

U.S. DEPARTMENT OF ENERGY
FOSSIL ENERGY
ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT

PUBLICATIONS
OF THE
FOSSIL ENERGY
ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT
MATERIALS PROGRAM

April 1, 1993, through March 31, 1995

Compiled by

Paul T. Carlson

April 1995

Prepared for
U.S. Department of Energy
Office of Fossil Energy
Advanced Research and Technology Development Materials Program
AA 15 10 10 0

by

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

PREVIOUS REPORTS IN THIS SERIES

P. T. Carlson, *Fossil Energy Materials Program Consolidated Bibliography of Publications, October 1, 1979, through April 30, 1986*, ORNL/FMP-86/5, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., August 1986.

P. T. Carlson, *Fossil Energy Materials Program Consolidated Bibliography of Publications, October 1, 1979, through April 30, 1987*, ORNL/FMP-87/3, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., September 1987.

P. T. Carlson, *Fossil Energy Materials Program Consolidated Bibliography of Publications, May 1, 1987, through May 31, 1989*, ORNL/FMP-89/3, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., June 1989.

P. T. Carlson, *Publications of the Fossil Energy Advanced Research and Technology Development Materials Program, June 1, 1989, through March 31, 1991*, ORNL/FMP-91/3, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., June 1991.

Paul T. Carlson, *Publications of the Fossil Energy Advanced Research and Technology Development Materials Program, April 1, 1991, through March 31, 1993*, ORNL/FMP-93/3, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., June 1993.

CONTENTS

1. INTRODUCTION	1
2. PROGRAM DEVELOPMENT AND TECHNOLOGY TRANSFER	3
2.1 GENERAL PROGRAM	3
2.1.1 Papers in Conference Proceedings	3
3. METALS AND ALLOYS	5
3.1 ALLOY DEVELOPMENT	5
3.1.1 Open Literature Publications	5
3.1.2 Papers in Conference Proceedings	5
3.2 MECHANICAL PROPERTIES	8
3.2.1 Open Literature Publications	8
3.2.2 Papers in Conference Proceedings	8
3.3 JOINING	9
3.3.1 Open Literature Publications	9
3.3.2 Topical Reports	10
3.3.3 Papers in Conference Proceedings	10
3.4 COATINGS DEVELOPMENT	11
3.4.1 Open Literature Publications	11
3.4.2 Topical Reports	12
3.4.3 Papers in Conference Proceedings	12
3.5 CORROSION AND ENVIRONMENTAL EFFECTS	12
3.5.1 Open Literature Publications	12
3.5.2 Topical Reports	13
3.5.3 Papers in Conference Proceedings	13
3.5.4 Books and Book Articles	14
4. CERAMICS	15
4.1 FIBER-REINFORCED COMPOSITES	15
4.1.1 Open Literature Publications	15
4.1.2 Topical Reports	15
4.1.3 Papers in Conference Proceedings	15
4.1.4 Books and Book Articles	17

Contents

4.2	MECHANICAL BEHAVIOR	17
4.2.1	Open Literature Publications	17
4.2.2	Topical Reports	18
4.2.3	Papers in Conference Proceedings	18
4.2.4	Books and Book Articles	19
4.3	JOINING	19
4.3.1	Open Literature Publications	19
4.3.2	Books and Book Articles	19
4.4	SOLID STATE ELECTROLYTE SYSTEMS	19
4.4.1	Open Literature Publications	19
4.4.2	Papers in Conference Proceedings	20
4.5	CERAMIC FILTERS	21
4.5.1	Open Literature Publications	21
4.5.2	Papers in Conference Proceedings	22
4.6	CERAMIC MEMBRANES	22
4.6.1	Open Literature Publications	22
4.6.2	Papers in Conference Proceedings	22
4.7	CERAMIC CATALYST MATERIALS	23
4.7.1	Open Literature Publications	23
4.7.2	Papers in Conference Proceedings	23
4.7.3	Books and Book Articles	23
4.8	NEW MATERIALS PROCESSES	24
4.8.1	Open Literature Publications	24
4.8.2	Topical Reports	24
4.8.3	Papers in Conference Proceedings	24
	INDEX	25

**PUBLICATIONS OF THE FOSSIL ENERGY
ADVANCED RESEARCH AND TECHNOLOGY DEVELOPMENT
MATERIALS PROGRAM**

April 1, 1993, through March 31, 1995

Compiled by
Paul T. Carlson

1. INTRODUCTION

The objective of the Fossil Energy Advanced Research and Technology Development (AR&TD) Materials Program¹ is to conduct research and development on materials for fossil energy applications, with a focus on the longer-term needs for materials with general applicability to the various fossil fuel technologies. The Program includes research aimed at a better understanding of materials behavior in fossil energy environments and on the development of new materials capable of substantial improvement in plant operations and reliability. The scope of the Program addresses materials requirements for all fossil energy systems, including materials for coal preparation, coal liquefaction, coal gasification, heat engines and heat recovery, combustion systems, and fuel cells. Work on the Program is conducted at national and government laboratories, universities, and industrial research facilities.

This bibliography covers the period of April 1, 1993, through March 31, 1995, and is a supplement to previous bibliographies in this series (see page iii).

It is the intent of this series of bibliographies to list only those publications that can be conveniently obtained by a researcher through relatively normal channels. The publications listed in this document have been limited to topical reports, open literature publications in refereed journals, full-length papers in published proceedings of conferences, full-length papers in unrefereed journals, and books and book articles. Oral presentations, periodic progress reports, management reports, letter reports, abstracts, and summaries have not been included.

¹Research sponsored by the U.S. Department of Energy, Office of Fossil Energy, AR&TD Materials Program [DOE/FE AA 15 10 10 0, Work Breakdown Structure Element ORNL-5(A)], under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

2. PROGRAM DEVELOPMENT AND TECHNOLOGY TRANSFER

2.1 GENERAL PROGRAM

2.1.1 Papers in Conference Proceedings

N. C. Cole and R. R. Judkins, comp., *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF 9305135, ORNL/FMP-93/1, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., July 1993.

N. C. Cole and R. R. Judkins, comp., *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF 9405143, ORNL/FMP-94/1, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., Oak Ridge, Tenn., August 1994.

R. R. Judkins, "The DOE Fossil Energy Advanced Research and Technology Development (AR&TD) Materials Program," in *Proceedings of the Fourth AIST-NEDO/DOE-HQ Joint Technical Meeting on Materials for Coal Liquefaction, San Francisco, California, October 12-14, 1992*, U.S. DOE, Pittsburgh Energy Technology Center, Pittsburgh, 1992.

R. R. Judkins, "Overview of the Fossil Energy Materials Program," in *Proceedings of the Fifth AIST-NEDO/DOE-HQ Joint Technical Meeting on Materials for Coal Liquefaction, Toya, Hokkaido, Japan, January 17-19, 1994*, Agency of Industrial Science and Technology-New Energy and Industrial Technology Development Organization, Tokyo, 1994.

3. METALS AND ALLOYS

3.1 ALLOY DEVELOPMENT

3.1.1 Open Literature Publications

B. G. Gieseke, D. J. Alexander, V. K. Sikka, and R. H. Baldwin, "Mechanical Properties of Ductile Fe₃Al-Based Plates," *Scr. Metall. Mater.* **29**, 129-34 (1993).

J. R. Knibloe, R. N. Wright, C. L. Trybus, and V. K. Sikka, "Microstructure and Mechanical Properties of Fe₃Al Alloys with Chromium," *J. Mater. Sci.* **28**, 2040-48 (1993).

C. G. McKamey, P. J. Maziasz, G. M. Goodwin, and T. Zacharia, "Effects of Alloying Additions on the Microstructures, Mechanical Properties, and Weldability of Fe₃Al-Based Alloys," *Mater. Sci. Eng. A* **174**, 59-70 (1994).

C. G. McKamey and D. H. Pierce, "Effect of Recrystallization on Room Temperature Tensile Properties of a Fe₃Al-Based Alloy," *Scr. Metall. Mater.* **28**, 1173-76 (1993).

V. K. Sikka, S. Viswanathan, and C. G. McKamey, "Development and Commercialization Status of Fe₃Al-Based Intermetallic Alloys," *J. Mater. Eng. Perf.* **2**(4), 505-10 (August 1993).

