5. McDowell, D.L., "An Improved Algorithm for Elastic-Plastic Rolling/Sliding Line Contact," submitted for publication in the ASME Journal of Tribology, August 1994.

6. Lim, T.J. and McDowell, D.L., "Path Dependence of Shape Memory Alloys During Cyclic Loading," submitted for publication to the J. Smart Mater. Struct., November 1994.

7. McDowell, D.L. and Poindexter-Bennett, V., "A Microcrack Growth Law for Multiaxial Fatigue," submitted for publication to Fat. Fract. Engng. Mater. Struct., November 1994.

8. Marin, E.B., McDowell, D.L. and Bertoncelli, C., "Models for Compressible Elasto-Plasticity Based on Internal State Variables," submitted for publication to the International Journal of Damage Mechanics, May 1995.

9. Marin, E.B. and McDowell, D.L., "Associative Versus Non-Associative Porous Viscoplasticity Based on Internal State Variable Concepts," submitted for publication to the International Journal of Plasticity, April 1995.

10. McDowell, D.L. and Voorhees, P.W., "Status of Constitutive Laws and Hydrocodes for Deformation and Damage of Structures Subjected to Impacts and Blasts," submitted for publication to Int. J. Impact Engng., April 1995.

11. Miller, M.P. and McDowell, D.L., "Modelling Large Strain Multiaxial Effects in FCC Polycrystals," submitted for publication to the International Journal of Plasticity, April 1995.

12. Miller, M.P. and McDowell, D.L., "Biaxial Deformation Experiments Over Multiple Strain Regimes," submitted for publication in an ASTM Special Technical Publication, presented at the ASTM Symp. on Multiaxial Fatigue and Deformation Testing Techniques, Denver, May 1995, in review for publication in an ASTM STP.

13. McDowell, D.L., "An Engineering Model for Propagation of Small Cracks in Fatigue," submitted

for publication in Engineering Fracture Mechanics, May 1995.

14. Hall, D.E., Hamilton, B.C., McDowell, D.L. and Saxena, A., "Creep Crack Growth Behavior of Aluminum Alloy 2519: Part II - Numerical Analysis," submitted for publication in ASTM STP resulting from the 27th National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 19, 1995.

15. Marin, E.B. and McDowell, D.L., "A Semi-Implicit Integration Scheme for Rate-Dependent and Rate-Independent Plasticity," Submitted to the Int. J. Numer. Meth. Engng., July 1995.

Papers with Conference Presentation:

16. Miller, M.P. and McDowell, D.L., "Stress-State Dependent Deformation Behaviour of FCC Polycrystals," Proc. 15th Ris0 International Symp. on Materials Science, Numerical Predictions of Deformation Processes and the Behaviour of Real Materials, eds. S.I. Andersen et al., Ris0 National Laboratory, Roskilde, Denmark, Sept. 5-9, 1994, pp. 421-426.

17. Melander, A, Gustavsson, A. and McDowell, D.L., "FEM Simulation of Sheet Metal Forming Followed by Fatigue Loading," Proc. 15th Ris0 International Symp. on Materials Science, Numerical Predictions of Deformation Processes and the Behaviour of Real Materials, eds. S.I. Andersen et al., Ris0 National Laboratory, Roskilde, Denmark, Sept. 5-9, 1994, pp. 413-420.

18. McDowell, D.L., "Cumulative Surface Displacement in Rolling Line Contact," 36th Mechanical Working and Steel Processing Conference, Iron & Steel Society, Baltimore, Oct. 16-19, 1994.

19. McDowell, D.L., "Multiaxial Effects in Metallic Materials," Symposium on Durability and Damage Tolerance, ASME AD-Vol. 43, ASME Winter Annual Meeting, Chicago, IL, Nov. 6-11, 1994, pp. 213-267.

20. McDowell, D.L., "Multiaxial Fatigue Modelling Based on Microcrack Propagation," Symposium on Material Durability/Life Prediction Modeling, ASME PVP-Vol. 290, ASME Winter Annual Meeting, Chicago, IL, Nov. 6-11, 1994, pp. 69-83.

21. Hall, D.E., McDowell, D.L. and Saxena, A., "Numerical Analysis of Crack Growth in Creep-Brittle Aluminum Alloy 8009," 1995 NSF Design, Manufacturing and Industrial Innovation Grantees Meeting, Institute for Mechanics and Materials, La Jolla, CA, January 4-6, 1995.

