

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

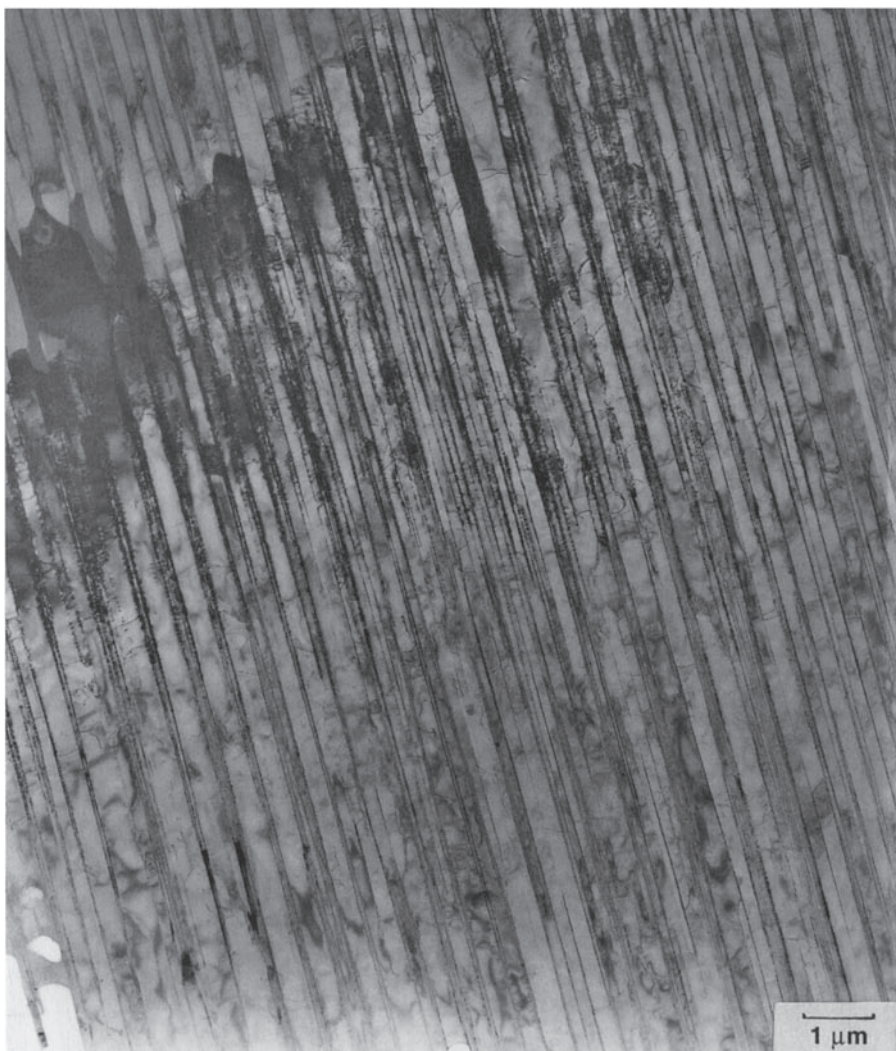
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)

## High-Temperature Ordered Intermetallic Alloys VII

Ultrafine Lamellar Structure in I/M super- $\alpha$  extruded  
TiAl (Ti-46Al-2Cr-1.8Nb-0.2W-0.15B, at.%) alloy,  
which shows 5% ductility in air at room-temperature



*Transmission electron micrograph of a lamellar structure provided by Drs. C.T. Liu and T.J. Maziasz.*

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)

---

Cambridge University Press  
978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII  
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner  
Frontmatter  
[More information](#)

**MATERIALS RESEARCH SOCIETY  
SYMPOSIUM PROCEEDINGS VOLUME 460**

# **High-Temperature Ordered Intermetallic Alloys VII**

Symposium held December 2-5, 1996, Boston, Massachusetts, U.S.A.

## **EDITORS:**

**C.C. Koch**

*North Carolina State University, Raleigh  
Raleigh, North Carolina, U.S.A.*

**C.T. Liu**

*Oak Ridge National Laboratory  
Oak Ridge, Tennessee, U.S.A.*

**N.S. Stoloff**

*Rensselaer Polytechnic Institute  
Troy, New York, U.S.A.*

**A. Wanner**

*Universität Stuttgart  
Stuttgart, Germany*



**PITTSBURGH, PENNSYLVANIA**

Cambridge University Press  
978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII  
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner  
Frontmatter  
[More information](#)

---

**CAMBRIDGE**  
UNIVERSITY PRESS

32 Avenue of the Americas, New York NY 10013-2473, USA

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

[www.cambridge.org](http://www.cambridge.org)

Information on this title: [www.cambridge.org/9781558993648](http://www.cambridge.org/9781558993648)

CODEN: MRSPDH

Copyright 1997 by Materials Research Society.

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

*A catalogue record for this publication is available from the British Library*

*Library of Congress Cataloguing in Publication data*

High-temperature ordered intermetallic alloys VII ; symposium held December 2–5, 1996, Boston, Massachusetts / editors, C.C. Koch, C.T. Liu, N.S. Stoloff, A. Wanner

p. cm—(Materials Research Society symposium proceedings ; v. 460  
ISSN 1067-9995)

Includes bibliographical references and index.

ISBN 1-55899-364-9

1. Koch, C.C. II. Liu, C.T. III. Stoloff, N.S. IV. Wanner, A. V. Title:

High-temperature ordered intermetallic alloys VII.