S. Viswanathan, B. R. Shelton, J. K. Wright, and V. K. Sikka, "Effect of Thermomechanical Processing on the Room-Temperature Tensile Properties of an Fe₃Al-Based Alloy," *Scr. Metall. Mater.* **29**, 589-94 (1993).

J. R. Woodyard and V. K. Sikka, "Effect of Aluminum Content on Environmental Embrittlement in Binary Iron-Aluminum Alloys - Acoustic Emission Analysis," *Scr. Metall. Mater.* **29**, 1489-93 (1993).

3.1.2 Papers in Conference Proceedings

D. J. Alexander and V. K. Sikka, "Mechanical Properties of Iron-Aluminum Alloys," pp. 219-28 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 11-13, 1993, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

R. R. Judkins, "Development of Iron Aluminides for Coal Conversion and Utilization," pp. 61-72 in *Proceedings of the Third AIST-NEDO/DOE PETC Joint Technical Meeting on Materials for Coal Liquefaction*, Fukuoka City, Kyusu, Japan, October 23, 1991, Agency of Industrial Science and Technology-New Energy and Industrial Technology Development Organization, Tokyo, 1991.

C. T. Liu, E. P. George, and C. G. McKamey, "Current Status of Research and Development on Nickel and Iron Aluminides," pp. 1147-58 in *Proceedings Japan International Symposium on Intermetallic Compounds for High-Temperature Structural Applications, Chiba, Japan, December 7-10, 1993*, ed. M. Yamaguchi and H. Fukutomi, Society for the Advancement of Material and Process Engineering, Tokyo, 1994.

P. J. Maziasz, C. G. McKamey, B. O. Cavin, C. R. Hubbard, and T. Zacharia, "Some Effects of Composition and Microstructure on the B2-D0₃ Ordered Phase Transition in Fe₃Al Alloys," pp. 209-15 in *High Temperature Ordered Intermetallics V*, proceedings of symposium held at Boston, Massachusetts, November 30 -December 2, 1992, Vol. 288, ed. I. Baker, J. D. Whittenberger, R. Darolia, and M. H. Yoo, Materials Research Society, Pittsburgh, 1993.

C. G. McKamey and P. J. Maziasz, "Effect of Alloying Additions and Microstructure on Creep-Rupture Properties of Fe₃Al-Based Alloys," pp. 147-58 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

C. G. McKamey and P. J. Maziasz, "Effect of Alloying Additions and Microstructure on Creep-rupture Properties of Fe₃Al-Based Alloys," pp. 169-83 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

C. G. McKamey, V. K. Sikka, and G. M. Goodwin, "Development of Ductile Fe₃Al-Based Aluminides," pp. 161-70 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

C. G. McKamey and E. H. Lee, "Measurement of the Critical Level of Moisture for Initiation of Water-Vapor-Induced Environmental Embrittlement in Fe₃Al-Based Alloys," pp. 983-88 in *High Temperature Ordered Intermetallics V*, proceedings of symposium held at Boston, Massachusetts, November 30 -December 2, 1992, Vol. 288, ed. I. Baker, J. D. Whittenberger, R. Darolia, and M. H. Yoo, Materials Research Society, Pittsburgh, 1993.

S. Schoenfeld, B. K. Kad, R. Asaro, and C. G. McKamey, "Hot Deformation Simulations in FeAl/Fe₃Al Alloys: Identifying Ideal Deformation Paths," pp. 39-46 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

V. K. Sikka, "Processing and Applications of Iron Aluminides," pp. 3-13 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

V. K. Sikka, S. Viswanathan, and C. G. McKamey, "Development and Commercialization Status of Fe₃Al-Based Intermetallic Alloys," pp. 483-91 in *Structural Intermetallics*, Champion, Pennsylvania, September 26-30, 1993, ed. R. Darolia, J. J. Lewandowski, C. T. Liu, P. L. Martin, D. B. Miracle, and M. V. Nathal, The Metallurgical Society, Warrendale, Pa., 1994.

V. K. Sikka, "Development of Nickel and Iron Aluminides and Their Applications," pp. 282-95 in *Advances in High Temperature Structural Materials and Protective Coatings*, ed. A. K. Koul, V. R. Parameswaran, J. P. Immarrigeon, W. Wallace, National Research Council of Canada, Ottawa, Canada, 1994.

V. K. Sikka, R. H. Baldwin and C. R. Howell, "Low-Aluminum Content Iron-Aluminum Alloys," p. 197-208 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 11-13, 1993, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

V. K. Sikka, "Low-Aluminum Content Iron-Aluminum Alloys," pp. 261-78 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 10-12, 1994, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

V. K. Sikka, S. Viswanathan, and S. Vyas, "Acceptable Aluminum Additions for Minimal Environmental Effect in Iron Aluminides," pp. 971-76 in *High Temperature Ordered Intermetallics V*, proceedings of symposium held at Boston, Massachusetts, November 30 - December 2, 1992, Vol. 288, ed. I. Baker, J. D. Whittenberger, R. Darolia, and M. H. Yoo, Materials Research Society, Pittsburgh, 1993.

M. N. Srinivasan and V. K. Sikka, "Tensile Properties of a Mechanically Alloyed Fe₃Al-Based Alloy," pp. 69-78 in *Processing, Properties, and Applications of Iron Aluminides*, San Francisco, California, February 27 - March 3, 1994, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

S. Viswanathan, C. G. McKamey, P. J. Maziasz, and V. K. Sikka, "Tensile Properties of As-Cast Iron-Aluminide Alloys," pp. 171-80 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 11-13, 1993, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

S. Viswanathan, C. G. McKamey, P. J. Maziasz, and V. K. Sikka, "Microstructures and Tensile Properties of As-Cast Iron Aluminide Alloys," pp. 159-69 in *Processing, Properties, and Applications of Iron Aluminides*, San Francisco, California, February 27 - March 3, 1994, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

S. Viswanathan, C. G. McKamey, and P. J. Maziasz, "Tensile Properties of As-Cast Fe₃Al-Based Alloys," pp. 195-204 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

3.2 MECHANICAL PROPERTIES

3.2.1 Open Literature Publications

C. A. Clark, R. N. Wright, J. K. Wright, and B. H. Rabin, "Elevated Temperature Mechanical Properties of Reaction Synthesized Fe₃Al," to be published in *Scr. Metall. Mater.* (1995).

T. A. Hyde, C. H. Sellers, J. K. Wright, and R. N. Wright, "Electrical Resistance Analysis of the DO₃-B2 Transition in Alloys of Fe₃Al," *Scr. Metall. Mater.* **30**(1), 113-18 (1994).

J. R. Knibloe, R. N. Wright, C. L. Trybus, and V. K. Sikka, "Microstructure and Mechanical Properties of Fe₃Al Alloys with Cr," *J. Mater. Sci.* **28**, 2040-2048 (1993).

B. H. Rabin, R. N. Wright, J. K. Wright, and C. H. Sellers, "Grain Growth Behavior of Fe₃Al Fabricated by Different Methods," *J. Mater. Res.* **9**(6), 1384-91 (June 1994).

C. H. Sellers, T. A. Hyde, T. O'Brien, and R. N. Wright, "Phase Transformations in Fe₃Al + Ti Alloys," *J. Phys. Chem. Solids* **55**, 505-15 (1994).

S. Viswanathan, B. R. Shelton, J. K. Wright and V. K. Sikka, "Effect of Thermomechanical Processing on the Room-Temperature Properties of An Fe₃Al-Based Alloy," *Scr. Metall. Mater.* **29**(5), 589-94 (1993).

3.2.2 Papers in Conference Proceedings

J. A. Cook, P. K. Liaw, and C. T. Liu, "Fracture Characteristics of Cr₂Nb-based Intermetallics," to be published in *Proceedings of the TMS Symposium on Fatigue and Fracture of Ordered Intermetallics, Rosemont, Illinois, October 2-6, 1994*, The Metallurgical Society, Warrendale, Pa., 1995.