22. Poindexter-Bennett, V. and McDowell, D.L., "A Microcrack Growth Law for Multiaxial Fatigue of Metals," NSBE Trans. on Emerging Technologies '95, Detroit, MI, March 22-26, 1995.

R.W. Neu

1. Neu, R.W., "TMF Life and Damage Mechanism Maps for Titanium Matrix Composites," Proc.

Int. Symp. on Fatigue Under Thermal and Mechanical Loading, Petten (N.H.), The Netherlands, May 22-24, 1995.

B. Park

1. C. Uslu, D.H. Lee, Y. Berta, B. Park, N.N. Thadhani, and D.B. Poker, "Synthesis of $(SiC)_3N_4$ Thin Films by Ion Implantation," Mat. Res. Soc. Symp. Proc. 316, 765 (1994).

2. B. Park, "Synthesis of Metastable Phases," AKPA Newsletter 16(1), 7 (1994).

3. B. Park, "Time-Resolved X-Ray Scattering Investigation of Ordering Kinetics in a Second-Order Phase Transition," in *International Workshop on Surface and Nano Structure* (The Korean Federation of Science and Technology Societies, October 1994).

4. C. Uslu, B. Park, and D.B. Poker, "Synthesis and Characterization of a Metastable $(SiC)_3N_4$ Phase," to be published in Mat. Res. Soc. Symp. Proc. 354 (1995).

5. B. Park, A. Saxena and T.P. Serene, "Enhanced Surface Hardness in $B^{\%}$ - Implanted NiTi," Invention Disclosure filed on November 4, 1994.

6. C. Uslu, B. Park and D.B. Poker, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds by Ion Implantation," to be published in Journal of Electronic Materials (1995).

7. C. Collins, N.N. Thadhani, B. Park, and Z. Iqbal, "Shock Compression of Organic Precursors for Synthesis of Carbon-Nitride Compounds," submitted to J. Am. Ceram. Soc. (1995).

8. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds," in *The Second Pacific Rim International Conference on Advanced Materials and Processing* (The Korean Institute of Metals and Materials, June 1995).

9. D.H. Lee, B. Park, A. Sacena, and T.P. Serene, "Enhanced Surface Hardness by Boron Implantation in Nitinol Alloy," to be published in J. Endodontics (1995).

10. C. Uslu, D.H. Lee, Y. Berta, B. Park, D.B. Poker, and L. Riester, "Enhanced Surface Hardness in Nitrogen-Implanted Silicon Carbide," to be published in Nucl. Instrum. Methods in Phys. Res. B (1995).

T.H. Sanders

1. “Alpha-phase Particles in 6XXX Aluminum Alloys” with P. Donnadieu, G. Lapasset, and B. Thanaboonsombut, accepted, Phil. Mag. Letters, in press.

2. “The Effect of Iron and Manganese on the Recrystallization Behavior of Hot Rolled and Solution

Heat Treated Aluminum Alloy 6013", with Richard A. Jeniski, Jr. and Buncha Thanaboonsombut, Metallurgical Transactions, in press.

3. "Icosohedral Phases in the Al-Fe-Mn-Si System," with P. Donnadieu and G. Lapasset, submitted to ICEM (International Conference on Electron Microscopy) 13, 17-22 July, 1994, Paris, France.

4. "Fabrication and Properties of Hollow Sphere Nickel Foams", R.B. Clancy, J.K. Cochran, and T.H. Sanders, Spheres and Microspheres: Synthesis and Applications, M. Berg, T. Bernat, J.K. Cochran, D. Kellerman, and D.L. Wilcox, eds., MRS Proceedings, V-372, Boston, MA, Nov. 1994. (8 pg, in press)

5. "Competitive Growth in Quench Modified and Impurity Modified Aluminum-Silicon Eutectics" with R.E. Napolitano, in The 4th International Conference on Aluminum Alloys, Their Physical and Mechanical Properties, Volume ø, edited by T.H. Sanders, Jr. and E.A. Starke, Jr., Georgia Tech, Atlanta, Georgia, 1994, pp. 99-106.

6. "Alpha-Phase Particles in 6XXX Aluminum Alloys", with P. Donnadieu, G. Lapasset and B. Thanaboonsombut, The 4th International Conference on Aluminum Alloys, Their Physical and Mechanical Properties, Volume ø, edited by T.H. Sanders, Jr. and E.A. Starke, Jr., Georgia Tech, Atlanta, Georgia, 1994, pp. 668 - 678

7. "A Review of the Physical Metallurgy of 6013", with B. Thanaboonsombut, in The 4th International Conference on Aluminum Alloys, Their Physical and Mechanical Properties, Volume øøø, edited by T.H. Sanders, Jr. and E.A. Starke, Jr., Georgia Tech, Atlanta, Georgia, 1994, pp. 197 - 201.

8. "The Effects of Modification to Composition and Processing on Recrystallization Resistance of 6013", with B. Thanaboonsombut in The 4th International Conference on Aluminum Alloys, Their Physical and Mechanical Properties, Volume øøø, edited by T.H. Sanders, Jr. and E.A. Starke, Jr., Georgia Tech, Atlanta, Georgia, 1994, pp. 202 - 215.

9. "A Study on the Dendritic Growth of Gamma Prime in Astroloy", with M.L. Macia, Second International Conference on Heat Resistant Materials, Conference Proceedings of the meeting to be held September 11-14, 1995, Gatlinburg, TN., in press.

A. Saxena

1. P. S. Grover and A. Saxena, "Characterization of Creep-Fatigue Crack Growth Behavior in 2.25 Cr-IMo Steel Using $(C_t)_{avg}$," accepted for publication in International Journal of Fracture (6/95).

2. J. Cernyar, F. Yang and A. Saxena, "Fracture and Fatigue Crack Growth Behavior of SiC/2124 Al Composite," accepted for publication in ASTM Journal of Composite Technology and Research

(5/95).

3. P. S. Grover and A. Saxena, "Creep Crack Growth in Power Plant Materials," accepted for publication in a special issue of the Journal of Indian Academy of Sciences.

4. B. C. Hamilton, D. E. Hall, A. Saxena and D. L. McDowell, "Creep Crack Growth Behavior of Aluminum Alloy 2519: Part I - Experimental Analysis," submitted for publication in ASTM STP resulting from the 27th National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 19, 1995.

5. D. E. Hall, B. C. Hamilton, D. L. McDowell and A. Saxena, "Creep Crack Growth Behavior of Aluminum Alloy 2519: Part II - Numerical Analysis," submitted for publication in ASTM STP resulting from the 27th National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 29, 1995.

6. Fan Yang, A. Saxena and T. L. Starr, "Fracture Mechanisms in Unidirectional SiC/Si_3N_4 Composite at Elevated Temperature," submitted for publication in ASTM STP resulting from the 27th National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 29, 1995.

7. P. S. Grover and A. Saxena, "Developments in Creep-Fatigue Crack Growth and Data Analysis," ECF-10, Structural Integrity: Experiments -Models - Applications, K. H. Schwalbe and C. Berger editors, pp 1 - 15, Oct. 1994.

8. A. Saxena and K. Jones, "Creep Crack Growth in Rapidly Solidified Aluminum Alloy 8009," Proceedings of the 4th International Conference on Al Alloys, T. H. Sanders and E. A. Starke editors, Sept. 1994.

9. B. C. Hamilton and A. Saxena, "Elevated Temperature Crack Growth of Aluminum Alloys," Proceedings of the 4th International Conference on Al Alloys, Sept. 1994.

10. A. Saxena, "Applications of Crack Growth Models in Life Prediction of Elevated Temperature Components," American Power Conference Proceedings, Volume 57 - III, 57th Annual Meeting, 1995 Chicago, IL, pp 1798 - 1821.

T.L. Starr

1. "Low Voltage Energy Dispersive X-ray Light Element Analysis of Ceramic Materials and Coatings," The Micorbeam Analysis Journal, 3:31-40 (1994), G.B. Freeman, T.L. Starr, W.J. Lackey and J.A. Hanigofsky.

2. "The Topology of Percolating Porosity in Woven Fiber Ceramic Matrix Composites," Applied

Composite Materials 1:325-331 (1994), J.H. Kinney, C. Henry, D.L. Haupt and T.L. Starr.

3. "Gas Transport Model for Chemical Vapor Infiltration," Journal of Materials Research, J. Materials Research 10(9) 1-7 (1995), T.L. Starr.

4. "Strength and Toughness of Slip-cast Fused Silica Composites", J. American Ceramic Society 77 (6) 1673-1675 (1994), J.S. Lyons and T.L. Starr.

5. "Scale-Up and Modeling of Forced Chemical Vapor Infiltration," Ceramic Engineering & Science Proceedings 15 (5) 897-907, T.M. Besmann, J.C. McLaughlin and T.L. Starr.