J. A. Cook, P. K. Liaw, and C. T. Liu, "Fracture Behavior of Cr₂Nb-based Intermetallics," pp. 401-12 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

M. L. Johnson, D. E. Mikkola, and R. N. Wright, "Influence of Alloying on Abrasive Wear and Cavitation Erosion Behavior of Fe_3Al -Based Alloys," pp. 311-25 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

J. K. Wright and R. N. Wright, "Processing Iron Aluminides by Reaction Synthesis," pp. 47-57 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

R. N. Wright and J. K. Wright, "The Influence of Processing on Microstructure and Properties of Iron Aluminides," pp. 279-86 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

J. K. Wright and R. N. Wright, "The Influence of Thermomechanical Processing on Microstructure and Properties of Iron Aluminides," pp. 209-18 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

R. N. Wright, J. R. Fincke, D. W. Swank, D. C. Haggard, and C. R. Clark, "The Influence of Processing Parameters on Microstructure and Properties of Fe_3Al -Based Coatings," to be published in *Proceedings of the TMS Symposium on High-Temperature Coatings, Rosemont, Illinois, October 2-6, 1994*, The Metallurgical Society, Warrendale, Pa., 1995.

R. N. Wright, J. K. Wright, C. H. Sellers, T. A. Hyde, and T. K. O'Brien, "Phase Transformations in Fe_3Al Alloyed with Ti and Cr," to be published in *Proceedings of the TMS Symposium on Mechanical Properties and Phase Transformations in Multi-Component Intermetallics, Rosemont, Illinois, October 2-6, 1994*, The Metallurgical Society, Warrendale, Pa., 1995.

3.3 JOINING

3.3.1 Open Literature Publications

A. A. Fasching, D. I. Ash, G. R. Edwards, and S. A. David, "Hydrogen Cracking Behavior in an Iron Aluminide Alloy," *Scr. Metall. Mater.* **32**, 389-94 (1995).

A. A. Fasching, G. R. Edwards, and S. A. David, "Grain Growth Kinetics of an Iron Aluminide Alloy," *Scr. Metall. Mater.* **30**, 1003-8 (1994).

C. D. Lundin and C.Y. P. Qiao, "Weld Stress Rupture Behavior of Advanced Austenitic High Temperature Alloys," *PVP, ASME* **286**, 97-102 (June 1994).

C. D. Lundin and C.Y.P. Qiao, "Microstructural Investigation of the Weld HAZ in a Modified 800H Alloy," *Trans. ASME* **116**, 629-34 (July 1974).

C. D. Lundin, C.Y.P. Qiao, T. P. S. Gill, and G. M. Goodwin, "Hot Ductility and Hot Cracking Behavior of Modified 316 Stainless Steels Designed for High-Temperature Service," *Weld J.* **72**, 189s-200s (May 1993).

C. D. Lundin, C.Y.P. Qiao, and R. W. Swindeman, "Weld HAZ Characterization of Modified 800H Alloys," *PVP, ASME* **262**, 65-74 (July 1993).

C. D. Lundin and C.Y.P. Qiao, "An Investigation on the Relationship between the Microstructure and HAZ Softening Behavior," *Microstruct. Sci.* **21**, 317-30 (1994).

3.3.2 Topical Reports

A. A. Fasching, G. R. Edwards, and S. A. David, *Weldability of Polycrystalline Aluminides*, MT-CWR-093-016, ORNL/SUB/85-27421/06, Center for Welding and Joining Research, Golden, Colorado, July 1993.

C. D. Lundin and C.Y.P. Qiao, *Weldability of Modified 800H Alloy*, ORNL/Sub/88-07685/04, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., June 1994.

3.3.3 Papers in Conference Proceedings

G. R. Edwards, A. A. Fasching, M. I. Onsoien, and J. W. Allen, "Advanced Concepts in Joining by Conventional Processes", pp. 222-39 in *Advanced Joining Technologies for New Materials II*, Cocoa Beach, Florida, March 2-4, 1994, 1994.

G. M. Goodwin, P. J. Maziasz, C. G. McKamey, J. H. DeVan, and V. K. Sikka, "Weldability of Iron Aluminides," pp. 205-10 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 10-12, 1994, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

G. M. Goodwin, C. G. McKamey, P. J. Maziasz, and V. K. Sikka, "Weldability of Iron Aluminides," pp. 181-88 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 11-13, 1993, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

C. D. Lundin and C.Y.P. Qiao, "Comparative Evaluation of the Weldability of Modified 800H and Other Advanced Austenitic Stainless Steels," pp. 341-51 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

C. D. Lundin and C.Y.P. Qiao, "Investigation on the Weldability of High Temperature Alloy Tubing Materials," pp. 365-75 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

C. D. Lundin and C.Y.P. Qiao, "Stress Rupture Evaluation of Weldments and Base Metal in a Modified 800H Alloy," pp. 97-104 in *Welding - Joining - Coating and Surface Modification of Advanced Materials*, proceedings of the Pre-Assembly Symposium of the 47th Annual Assembly of IIW, Dalian, China, September 1994.

3.4 COATINGS DEVELOPMENT

3.4.1 Open Literature Publications

F. D. Geib and R. A. Rapp, "Simultaneous Chromizing-Aluminizing Coating of Low-Alloy Steels by a Halide-Activated Pack Cementation Process," *Oxid. Met.* **40**, 213-28, (1993).

M. A. Harper and R. A. Rapp, "Codeposited Chromium and Silicon Diffusion Coatings for Fe-Base Alloys Via Pack Cementation," *Oxid. Met.* **42** (3/4), 303-33 (1994).

N. He, G. Wang, and R. A. Rapp, "The Common Component Effect in Multiphase, Multicomponent Equilibria," submitted to *High Temp. Sci.* (1994).

C. McVay and R. A. Rapp, "Diffusion Aluminizing Coatings to Produce Ni₃Al Alloy Welding Rods," submitted to *Scr. Metall. Mater.* (1994).

E. Pangestuti, G. Wang, and R. A. Rapp, "Aqueous Corrosion Resistance of Cr-Si Diffusion Coatings," submitted to *Corrosion*.

R. A. Rapp, "Fundamental Aspects of High-Temperature Corrosion," *J. Phys. IV C9*(3), 1-15, (December 1993).

3.4.2 Topical Reports

R. N. Johnson, *Electro-Spark Deposited Coatings for High Temperature Wear and Corrosion Applications*, WHC-SA-2673-FP, Westinghouse Hanford Co., Richland, Washington, October 1995.

3.4.3 Papers in Conference Proceedings

R. N. Johnson, "Electro-Spark Deposited Coatings for Fossil Energy Environments," in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

R.N. Johnson, "Electro-Spark Deposited Coatings for Fossil Energy Environments," in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

R. A. Rapp, "The Codeposition of Elements in Diffusion Coatings by the Pack Cementation Method," pp. 181-84 in *Proceedings of the First International Workshop on Materials for Coal Gasification Power Plants*, Petten, The Netherlands, June 14-16, 1993, Butterworth-Heinemann, Norwich, United Kingdom, 1993.

X. Wan, G. Wang, and R. A. Rapp, "Resistance to Aqueous Corrosion of Steels Protected by a Cr-Si Diffusion Coating," pp. 353-69 in *Proceedings of the International Corrosion Congress, September 1993*, Vol. 1, National Association of Corrosion Engineers, Houston, Texas.

3.5 CORROSION AND ENVIRONMENTAL EFFECTS

3.5.1 Open Literature Publications

J. H. DeVan and P. F. Tortorelli, "Oxidation-Sulfidation Behavior of Iron Alloys Containing 16 to 40 Atomic Percent Aluminum," *Corros. Sci.* **35**, 1065-71 (1993).

J. G. Kim and R. A. Buchanan, "Pitting and Crevice Corrosion of Iron Aluminides in a Mild Acid-Chloride Solution," *Corrosion* **50**(9), 658-68 (September 1994).

P. F. Tortorelli, "Mechanical Properties of Chromia Scales," *J. Phys. IV C9*, 943-49 (1993).

3.5.2 Topical Reports

J. G. Kim and R. A. Buchanan, *Aqueous Corrosion Properties and Slow-Strain-Rate Ductilities of Fe₃Al-Based and Lean-Aluminum Iron Aluminides*, ORNL/Sub/88-07685CT92/03, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1993.