6. "Modeling of Chemical Vapor Infiltration for Ceramic and Carbon Matrix Composites," pp. 149-164, in Research in Structural Carbons, M.A. Wright and K.R. Palmer, eds., Southern Illinois University (Carbondale, IL., 1994), T.L. Starr and A.W. Smith.

C. Ume

1. Chia-Yu Fu and Charles Ume, "Characterizing the Temperature Dependence of Electronic-Packing Materials Properties," JOM, Vol. 47, No. 6, June, 1995, pp. 31-35.

2. Chiu-Ching Tsang, Michael Stiteler and Charles Ume, "Real-Time Measurement of Printed Wiring Board Flatness in a Simulated Manufacturing Environment," ASME InterPack '95, Hawaii, March, 1995.

APPENDIX C

Presentations

A. Gokhale

1. A.M. Gokhale, N.U. Deshpande, and D.K. Denzer: "Characterization of Fracture Path and its Relationship to Microstructure in Wrought Aluminum Alloy 7050", 4th International Conference on Aluminum Alloys, Atlanta, GA., September 12-16, 1994.

2. Pascal LOUIS and M. Gokhale: "Quantitative Characterization of Spatial Arrangement of Fibers/Particles in Composite Materials", International Symposium on High Performance Composites: Commonality of Phenomena, Organized by TMS, Rosemont, IL., October 2-6, 1994.

3. A.T. Joenes, A.M. Gokhale, and S.P. Bhat: "Relationship Between Microstructure and Fatigue Response of SAE 10B20 Steel", Fall Technical Meeting of TMS, Rosemont, IL., October 2-6, 1994.

4. A.M. Gokhale and N.U. Deshpande, "Characterization of Fracture Path in a Wrought Aluminum Alloy", The Fall Technical Meeting of TMS, Rosemont, IL., October 2-6, 1994.

5. A.M. Gokhale: "Estimation of Bivariate Size and Orientation Distribution of Microcracks From Vertical Sections", 4th International Conference on Sterology and Image Analysis in Materials Science, Baskidy Mountains, Poland, October 3-6, 1994 (Invited paper).

6. A.M. Gokhale and N.U. Deshpande: "Applications of Location Specific Quantitative Fractography", 4th International Conference Stereology and Image Analysis in Materials Science, Baskidy Mountains, Poland, October 3-6, 1994 (Invited paper).

7. A.M. Gokhale: "Quantitative Characterization of Microstructural Damage Evolution in Composites", NSF Workshop on Processing and Constitutive Modelling of Advanced Engineered Materials-II, Lake Lanier Islands, GA., October 24-26, 1994 (Invited paper).

8. A.M. Gokhale: "Characterization of Spatial Arrangement of Features in Microstructure: Applications to Quantify the Role of Gravity in Microstructural Evolution", Seminar at NASA Lewis Research Center, Cleveland, OH, January 11, 1995.

9. N.U. Deshpande and A.M. Gokhale: "Quantitative Fractographic Evaluation of the Fracture Surfaces of Aluminum Alloy 7050", Symposium on Light Weight Alloys for Aerospace Applications, Annual Technical Meeting of TMS, Las Vegas, Nevada, February 13-16, 1995.

J. Hampikian

1. "Combustion Chemical Vapor Deposition of Protective Coatings", United Technologies Research Center, East Harford, July 19, 1994 (one hour seminar).

2. "Ion Implantation of Co-Cr and Ni-Cr Alloys", presented at High Temperature Coatings I Symposium, Metallic and Composite Coatings session, Materials Week, Rosemont IL, October 6, 1994 (technical presentation).

3. "The Effects of Aluminum Ion Implantation on the Oxidation of Group Vb Metals," presented at the David L. Douglass Symposium on High Temperature Corrosion, Annual Meeting of the Electrochemical Society, Miami Beach, FL, October 9-14, 1994 (technical presentation).

4. "CCVD of Thermal Barrier Coatings", Schenectady, New York, General Electric Power Generation, December 7, 1994 (2 hour seminar).

5. ATS annual program review meeting: "Combustion Chemical Vapor Deposited Coatings for Thermal Barrier Coating Systems," W.B. Carter, J.M. Hampikian, M.R. Hendrick and T.A. Polley, poster presentation.

6. "Thermal Cycling Behavior of Combustion Chemical Vapor Deposited Oxide Coatings", W.B. Carter, S. Godfrey, T. Polley and J.M. Hampikian, February, 1995, Las Vegas, Nevada.