J. G. Kim and R. A. Buchanan, *Localized Corrosion and Stress Corrosion Cracking Characteristics of a Low-Aluminum-Content Iron Aluminum Alloy*, ORNL/Sub/88-07685CT92/04, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1994.

3.5.3 Papers in Conference Proceedings

J. H. DeVan and P. F. Tortorelli, "Environmental Effects on Iron Aluminides," pp. 277-88 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

J. H. DeVan, P. F. Tortorelli, and M. J. Bennett, "Environmental Effects on Iron Aluminides," pp. 309-20 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

J. H. DeVan and P. F. Tortorelli, "Oxidation/Sulfidation of Iron-Aluminum Alloys," pp. 30-35 in *Proceedings of the First International Workshop on Materials for Coal Gasification Power Plants, Petten, The Netherlands, June 14-16, 1993*, Butterworth-Heinemann, Norwich, United Kingdom, 1993.

R. R. Judkins and S. Wasaka, "Tests of Nickel Aluminide for Coal Liquefaction Letdown Valves," in *Proceedings of the Fourth AIST-NEDO/DOE-HQ Joint Technical Meeting on Materials for Coal Liquefaction, San Francisco, California, October 12-14, 1992*, U.S. DOE, Pittsburgh Energy Technology Center, Pittsburgh, 1992.

J. R. Keiser, A. J. Patko, and R. R. Judkins, "Materials Performance at the Wilsonville Coal Liquefaction Facility: 1989-1991," pp. 43-60 in *Proceedings of the Third AIST-NEDO/DOE PETC Joint Technical Meeting on Materials for Coal Liquefaction, Fukuoka City, Kyusu, Japan, October 23, 1991*, Agency of Industrial Science and Technology-New Energy and Industrial Technology Development Organization, Tokyo, 1991.

J. G. Kim and R. A. Buchanan, "Aqueous Corrosion and Corrosion-Sensitive Embrittlement of Fe₃Al-Based and Lean-Aluminum Iron Aluminides," pp. 239-48 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

J. G. Kim and R. A. Buchanan, "Localized Corrosion and Stress Corrosion Cracking Characteristics of Low-Aluminum-Content Iron-Aluminum Alloys," pp. 321-30 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

P. F. Tortorelli and J. H. DeVan, "Compositional Influences on the High-Temperature Corrosion Resistance of Iron Aluminides," pp. 257-70 in *Processing, Properties, and Applications of Iron Aluminides, San Francisco, California, February 27 - March 3, 1994*, ed. J. H. Schneibel and M. A. Crimp, The Metallurgical Society, Warrendale, Pa., 1994.

P. F. Tortorelli and J. H. DeVan, "Alloying Effects on the High-Temperature Oxidation Resistance of Cr-Cr₂Nb," pp. 391-400 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

P. F. Tortorelli, L. J. Carson, and J. H. DeVan, "Effects of Alloying and Temperature on the High-Temperature Oxidation of Cr-Cr₂Nb," pp. 309-18 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

I. G. Wright, V. Srinivasan, and K. M. Vedula, "Some Effects of Minor Alloying Additions on the Development and Breakdown of Protective Oxide Scales," pp. 159-66 in *Proceedings of the First International Workshop on Materials for Coal Gasification Power Plants, Petten, The Netherlands, June 14-16, 1993*, Butterworth-Heinemann, Norwich, United Kingdom, 1993.

3.5.4 Books and Book Articles

R. A. Buchanan, J. G. Kim, R. E. Ricker, and L. A. Heldt, "Aqueous Corrosion of Intermetallic Alloys," pp. 517-58 in *Physical Metallurgy and Processing of Intermetallic Compounds*, ed. N. S. Stoloff and V. K. Sikka, Chapman & Hall, New York, 1995.

4. CERAMICS

4.1 FIBER-REINFORCED COMPOSITES

4.1.1 Open Literature Publications

T. M. Besmann, J. C. McLaughlin, and T. L. Starr, "Scale-up and Modeling of Forced Chemical Vapor Infiltration," *Ceram. Eng. Sci. Proc.* **15**(5), 897-907 (1994).

T. M. Besmann, J. C. McLaughlin, and H. T. Lin, "Fabrication of Ceramic Composites: Forced CVI," *J. Nucl. Mater.*, in press.

R. A. Lowden, O. J. Schwarz, and K. L. More, "Improved Fiber Coatings for Nicalon/SiC Composites," *Ceram. Eng. Sci. Proc.*, **14**(7-8), 375-84 (1993).

K. R. Vaidyanathan, J. Sankar, A. D. Kelkar, D. P. Stinton, and M. H. Headinger, "Investigation of Mechanical Properties of Chemically Vapor Infiltrated Ceramic Matrix Composites Under Pure Tension," *Ceram. Eng. Sci. Proc.* **14**(9-10), 1016-27 (1993).

B. Weaver, R. A. Lowden, J. C. McLaughlin, D. P. Stinton, and T. M. Besmann, O. J. Schwarz, "Nextel/SiC Composites Fabricated Using Forced Chemical Vapor Infiltration," *Ceram. Eng. Sci. Proc.* **14**(9-10), 1008-15 (1993).

4.1.2 Topical Reports

T. L. Starr, D. L. Mohr, W. J. Lackey, and J. A. Hanigofsky, *Development of Silicon Nitride Composites with Continuous Fiber Reinforcement*, ORNL/Sub/87-00184/04, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1993.

T. L. Starr and A. W. Smith, *Modeling of Forced CVI for Tube Fabrication*, ORNL/Sub/85-55901/04, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., May 1994.

4.1.3 Papers in Conference Proceedings

T. D. Burchell, C. E. Weaver, F. Derbyshire, Y. Q. Fei, and M. Jagtoyen, "Carbon Fiber Composite Molecular Sieves: Synthesis and Characterization," pp. 650-51 in *Proceedings of CARBON '94, Granada, Spain, July 3-8, 1994*, 1994.

T. D. Burchell, F. Derbyshire, Y. Q. Fei, M Jagtoyen, and C. E. Weaver, "Carbon Fiber Composite Molecular Sieves," p. 120 in *Proceedings of the Eighth CIMTEC World Ceramics Conference, Florence, Italy, June 28 -July 8, 1994*, 1994.

F. Derbyshire, Y. Q. Fei, M Jagtoyen, G. Kimber, T. D. Burchell, and C. E. Weaver, "Carbon Fiber Composite Molecular Sieves: Activation, Pore Structure, and Adsorptive Behavior," pp. 654-55 in *Proceedings of CARBON '94, Granada, Spain, July 3-8, 1994*, 1994.

M. Jagtoyen, F. Derbyshire, N. Custer, and T. D. Burchell, "Carbon Fiber Composite Molecular Sieves for Gas Separation," pp. 77-81 in *Proceedings of the MRS 1994 Spring Meeting, San Francisco, California, April 4-8, 1994*, Vol. 344, Materials Research Society, Pittsburgh, 1994.

R. R. Judkins, D. P. Stinton, and J. H. DeVan, "A Review of the Efficacy of Silicon Carbide Hot Gas Filters in Coal Gasification and Pressurized Fluidized Bed Combustion Environments," Paper 94-GT-314, American Society of Mechanical Engineers, New York, June 1994.

R. R. Judkins, T. D. Burchell, and F. Derbyshire, "Development of a Carbon Fiber Composite Molecular Sieve," in *Proceedings of the Fifth AIST-NEDO/DOE-HQ Joint Technical Meeting on Materials for Coal Liquefaction, Toya, Hokkaido, Japan, January 17-19, 1994*, Agency of Industrial Science and Technology-New Energy and Industrial Technology Development Organization, Tokyo, 1994.

R. R. Judkins, D. P. Stinton, R. G. Smith, and E. M. Fischer, "Ceramic Fiber Ceramic Matrix Filter Development," pp. 145-51 in *Proceedings of the Coal-Fired Power Systems '94 - Advances in IGCC and PFBC Review Meeting, Morgantown, W. Va., June 22, 1994*, DOE/METC-94/1008, Vol. I (DE94012252), U.S. DOE, Morgantown, W. Va., June 1994.

R. A. Lowden, O. J. Schwarz, and D. P. Stinton, "Development of Oxidation-Resistant Interface Coatings," in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

W. M. Matlin, P. K. Liaw, T. M. Besmann, and D. P. Stinton, "Application of a Finite Volume Model in the Optimization of Forced Flow/Thermal Gradient Chemical Vapor Infiltration," in *Proceedings of the Second International Conference on High Temperature Ceramic Matrix Composites HT-CMC-2, Santa Barbara, California, American Ceramic Society, Westerville, Ohio, August 1995*.

W. M. Matlin, D. P. Stinton, T. M. Besmann, and P. K. Liaw, "Optimization of Bundle Infiltration in the Forced Chemical Vapor Infiltration (FCVI) Process," in *Proceedings of the MRS 1994 Fall Meeting, Symposium M, Ceramic Matrix Composites: Advanced High-Temperature Structural Materials, Boston, Massachusetts, November 28 - December 2, 1994*. (in press)

W. M. Matlin, D. P. Stinton, T. M. Besmann, P. K. Liaw, Y. G. Roman, and T. L. Starr, "Development of a Multi-Step Forced Chemical Vapor Infiltration Process", in *Proceedings of the American Ceramic Society 19th Annual Cocoa Beach Conference and Exposition on Composites, Advanced Ceramics, Materials, and Structures, Cocoa Beach, Florida, January 8-12, 1995*. (in press)

K. L. Reifsnider, W. Stinchcomb, K. Liao, L. Oleksuk, and D. Stinton, "Characterization of Ceramic Composite Materials for Gas Turbine Applications," Paper 93-GT-308 in *Proceedings of the ASME Gas Turbine and Aerospace Congress and Exposition, Cincinnati, Ohio, May 24-27, 1993*, American Society of Mechanical Engineers, New York, June 1993.

4.1.4 Books and Book Articles

T. M. Besmann, D. P. Stinton, and R. A. Lowden, "Chemical Vapor Deposition and Infiltration," in *Non-Oxide Ceramic Engineering*, Van Nostrand-Reinhold, New York, in press.

T. M. Besmann, D. P. Stinton, and R. A. Lowden, "Chemical Vapor Infiltration of Non-Oxide Ceramic Matrix Composites," pp. 253-62 in *Covalent Ceramics II: Non-Oxides*, Vol. 327, ed. A. R. Barron, G. S. Fischman, M. A. Fury, and A. F. Hepp, Materials Research Society, Pittsburgh, 1994.

T. M. Besmann, R. A. Lowden, and D. P. Stinton, "Overview of Chemical Vapor Infiltration," pp. 215-30 in *High Temperature Ceramic Matrix Composites*, ed. R. Naslain, J. Lamon, and D. Doumeingts, Woodhead Publishing Ltd., 1993.

B. Weaver, R. A. Lowden, J. C. McLaughlin, D. P. Stinton, T. M. Besmann, O. J. Schwarz, "Nextel/SiC Composites Fabricated Using Forced Chemical Vapor Infiltration," pp. 353-60 in *High Temperature Ceramic Matrix Composites*, ed. R. Naslain, J. Lamon, and D. Doumeingts, Woodhead Publishing Ltd., 1993.

4.2 MECHANICAL BEHAVIOR

4.2.1 Open Literature Publications

K. Breder, "Time-Dependent Strength Degradation of a Siliconized Silicon Carbide Determined by Dynamic Fatigue," submitted to *J. Am. Ceram. Soc.* (1994).

K. Breder and V. J. Tennery, "Comparison of the Dynamic Fatigue Behavior of Two Monolithic SiC Ceramics and an Al₂O₃/SiC Composite," *Ceram. Eng. Sci. Proc.* **15**(4), 23-31 (1994).

T. M. Strobel, J. P. Hurley, K. Breder, and J. E. Holowczak "Coal-Slag Corrosion and Strength Degradation of Silicon Carbide/Alumina Composites," *Ceram. Eng. Sci. Proc* **15**(4), 579-86 (1994).

4.2.2 Topical Reports

K. Breder and V. J. Tennery, *Materials Support for HITAF, Final Report for Phase 1*, ORNL/TM-12815, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., February 1995.

W. W. Stinchcomb, K. L. Reifsnider, L. Oleksuk, S. S. Lee, and D. P. Stinton, *Effect of Elevated Temperature and Cyclic Loading on Properties and Damage Modes in Ceramic Composites*, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., May 1993.

4.2.3 Papers in Conference Proceedings

K. Breder and V. J. Tennery, "Materials Support for High Temperature Advanced Furnace (HITAF)," pp. 234-35 in *Proceedings from the Ninth Annual Coal Preparation, Utilization, and Environmental Control Contractors Conference*, Pittsburgh Energy Technology Center, Pittsburgh, July 1993.

K. Breder and V. J. Tennery, "Materials Support for the Development of High Temperature Advanced Furnaces (HITAF) - A Comparison of Selected Mechanical Properties for three SiC-Based Ceramics," pp. 347-58 in *Proceedings from the Tenth Annual Coal Preparation, Utilization, and Environmental Control Contractors Conference*, Pittsburgh Energy Technology Center, Pittsburgh, PA, July 1994.

K. L. Reifsnider, W. W. Stinchcomb, L. Oleksuk, and S. S. Lee, "Effect of Elevated Temperatures and Cyclic Loading on Properties and Damage Modes in Ceramic Composites," in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials*, Oak Ridge, Tennessee, May 10-12, 1994, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

D. J. Seery, J. J. Sangiovanni, F. L. Robson, W. M. Proscia, J. E. Holowczak, M. Bak, J. D. Freihaut, M. Heap, D. W. Pershing, P. J. Smith, A. F. Sarofim, E. Eddings, A. A. Boni, S. A. Johnson, C. L. Senior, S. Srinivasachar, J. J. Helble, M. L. Jones, J. P. Hurley, T. Strobel, V. J. Tennery, K. Breder, and J. H. Westsik, "Combustion 2000: Burning Coal in the Twenty-First Century", pp. 356-63 in *Proceedings from the Ninth Annual Coal Preparation, Utilization, and Environmental Control Contractors Conference*, Pittsburgh Energy Technology Center, Pittsburgh, July 1993.

W. W. Stinchcomb, K. L. Reifsnider, K. Liao, and L. Oleksuk, "Characterization of Ceramic Composite Materials for Gas Turbine Applications," Paper 93-GT-308 in *Proceedings of the ASME Gas Turbine and Aerospace Congress and Exposition, Cincinnati, Ohio, May 24-27, 1993*, American Society of Mechanical Engineers, New York, June 1993.

4.2.4 Books and Book Articles

K. Liao, T. J. Dunyak, W. W. Stinchcomb, and K. L. Reifsnider, "Monitoring of Fatigue Damage Development in Ceramic Composite Tubular Specimens by Thermoelastic Techniques," pp. 620-36 in *Composite Materials: Fatigue and Fracture, ASTM STP 1156*, Vol. 4, American Society for Testing and Materials, Philadelphia, 1993.

4.3 JOINING

4.3.1 Open Literature Publications

B. H. Rabin and G. A. Moore, "Joining of SiC-Based Ceramics by Reaction Bonding Methods," *J. Mater. Synthesis Proc.* 1(3), 195-201 (1993).

4.3.2 Books and Book Articles

B. H. Rabin and G. A. Moore, "Microstructure and Properties of SiC-to-SiC Joints Produced by Reaction Bonding," pp. 145-56 in *Silicon-Based Structural Ceramics*, ed. B. Sheldon, American Ceramic Society, Westerville, Ohio, 1993.

B. H. Rabin and G. A. Moore, "Joining of SiC Using Reaction Bonding Methods," pp. 291-99 in *Ceramic Transactions, Vol. 35: Structural Ceramics Joining II*, American Ceramic Society, Westerville, Ohio, 1993.

B. H. Rabin and G. A. Moore, "Reaction Bonding Methods for Joining SiC," pp. 197-203 in *Joining and Adhesion of Advanced Inorganic Materials*, Vol. 314, Materials Research Society, Pittsburgh, 1993.

4.4 SOLID STATE ELECTROLYTE SYSTEMS

4.4.1 Open Literature Publications

G. W. Coffey, L. R. Pederson, and W. J. Weber, "Water Uptake and Conduction in Strontium Ytterbium Cerate," *Mater. Res. Soc. Symp. Proc.*, 1994 (in press).