W.S. Johnson

1. Johnson, W.S., Mirdamadi, M., Bakuckas, J. G., Jr., "Damage Accumulation in Titanium Matrix Composites Under Generic Hypersonic Vehicle Flight Simulation and Sustained Loads," ASTM Symposium *Thermo-Mechanical Fatigue of Materials*, Phoenix, AZ, November, 1994.

2. Johnson, W.S., Miller, J.L., Mirdamadi, M., "Fractographic Interpretation of Failure Mechanisms in Titanium Matrix Composites", *TMS Annual Meeting*, Chicago, October 1994, (Keynote speaker)

3. Johnson, W.S., "Constituent Level Modeling of TMF Stress-Strain Response in Titanium Matrix Composites," Workshop on Processing and Constitutive Modeling of Advanced Engineering Materials II, Laker Lanier Islands, GA, October, 1994.

4. Johnson, W.S., "Observations of Damage Development in Titanium Matrix Composites," Invited presentation to the Prager Award Symposium of SES, College Station TX, October, 1994.

5. Johnson, W.S., "Approach for Assessing Mechanical Durability of Polymeric- Based Systems: Resins, Composites and Joints," International Conference on Progress in Durability Analysis of Composite Systems, Brussels, July 1995.

D.L. McDowell

1. McDowell, D.L., "Challenges in Modelling Nonproportional Cyclic Material Behavior," NSF Workshop on the Mechanics and Materials Science of Contact: Issues and Opportunities," Vanderbilt University, July 18-20, 1994.

2. Lacy, T.E., Willice, P.A., McDowell, D.L. and Talreja, R., "Representative Volume Element (RVE) Averaging Concepts for Damage Evolution," Symposium on Mechanics of Damage in Composites, Society of Engineering Science 31st Annual Technical Meeting, College Station, TX, Oct. 10-12, 1994.

3. Saxena, A. and McDowell, D.L., "Crack Growth in Creep-Brittle Light Alloys at Elevated Temperature,"NSF Workshop on Processing and Constitutive Modelling of Advanced Engineered Materials II, Lake Lanier Islands, GA, October 24-26, 1994.

4. McDowell, D.L., "Continuum Damage Mechanics (CDM) in Fracture and Fatigue," ASTM Spring Meeting, E.08 Subcommittee Research, Phoenix, Az, Nov. 15, 1994.

5. McDowell, D.L., "Mechanics-Related High Cycle Fatigue Research Issues," invited presentation, AFOSR Workshop on Basic Research Issues in the Materials and Mechanics of HCF, Dayton, OH, June 7, 1995.

6. McDowell, D.L., "Multiaxial Effects in Metallic Materials," Cornell University, Sibley School of Mechanical Engineering, February 14, 1995.

7. McDowell, D.L., "Anisotropy and Compressibility Effects of FCC Polycrystals at Large Strain," Georgia Tech Institute-Wide Materials Seminar Series, April 18, 1995.

8. McDowell, D.L., "Multiaxial Effects on the Evolving Internal State of Metallic Materials," Florida State University, College of Engineering, April 25, 1995.

9. McDowell, D.L., "Multiaxial Effects on the Evolving Internal State of Metallic Materials," University of Nebraska-Lincoln, Dept. of Engineering Science and Mechanics, July 25, 1995.

R.W. Neu

1. Neu, R., "TMF Life and Damage Mechanism Maps for Titanium Matrix Composites," proc. Int. Symp. on Fatigue Under Thermal and Mechanical Loading, Petten (N.H.), The Netherlands, May 22-24, 1995.

2. Neu, R., "TMF Damage-Mechanism and Life Maps for [0/90] TMCs," ASME Joint Applied Mechanics and Materials Summer Conf., UCLA, June 28-30, 1995.

B. Park

1. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds by Ion Implantation," TMS Fall Meeting Materials Week Conference, Rosemont, IL, October 1994.

2. B. Park, C. Uslu, D.H. Lee, and D.B. Poker, "Synthesis of Metastable Carbon- Silicon-Nitrogen Compounds by Ion Implantation," TMS Annual Meeting, Las Vegas, NV, February 1995.

3. B. Park, " Synthesis of Metastable Superhard Materials," The 6th Korean- American Scientists and Engineers Association (KSEA) Northeast Regional Conference, Rutgers University, New Brunswick, NJ, March 1995.

4. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds," Journal Club, School of Physics, Georgia Institute of Technology, Atlanta, GA May 1995.

5. B. Park, "Kinetics of Phase Transformations," Department of Metallurgical Engineering Seminar, Seoul National University, Seoul, Korea, June 1995.

6. B. Park, "Kinetics of Phase Transformations," Department of Inorganic Materials Engineering Seminar, Hanyang University, Seoul, Korea, June 1995.

7. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds," New Materials Laboratory Seminar, Samsung Advanced Institute of Technology, Suwon, Korea, June 1995.

8. B. Park, "Kinetics of Phase Transformations," Devices and Materials Laboratory Seminar, LG Electronics Research Center, Seoul, Korea, June 1995.

9. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds," Materials Science and Metallurgy Seminar, Columbia University, New Yor, NY, July 1995.

Contributed Presentations:

1. C. Collins, N.N. Thadhani, B. Park, K. Barefield, and Z. Iqbal, "Shock Compression of Carbon Nitrogen Precursors for Synthesis of Super-Hard Materials," TMS Fall Meeting Materials Week Conference, Rosemont, IL, October 1994.

2. C. Uslu, B. Park and D.B. Poker, "Synthesis and Characterization of a Metastable $(SiC)_3N_4$ Phase," Materials Research Society Fall Meeting, Boston, MA, December 1994.

3. D.H. Lee, B. Park and D.B. Poker, "Synthesis of Carbon-Nitrogen Compounds by Nitrogen Ion Implantation into Defective Graphite," Materials Research Society Fall Meeting, Boston, MA, December 1994.

4. B. Park, C. Uslu, D.H. Lee, and D.B. Poker, "Formation of Metastable Carbon-Silicon Nitride

by Nitrogen Implantation," The Twelfth International Conference on Ion Beam Analysis, Arizona State University, Tempe, AZ, May 1995.

5. B. Park, "Synthesis of Metastable Carbon-Silicon-Nitrogen Compounds," The Second Pacific Rim International Conference on Advanced Materials and Processing, The Korean Institute of Metals and Materials, Kyongju, Korea, June 1995.

T.H. Sanders

1. ICEM, International Conference on Electron Microscopy, July 17-22, 1994, Paris, France
"Icosohedral Phases in the Al-Fe-Mn-Si System", with P. Donnadieu and G. Lapasset.

2. The Fourth International Conference on Aluminum Alloys - Their Physical and Mechanical Properties, September 11-16, 1994, Atlanta, Georgia
"Quench and Impurity Modifications in Al-Si Eutectics", with R. Napolitano.
"Alpha-phase Particles in 6XXX Aluminum Alloys" with P. Donnadieu, G. Lapasset and B. Thanaboonsombut.
"Recrystallization Behavior of 6XXX", with B. Thanaboonsombut.
"Modeling Recrystallization in Commercial Heat Treatable Aluminum Alloys".

3. MRS - November, 1994, Boston, MA
"Fabrication and Properties of Hollow Sphere Nickel Foams", R.B. Clancy and J.K. Cochran.

4. Second International Conference on Heat Resistant Materials, Gatlinburg, TN, September 11-14, 1995
"A Study on the Dendritic Growth of Gamma Prime in Astroloy", with M. Macia.

A. Saxena

1. A. Saxena, "Life Prediction Methods in High Temperature Petro-Chemical Plants," seminar presented at IPT, Sao Paulo, Brazil, Aug 1994.

2. B. C. Hamilton and A. Saxena, "Creep Crack Growth in Alloy 2519," ASTM Task Group E.08.06.05, Phoenix, AZ, Nov. 1994.

3. A. Saxena and K. Jones, "Creep Crack Growth in Rapidly Solidified Al Alloy 8009," Fourth International Conference on Al Alloys, Atlanta, Sept. 1993.

4. B. C. Hamilton and A. Saxena, "Elevated Temperature Crack Growth in Al-Alloys," Fourth International Conference on Al Alloys, Atlanta, Sept. 1993.

5. A. Saxena and P. S. Grover (invited keynote), "Developments in Elevated Temperature Crack Growth Testing," Tenth European Conference on Fracture, Berlin, Sept. 1994.

6. A. Saxena and D. L. McDowell, "Elevated Temperature Cracking in Creep-Brittle Materials," NSF Workshop on Mechanics and Processing Interfaces, Lake Lanier Island, Ga, Oct. 1994.