J. J. Kingsley and L. R. Pederson, "Self-Propagating Synthesis of Lanthanide Chromites using Ammonium Dichromate," *Mater. Lett.* **18**, 89-96 (1993).

J. J. Kingsley and L. R. Pederson, "Energetic Materials in Ceramics Synthesis," *Mater. Res. Soc. Symp. Proc.* **296**, 361-66 (1993).

W. J. Weber, J. W. Stevenson, T. R. Armstrong, and L. R. Pederson, "Processing and Electrochemical Properties of Mixed Conducting LaACoFeO ($A=\text{Sr, Ca}$)," *Mater. Res. Soc. Symp. Proc.*, 1994 (in press).

G. E. Youngblood, A. S. Rupaal, L. R. Pederson, and J. L. Bates, "Oxygen Reduction at a Stabilized Zirconia Interface with Yttrium Calcium Manganite or Lanthanum Strontium Manganite Cathode Materials," *Proc. Electrochem. Soc.*, 585-96 (1993).

4.4.2 Papers in Conference Proceedings

T. R. Armstrong, J. L. Bates, G. W. Coffey, J. J. Kingsley, L. R. Pederson, J. W. Stevenson, W. J. Weber, and G. E. Youngblood, "Advanced Electrolytes and Synthesis of Advanced Catalysts and Membrane Materials," p. 89 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

T. R. Armstrong, J. L. Bates, L. A. Chick, J. J. Kingsley, and L. R. Pederson, "Synthesis and Processing of Complex Ceramic Oxides," p. 43 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

T. R. Armstrong, J. L. Bates, J. J. Kingsley, L. R. Pederson, J. W. Stevenson, W. J. Weber, C. F. Windisch, Jr. and G. E. Youngblood, "Advanced Materials, Electrochemical Studies, and Electrochemical Catalysis Studies for Solid Oxide Fuel Cells," p. 71 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

T. R. Armstrong and L. R. Pederson, "Stability of High-Temperature Solid Oxide Fuel Cell Materials," Sect. 18 in *Proceedings of the EPRI/GRI Workshop on Fuel Cell Technology Research and Development*, TR-103852, Stonehart Associates, Madison, Connecticut, 1994.

T. R. Armstrong, J. L. Bates, G. W. Coffey, J. J. Kingsley, T. O. Mason, L. R. Pederson, J. W. Stevenson, W. J. Weber, C. F. Windisch, Jr. and G. E. Youngblood, "Advanced Ceramic Materials and Electrochemical Processes at Interfaces," p. 155 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

L. A. Chick, T. R. Armstrong, J. L. Bates, G. W. Coffey, J. J. Kingsley, G. D. Maupin, D. E. McCready and L. R. Pederson, "Advanced Ceramic Materials and Electrochemical Processes at Interfaces," p. 149 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

L. A. Chick, T. R. Armstrong, D. E. McCready, G. W. Foffey, G. D. Maupin, and J. L. Bates, "Low-Temperature Sintering and Phase Changes in Chromite Interconnect Materials," pp. 374-84 in *Proceedings of the Third International Symposium on Solid Oxide Fuel Cells*, Vol. 93-94, ed. S. C. Singhal and H. Iwahara, The Electrochemical Society, Pennington, N.J., 1993.

G. E. Youngblood, J. L. Bates, J. J. Kingsley, L. R. Pederson, A. S. Rupaal, W. J. Weber and C. F. Windisch, Jr., "Electrochemical Processes at Interfaces and Mixed Conductor Development," p. 87 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

G. E. Youngblood, C. F. Windisch, Jr., and J. L. Bates, "Oxygen Reduction at a YSZ Interface with Cathode Materials $\text{La}_{1-x}(\text{Ca or Sr})_x\text{MnO}_3$ or $\text{Y}_{1-x}\text{Ca}_x\text{MnO}_3$," pp. 479-485 in *Proceeding of the 14th Riso International Symposium on Materials Science: High Temperature Electrochemical Behavior of Fast Ion and Mixed Conductors*, ed. F. W. Poulson, J. J. Bentzen, T. Jacobsen, E. Skou, and M. J. L. Ostergard, Riso National Laboratory, Roskilde, Denmark, 1993.

4.5 CERAMIC FILTERS

4.5.1 Open Literature Publications

R. R. Judkins, D. P. Stinton, and J. H. DeVan, "A Review of the Compatibility of Silicon Carbide Hot Gas Filters in Coal Gasification and Pressurized Fluidized Bed Combustion Environments," pp. 1-3 in *Materials and Components in Fossil Energy Applications*, Vol. 111, August 1, 1994.

R. R. Judkins, D. P. Stinton, and J. H. DeVan, "A Review of the Efficacy of Silicon Carbide Hot Gas Filters in Coal Gasification and Pressurized Fluidized Bed Combustion Environments," *J. Eng. Gas Turbines Power*, American Society of Mechanical Engineers, New York, in press.

4.5.2 Papers in Conference Proceedings

R. R. Judkins, D. P. Stinton, and J. H. DeVan, "A Review of the Efficacy of Silicon Carbide Hot Gas Filters in Coal Gasification and Pressurized Fluidized Bed Combustion Environments," Paper 94-GT-314 in *Proceedings of the International Gas Turbine and Aeroengine Congress and Exposition, The Hague, The Netherlands, June 13-16, 1994*, American Society of Mechanical Engineers, New York, 1994.

R. R. Judkins, D. P. Stinton, R. G. Smith, and E. M. Fischer, "Ceramic Fiber Ceramic Matrix Filter Development," pp. 145-51 in *Proceedings of the Coal-Fired Powered Systems 94 - Advances in IGCC and PFBC Review Meeting, Volume I, Morgantown, West Virginia, June 22, 1994*, DOE/METC-94/1008, Vol. I (DE94012252), ed. H. M. McDaniel, R. K. Staubly, and V. K. Venkataraman, U.S. DOE, Morgantown Energy Technology Center, Morgantown, W. Va., June 1994.

4.6 CERAMIC MEMBRANES

4.6.1 Open Literature Publications

D. E. Fain and G. E. Roettger, "Coal Gas Cleaning and Purification With Inorganic Membranes," *Trans. ASME* 115(3), 628-33 (July 1993).

4.6.2 Papers in Conference Proceedings

D. E. Fain, R. B. Neal, and G. E. Roettger, "Ceramic Membranes for High Temperature Hydrogen Separation," pp. 51-60 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

D. E. Fain and G. E. Roettger, "Hydrogen Production Using Inorganic Membranes," pp. 51-61 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

R. R. Judkins and D. E. Fain, "Carbon Dioxide Removal With Inorganic Membranes," pp. 63-70 in *A Report from the Second U.S./Japan Workshop on Global Change Research: Environmental Response Technologies (Mitigation and Adaptation), Honolulu, Hawaii, February 1-3, 1993*, CONF-930285, comp. Sylvia Edgerton and Tateki Mizuno, U.S. DOE, Washington, D.C., 1993.

4.7 CERAMIC CATALYST MATERIALS

4.7.1 Open Literature Publications

D. Kalakkad, S. L. Anderson, A. D. Logan, J. Pena, E. J. Braunschweig, C. H. F. Peden, and A. K. Datye, "N-butane Hydrogenolysis as a Probe of Surface Sites in Rh Metal Particles: Correlations with Single Crystals," *J. Phys. Chem.* **97**, 1437-44 (1993).

A. G. Sault, E. P. Boespflug, and C. H. F. Peden, "Metal Support Interactions in Hydrous Titanium Oxide-Supported Nickel Catalysts," *J. Phys. Chem.* **98**, 1652-62 (1994).

A. G. Sault, "Reduction Behavior of Metals Supported on Hydrous Titanium Oxide Ion-exchange Materials," submitted to *J. Catal.*

S. Srinivasan, A. K. Datye, M. H. Smith and C. H. F. Peden, "Interaction of Titanium Isopropoxide with Surface Hydroxyls on Silica," *J. Catal.* **145**, 565-73 (1994).

4.7.2 Papers in Conference Proceedings

A. G. Sault, T. J. Gardner, C. S. Ashley, S. Srinivasan and A. K. Datye, "Thin Film Ceramic Catalyst Support Materials," pp. 139-148 in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

A. G. Sault, T. J. Gardner, S. Srinivasan, A. Hanprasopwattana and A. K. Datye, "Ceramic Catalyst Materials," pp. 145-154 in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

4.7.3 Books and Book Articles

T. J. Gardner, *Activation of Hydrous Titanium Oxide-Supported Metal Catalysts*, Ph.D. Thesis, University of New Mexico, Albuquerque, N.M., December 1994.

4.8 NEW MATERIALS PROCESSES

4.8.1 Open Literature Publications

W. Chen, A. Pechenik, S. J. Dapkunas, G. Piermarini, and S. G. Malghan, "Novel Equipment for the Study of the Compaction of Fine Powders," *J. Am. Ceramic Soc.* **77**(4), 1005-10 (1994).

W. Chen and S. G. Malghan, "Investigation of Compaction Equations for Powders," *Powder Technol.* **81**, 75-81 (1994).

A. Pechenik and G. J. Piermarini, "Fabrication of Transparent Silicon Nitride From Nanosize Particles," *J. Am. Cer. Soc.* **75**(12), (1992).

4.8.2 Topical Reports

W. Chen, S. G. Malghan, S. C. Danforth, and A. Pechenik, *Low Temperature Fabrication of Transparent Silicon Nitride*, ORNL/Sub/92-22041/01, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., May 1994.

4.8.3 Papers in Conference Proceedings

W. Chen, A. Pechenik, G. J. Piermarini, S. Danforth, S. J. Dapkunas, and S. G. Malghan, "Equipment for Investigation of Cryogenic Compaction of Nanosize Silicon Nitride Powders," in *Proceedings of the Seventh Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 11-13, 1993*, CONF-9305135, ORNL/FMP-93/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1993.

W. Chen, S. J. Dapkunas, G. Piermarini, A. Pechenik, S. Danforth, and S. G. Malghan, "Densification of Nanosize Powders" in *Proceedings of the Eighth Annual Conference on Fossil Energy Materials, Oak Ridge, Tennessee, May 10-12, 1994*, CONF-9405143, ORNL/FMP-94/1, comp. N. C. Cole and R. R. Judkins, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., August 1994.

INDEX

316 stainless steels	10
800H	10, 11
abrasive wear	9
acoustic	5
acoustic emission	5
alloy development	5
alloying	5, 6, 9, 14
alloying additions	5, 6, 14
alloys	5-14
alumina	18
aluminides	5-7, 9, 10, 12-14
aluminizing	11
aluminum	5, 7, 12-14
aluminum alloys	5, 7, 13, 14
aqueous corrosion	11-13
AR&TD Materials Program	1
breakdown	1, 14
catalyst materials	23
catalysts	20, 23
cavitation erosion	9
ceramic catalyst	23
ceramic composites	15, 18
ceramic fiber	16, 22
ceramic matrix	15-17, 22
ceramic membranes	22
ceramics	15-20
chemical vapor deposition	17
chemical vapor infiltration	15-17
chromia	12
chromites	20
chromium	5, 11
chromizing	11
cleaning	22
coal gasification	1, 12-14, 16, 21, 22
coal-fired	16, 22
coatings	7, 9, 11, 12, 15, 16
coatings development	11
codeposition	12
combustion environments	16, 21, 22
components	21
composites	15-19
Conference on Fossil Energy Materials	3, 5-14, 16, 18, 20-24
corrosion	11-14, 18

Index

corrosion resistance	11, 14
cracking	9, 10, 13, 14
cracking behavior	9, 10
creep	6
deformation	6
diffusion coatings	11, 12
ductilities	13
ductility	10
electrochemical processes	21
electrolyte systems	19
electro-spark deposited coatings	12
embrittlement	5, 6, 13
environmental effects	12, 13
environmental embrittlement	5, 6
erosion	9
fabrication	15, 24
fiber	15, 16, 22
fiber coatings	15
fiber-reinforced composites	15
filters	16, 21, 22
fluidized bed combustion	16, 21, 22
fracture	8, 19
fuel cell materials	20
fuel cells	1, 20, 21
gas cleaning	22
gas separation	16
gas turbine applications	17, 19
gas turbines	21
grain growth	8, 9
HAZ	10
heat recovery	1
high-temperature	6, 9-11, 14, 20
hot ductility	10
hot gas filters	16, 21, 22
interface coatings	16
interfaces	21
intermetallic alloys	5, 7, 14
intermetallics	6-9
ion-exchange materials	23
iron aluminides	5-7, 9, 10, 12-14
iron-aluminum alloys	7, 13, 14
joining	9-11, 19
joints	19
kinetics	9
liquefaction	1, 3, 5, 13, 16

materials performance	13
mechanical behavior	17
mechanical properties	5, 8, 9, 12, 15, 18
membranes	22
microstructure	5, 6, 8-10
microstructures	5, 7
model	16
modeling	15
monolithic	17
Nextel	15, 17
Nicalon/SiC composites	15
nickel aluminide	13
ordered intermetallics	6-8
oxidation-sulfidation	12
oxidation	12-14, 16
oxide scales	14
pack cementation	11, 12
particles	23, 24
polycrystalline aluminides	10
powders	24
processing	5-9, 14, 20
program development	3
purification	22
recrystallization	5
reinforced	15
scales	12, 14
separation	16, 22
SiC	15, 17-19
silicon	11, 15-19, 21, 22, 24
silicon carbide	16-18, 21, 22
silicon nitride	15, 24
siliconized	17
sintering	21
softening behavior	10
stainless steels	10, 11
strength	17, 18
stress corrosion	13, 14
sulfidation	12, 13
synthesis	9, 15, 19, 20
technology transfer	3
tensile properties	5, 7, 8
testing	19
thermomechanical processing	5, 8, 9
titanium oxide	23
tubing	11

Index

turbine	17, 19, 22
vapor deposition	17
weldability	5, 10, 11
welding	10, 11
weldments	11
yttrium	20
zirconia	20

INTERNAL DISTRIBUTION

K. Breder
T. D. Burchell
P. T. Carlson (5)
N. C. Cole
D. F. Craig
M. A. Janney
R. R. Judkins
J. R. Keiser
C. T. Liu
C. G. McKamey
J. Sheffield

V. K. Sikka
J. O. Stiegler
D. P. Stinton
R. W. Swindeman
P. T. Thornton
P. F. Tortorelli
I. G. Wright
Central Research Library
Document Reference Section
ORNL Patent Section
Laboratory Records Department (2)
LRD - RC

EXTERNAL DISTRIBUTION

3M COMPANY
Ceramic Materials Department
201-4N-01 3M Center,
St. Paul, MN 55144
M. A. Leitheiser

A. P. GREEN REFRACTORIES
COMPANY
Green Blvd.
Mexico, MO 65265
J. L. Hill

AIR PRODUCTS AND CHEMICALS
P.O. Box 538
Allentown, PA 18105
S. W. Dean

ALBERTA RESEARCH COUNCIL
Oil Sands Research Department
P.O. Box 8330
Postal Station F
Edmonton, Alberta
Canada T6H5X2
L. G. S. Gray

ALLISON GAS TURBINE DIVISION
P.O. Box 420
Indianapolis, IN 46206-0420
P. Khandelwal (Speed Code W-5)
R. A. Wenglarz (Speed Code W-16)

AMA RESEARCH & DEVELOPMENT
CENTER
5950 McIntyre Street
Golden, CO 80403
T. B. Cox

ARGONNE NATIONAL
LABORATORY-WEST
P.O. Box 2528
Idaho Falls, ID 83403-2528
S. P. Henslee

ARGONNE NATIONAL LABORATORY
9700 S. Cass Avenue
Argonne, IL 60439
W. A. Ellingson
K. Natesan
J. P. Singh

ARMY MATERIALS TECHNOLOGY
LABORATORY SLCMT-MCC
Watertown, MA 02172-0001
D. R. Messier

AVCO RESEARCH LABORATORY
2385 Revere Beach Parkway
Everett, MA 02149
R. J. Pollina

BABCOCK & WILCOX
1562 Beeson St.
Alliance, OH 44601
T. I. Johnson

BABCOCK & WILCOX
Domestic Fossil Operations
20 South Van Buren Avenue
Barberton, OH 44023
M. Gold