7. A. Saxena (invited keynote), "Mechanics and Mechanisms of Cracking in High Temperature Brittle Materials,"TMS Symposium on High Temperature Performance of Advanced Materials, Chicago, IL, Oct. 1994.

8. B. C. Hamilton, D. E. Hall, A. Saxena and D. L. McDowell, "Creep Crack Growth Behavior of Aluminum Alloy 2519: Part I - Experimental Analysis," 27th ASTM National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 29, 1995.

9. Fan Yang, A. Saxena and T. L. Starr, "Fracture Mechanisms in Unidirectional SiC/Si_3N_4 Composite at Elevated Temperature," 27th ASTM National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 29, 1995.

C. Ume

1. Ume, Charles and Michael Stiteler, "Application of Shadow Moiré Techniques for Assessment of PWA Flatness in Real-Time," 1995 SEM Spring Conference, Grand Rapids, Michigan, June 12-14.

APPENDIX D

Funding

A. Gokhale

Title: Quantitative Analysis of Fracture Surfaces Using Stereological Methods
Sponsor: NSF
Annual Funding: $74,000

Title: Evolution of Microstructural Distance Distributions in Normal Gravity and Microgravity
Sponsor: NASA
Annual Funding: $50,000

Title: Quantitative Fractography of Fracture Toughness Test Specimens
Sponsor: ALCOA
Annual Funding: $16,000

Title: Quantitative microstructure-properties studies in steels
Sponsor: Southern Saw Svcs.
Annual Funding: $25,000

Title: Microstructure-properties correlations research in steels
Sponsor: Inland Steel
Annual Funding: $5,000

J. Hampikian

Title: Combustion Chemical Vapor Deposition of Thermal Barrier Coatings
Sponsor: Advanced Turbine Systems, Advanced Gas Turbine Systems Research Program, through DOE (Co-PI B. Carter)
Annual Funding: $155K

Title: The Effects of Zr^+, Mg^+, Y^+ Ion Implantation on Si and Al_2O_3 Substrate-Superconductor Interfaces
Sponsor: The Engineering Foundation Research Initiation Awards Program (ERIA).
Annual Funding: $23K

W.S. Johnson

Title: Fatigue Behavior of Hybrid Titanium Composite Laminates
Sponsor: NASA/CAU HiPPAC
Annual Funding: $50K

Title: Fracture Mechanics Applications to the Durability of Bonded Composite Joints
Sponsor: FAA/Air Force
Annual Funding: $75K

Title: Creep Bearing Behavior in Highly Loaded Bolted Joints
Sponsor: Lockheed/NASA
Annual Funding: $50K

Title: Crack Initiation, Growth, and Detection under Simulated Rotorcraft Specturm Loading
Sponsor: ONR
PI: Ward Winer
Annual Funding: $50K

D.L. McDowell

Title: A Critical Study of Constitutive Relations for Finite Strain Inelasticity
Sponsor: ARO
Annual Funding: $20,000

Title: Crack Growth in Creep Brittle Materials
Sponsor: NSF (co-PI A. Saxena)
Annual Funding: $60,000

Title: A Critical Study of Constitutive Relations for Finite Strain Inelasticity
Sponsor: ARO AASERT Award Proposal
Annual Funding: $28,000

Title: Processing, Constitutive Behavior and Damage in Advanced Engineering Materials: Workshop
Sponsor: NSF (Co-PI with S.D. Antolovich, Wash. State Univ.)
Annual Funding: $25,000

Title: Damage Evolution in High Temperature Composites
Sponsor: NASA Graduate Student Researchers Program (Mr. T. Lacy)
Annual Funding: $22,000

Title: Cyclic Multiaxial Behavior of Shape Memory Alloys
Sponsor: NSF
Annual Funding: $56,000

Title: Internal State Variable Models for Rate and Temperature History Dependent Behavior at Finite Strain
Sponsor: ARO
Annual Funding: $22,000

Title: Equipment for a Laboratory Course on Mechanical Reliability of Microelectronic Devices
Sponsor: NSF (Co-PIs J. Qu and S. Danyluk, ME)
Annual Funding: $29,291

Title: Damage Coupled Thermal Response of Ceramic Matrix Composites
Sponsor: United Technologies Fellowship (Mr. S. Graham)
Annual Funding: $35,000

Title: ERC in Low Cost Electronic Packaging
Sponsor: NSF
PI: R. Tummala, ECE
Annual Funding: $12,000

Title: Integrated Diagnostics
PI: W.O. Winer, ME
Sponsor: ONR
Annual Funding: $22,000

B. Park

Title: "Mechanisms of Shock-Initiated Intermetallic Reactions"
Sponsor: Office of Naval Research (ONR) (Co-PI N.N. Thadhani)
Annual Funding: $124,835 (12/93-11/94)

Title: "Surface Modification of Nitinol Root Canal Files by Ion-Beam Techniques"
Sponsor: Tulsa Dental Company (Co-PI A. Saxena)
Annual Funding: $5K (6/94-6/95)

Title: "Microstructural Characterization of Shock-Compressed Materials"
Sponsor: Sandia National Laboratory (Co-PI N.N. Thadhani)
Annual Funding: $25K (6/94-9/95)

Title: "Synthesis of Metastable Carbon-Silicon Nitride by Non-Equilibrium Processing"
Sponsor: Department of Energy (DOE) - Southeastern Universities Research Association
Annual Funding: $6K (5/95-9/95)

A. Saxena

Title: "Integrated Diagnostics"
Sponsor: ONR
PI: W.O. Winer
Annual Funding: $40,000

Title: Creep Crack Growth in Cro-Mo Steel Weldments
Sponsor: Welding Research Council
Annual Funding: $15,000

Title: Life Assessment Methods for Repair Welded Components
Sponsor: EPRI
Annual Funding: $80,000

Title: Creep Crack Growth in Al Alloy 2519
Sponsor: NASA
Annual Funding: $22,000

Title: Creep and Creep-Fatigue Crack Growth in HSCT Materials
Sponsor: NASA
Annual Funding: $58,000

Title: Near Threshold Fatigue Crack Growth Behavior of Alloy 6415
Sponsor: Lockheed
Annual Funding:$75,000

Title: NSF Graduate Traineeship in Composites
Sponsor: NSF
Co-PI: Ueng
Annual Funding: $110,000

T.L. Starr

Title: Transport Properties of Ceramic Composites
Sponsor: DOE
Annual Funding: $140,000

Title: Modeling of Fibrous Preforms for CVD Infiltration
Sponsor: DOE
Annual Funding: $42,000

Title: Characterization of CVI
Sponsor: DOE
Annual Funding: $55,000

Title: Review of Gas Permeability Estimation Methods
Sponsor: Materials Science Corp.
Annual Funding: $16,000

APPENDIX E

Major Honors and Awards

A.M. Gokhale

1. Invited to give Keynote lecture in the 9th International Congress for Stereology, scheduled in August, 1995, at Copenhagen, Denmark.

2. To be listed in the 5th edition of Marquis Whos' Who in American Education (1996-97).

3. Vice-President of International Society for Stereology

J. Hampikian

1. Certificate of recognition and appreciation for outstanding service as an organizer for the symposium entitled "High Temperature Coatings I", held in Rosemont, IL during Materials Week, Oct. 2-6, 1994, presented by the Minerals, Metals and Materials Society (TMS).

W.C. Hutton

1. The Scoliosis Research Society (1994): Russell S. Hibbs Award. Experimental Spine Fusion with Recombinant Human BMP.

2. The North American Spine Society (1994): Outstanding Paper Award.

3. The Volvo Prize on Back Pain Research (1995): The Use of Osteoinductive Growth Factor for Lumbar Spinal Fusion.

D.L. McDowell

1. Woodruff Fellow, Woodruff School of Mechanical Engineering, Georgia Tech, 1991-1996.

2. Institute Fellow, Georgia Tech, 1994-1999.

3. Appointed as Member of U.S. National Committee on Theoretical and Applied Mechanics, administered by the National Research Council (ASTM Representative), 1994-present.

T.H. Sanders, Jr.

1. Distinguished Lecturer, International Mettalographic Society, July 1994.

2. Elected Fellow of ASM

3. Ph.D. student Mr. Ralph E. Napolitano won one of the best paper awards for the 1995 Georgia Tech Student Paper Competition sponsored by SAIC. The award was based on his M.S. thesis research "Quench and Impurity Modifications in Al-Si Eutectics".

A. Saxena

1. ASTM Award of Merit and election to Society Fellow, July 1995.

2. Sigma Xi Award for contribution as adviser to the Best M.S. Thesis award winner (B. C. Hamilton).

3. Commendation for service as co-organizer of the 27th ASTM National Symposium on Fatigue and Fracture, Williamsburg, VA, June 26 - 29, 1995.

C. Ume

1. Elected Senior Member of IEEE Society