BABCOCK & WILCOX
1562 Beeson St.
Alliance, OH 44601
T. I. Johnson
T. Modrak

BETHLEHEM STEEL CORPORATION
Homer Research Laboratory
Bethlehem, PA 18016
B. L. Bramfitt
J. M. Chilton

BRITISH COAL CORPORATION
Coal Research Establishment
Stoke Orchard, Cheltenham
Gloucestershire, England GL52 4RZ
J. Oakey

CANADA CENTER FOR MINERAL &
ENERGY TECHNOLOGY
568 Booth Street
Ottawa, Ontario
Canada K1A 0G1
R. Winston Revie
Mahi Sahoo

COLORADO SCHOOL OF MINES
Department of Metallurgical Engineering
Golden, CO 80401
G. R. Edwards

CONSOLIDATION COAL COMPANY
4000 Brownsville Road
Library, PA 15129
S. Harding

DOE
DOE OAK RIDGE OPERATIONS
P.O. Box 2008
Building 4500N, MS 6269
Oak Ridge, TN 37831
E. E. Hoffman

DOE
DOE OAK RIDGE OPERATIONS
P.O. Box 2001
Oak Ridge, TN 37831
Assistant Manager for
Energy Research and Development

DOE
OFFICE OF BASIC ENERGY
SCIENCES
Materials Sciences Division
ER-131 GTN
Washington, DC 20545
J. B. Darby

DOE
MORGANTOWN ENERGY
TECHNOLOGY CENTER
P.O. Box 880
Morgantown, WV 26505
R. C. Bedick
D. C. Cicero
F. W. Crouse, Jr.
N. T. Holcombe
W. J. Huber
J. E. Notestein

DOE
OFFICE OF SCIENTIFIC AND
TECHNICAL INFORMATION
P.O. Box 62
Oak Ridge, TN 37831
For distribution by microfiche as shown in
DOE/TIC-4500, Distribution Category:
UC-114 (Coal Based Materials and
Components)

DOE
OFFICE OF FOSSIL ENERGY
Washington, DC 20545
J. P. Carr (FE-72) GTN

DOE
PITTSBURGH ENERGY
TECHNOLOGY CENTER
P.O. Box 10940
Pittsburgh, PA 15236
A. L. Baldwin
G. V. McGurl
R. Santore
T. M. Torkos

DOW CORNING CORPORATION
3901 S. Saginaw Road
Midland, MI 48686-0995
H. Atwell

EC TECHNOLOGIES INC.
3614 Highpoint Drive
San Antonio, TX 78217
D. J. Kenton

ELECTRIC POWER RESEARCH
INSTITUTE
P.O. Box 10412
3412 Hillview Avenue
Palo Alto, CA 94303
W. T. Bakker
J. Stringer
H. Wolk

EUROPEAN COMMUNITIES JOINT
RESEARCH CENTRE
Petten Establishment
P.O. Box 2
1755 ZG Petten
The Netherlands
M. Van de Voorde

FLUIDIZED BED TECHNOLOGIES
P.O. Box 4469
Chattanooga, TN 37405
R. Q. Vincent

FOSTER WHEELER DEVELOPMENT
CORPORATION
Materials Technology Department
John Blizzard Research Center
12 Peach Tree Hill Road
Livingston, NJ 07039
J. L. Blough

GA TECHNOLOGIES, INC.
P.O. Box 85608
San Diego, CA 92138
T. D. Gulden

GAS RESEARCH INSTITUTE
8600 West Bryn Mawr Avenue
Chicago, IL 60631
H. S. Meyer

Distribution

GEORGIA INSTITUTE OF
TECHNOLOGY
Georgia Tech Research Institute
Atlanta, GA 30332
T. L. Starr

IDAHO NATIONAL ENGINEERING
LABORATORY
P.O. Box 1625
Idaho Falls, ID 83415
A. B. Denison
B. H. Rabin
R. N. Wright

LAVA CRUCIBLE-REFRACTORIES
CO.
P.O. Box 278
Zelienople, PA 16063
T. Mulholland

LAWRENCE LIVERMORE
LABORATORY
P.O. Box 808, L-325
Livermore, CA 94550
W. A. Steele

LOS ALAMOS NATIONAL
LABORATORY
P.O. Box 1663
Los Alamos, NM 87545
J. D. Katz

MOBIL RESEARCH & DEVELOPMENT
CORPORATION
P.O. Box 1026
Princeton, NJ 08540
R. C. Searles

NATIONAL INSTITUTE OF
STANDARDS AND TECHNOLOGY
U.S. Dept. of Commerce
Bldg. 220, Rm A215
Gaithersburg, MD 20899
S. G. Malghan

NATIONAL MATERIALS ADVISORY
BOARD
National Research Council
2101 Constitution Avenue
Washington, DC 20418
K. M. Zwilsky

NEW ENERGY AND INDUSTRIAL
TECHNOLOGY DEVELOPMENT
ORGANIZATION
Sunshine 60 Bldg.
P.O. Box 1151
1-1, Higashi-Ikebukuro 3-chrome
Toshima-Ku, Tokyo, 170
Japan
H. Narita
S. Ueda

OFFICE OF NAVAL RESEARCH
Code 431, 800 N. Quincy Street
Arlington, VA 22217
S. G. Fishman

RESEARCH TRIANGLE INSTITUTE
P.O. Box 12194
Research Triangle Park, NC 27709
T. W. Sigmon

RISOE NATIONAL LABORATORY
P.O. Box 49
DK-4000
Roskilde, Denmark
Aksel Olsen

SANDIA NATIONAL LABORATORIES
Department 6211, MS 0710
Albuquerque, NM 87185
R. J. Buss
G. A. Carlson

SHELL DEVELOPMENT COMPANY
P.O. Box 1380
Houston, TX 77251-1380
L. W. R. Dicks

SOUTHWEST RESEARCH INSTITUTE
6620 Culebra Road
P.O. Drawer 28510
San Antonio, TX 78284
F. F. Lyle, Jr.

TENNESSEE VALLEY AUTHORITY
1101 Market Street
3A Missionary Ridge
Chattanooga, TN 37402-2801
A. M. Manaker

TENNESSEE VALLEY AUTHORITY
Energy Demonstration & Technology
MR 2N58A
Chattanooga, TN 37402-2801
C. M. Huang

THE JOHNS HOPKINS UNIVERSITY
Materials Science & Engineering
Maryland Hall
Baltimore, MD 21218
R. E. Green, Jr.

THE MATERIALS PROPERTIES
COUNCIL, INC.
United Engineering Center
345 E. Forty-Seventh Street
New York, NY 10017
M. Prager

THE NORTON COMPANY
High Performance Ceramics Division
Goddard Road
Northborough, MA 01532-1545
N. Corbin

THE TORRINGTON COMPANY
Advanced Technology Center
59 Field Street
Torrington, CT 06790
W. J. Chmura

UNION CARBIDE CORPORATION
Linde Division
P.O. Box 44
175 East Park Drive
Tonawanda, NY 14151-0044
Harry Cheung

UNITED TECHNOLOGIES RESEARCH
CENTER
MS 24, Silver Lane
East Hartford, CT 06108
K. M. Prewo

UNIVERSITY OF TENNESSEE AT
KNOXVILLE
Materials Science and Engineering
Department
Knoxville, TN 37996
R. A. Buchanan
P. Liaw
C. D. Lundin

UNIVERSITY OF TENNESSEE SPACE
INSTITUTE
Tullahoma, TN 37388
J. W. Muehlhauser

UNIVERSITY OF WASHINGTON
Department of Materials Science and
Engineering
101 Wilson, FB-10
Seattle, WA 98195
T. G. Stoebe

VIRGINIA POLYTECHNIC INSTITUTE
& STATE UNIVERSITY
Department of Materials Engineering
Blacksburg, VA 24601
W. A. Curtin
K. L. Reifsnider

Distribution

WESTERN RESEARCH INSTITUTE

365 N. 9th Street

P.O. Box 3395

University Station

Laramie, WY 82071

V. K. Sethi

WESTINGHOUSE ELECTRIC

CORPORATION

Research and Development Center

1310 Beulah Road

Pittsburgh, PA 15235

S. C. Singhal