ISBN 978-1-558-99364-8 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

CONTENTS

Preface ..... xv

Acknowledgments ..... xvii

Materials Research Society Symposium Proceedings ..... xviii

PART I: PROCESSING

\*Phase Stability in Processing of High-Temperature  
Intermetallic Alloys ..... 3  
*J.H. Perepezko, C.A. Nuñez, S-H. Yi, and D.J. Thoma*

\*Commercialization Status of Ni<sub>3</sub>Al-Based Alloys ..... 15  
*V.K. Sikka*

\*Processing, Properties, and Applications of Gamma  
Titanium Aluminide Sheet and Foil Materials ..... 29  
*H. Clemens, W. Glatz, N. Eberhardt, H-P. Martinz, and W. Knabl*

Effect of Initial Microstructure on the Compactibility of  
Rapidly Solidified Ti-Rich TiAl Powder ..... 45  
*M. Nishida, A. Chiba, Y. Morizono, T. Kai, and J. Sugimoto*

PART II: TITANIUM ALUMINIDES

\*Deformation of Diffusion-Bonded Bi-PST and Directionally  
Solidified Crystals of TiAl ..... 53  
*K. Kishida, D.R. Johnson, Y. Shimada, Y. Masuda, H. Inui,  
and M. Yamaguchi*

Strain Rate Sensitivity of Mechanical Properties and  
Related Thermal Activation Process in a Two-Phase  
 $\gamma$ -Titanium Aluminide ..... 65  
*Dongliang Lin, Yu Wang, Yun Lin, and Young-Won Kim*

Ductility Improvement of Direct-Cast Gamma TiAl-Based  
Alloy Sheet ..... 71  
*Toshihiro Hanamura and Keizo Hashimoto*

Solution and Precipitation Hardening in Carbon-Doped  
Two-Phase  $\gamma$ -Titanium Aluminides ..... 77  
*F. Appel, U. Christoph, and R. Wagner*

Key Microstructures Controlling the Mechanical Properties  
of Two-Phase TiAl Alloys With Lamellar Structures ..... 83  
*C.T. Liu, P.J. Maziasz, and J.L. Wright*

\*Invited Paper

**Alloying Effect of Vanadium Upon Structure and Strength of  $\delta$ -Phase Titanium Trialuminide** ..... 91  
*Tohru Takahashi, Kenji Iwami, and Tadashi Hasegawa*

**The Effect of Aluminum on the Formation of Orthorhombic Plates in the Nb-Ti-Al Ternary System** ..... 97  
*D.T. Hoelzer and F. Ebrahimi*

**Microstructure Analysis of Melt-Spun  $\text{Al}_3\text{Ti}$  Intermetallics by XRD and EXAFS** ..... 103  
*Jinmin Chen, W.E. Frazier, and E.V. Barrera*

**The Yield Stress of the Fully-Lamellar Microstructure** ..... 109  
*Y.Q. Sun*

**Fracture Toughness of Stoichiometric, Nonstoichiometric, and Ternary-Alloyed  $\text{Al}_2\text{Ti}$**  ..... 115  
*J.C. Ma, M.J. Lukitsch, C.E. Ambrow, and J.E. Benci*

**Temperature Dependence of Fracture Toughness of the Cubic ( $\text{L}_{12}$ ) Titanium Trialuminides** ..... 121  
*R.A. Varin and L. Zbroniec*

**\*Processing-Property-Microstructure Relationships in TiAl-Based Alloys** ..... 127  
*M.H. Loretto, D. Hu, and A. Godfrey*

**Formation of Fine  $\gamma$  Grain Structure Through Fine  $\alpha_2/\gamma$  Lamellar Structure in Ti-Rich TiAl Alloy** ..... 135  
*T. Kumagai, E. Abe, and M. Nakamura*

**Mechanical Anisotropy in Sheets of  $\gamma$ -TiAl Alloys** ..... 141  
*A. Bartels, H. Clemens, C. Hartig, and H. Mecking*

**Plasticity and Interfacial Dislocation Structures in Ti-Al** ..... 147  
*L. Parrini, H. Heinrich, and G. Kostorz*

**Nanocrystalline TiAl Compacts Prepared by HDDR and Hot Pressing** ..... 153  
*K. Aoki, Y. Itoh, Y. Kawamura, A. Inoue, and T. Masumoto*

**Microstructure, Mechanical Properties, and High-Temperature Oxidation Resistance of Boronized  $\gamma$ -TiAl(Mn)** ..... 159  
*S. Kim, Y. Yoon, H. Kim, and K. Park*

**Al-21Ti-23Cr High-Temperature Protective Coating on TiAl Intermetallic Compounds by rf-Magnetron Sputtering** ..... 165  
*J.Y. Park, H.N. Lee, S.W. Park, M.H. Oh, and D.M. Wee*

\*Invited Paper

**Tensile and Compression Testing of Single-Crystal  
Gamma Ti-55.5 Al ..... 171**  
*Marc Zupan, David LaVan, and K.J. Hemker*

**Influence of Microstructure Refinement on Strength,  
Ductility, and Toughness of TiAl Alloys ..... 177**  
*M.A. Morris and M. Leboeuf*

**Hall-Petch and Multiple Linear Regression Equations for  
the Prediction of Mechanical Properties in Gamma-Based  
Titanium Aluminides ..... 183**  
*W.O. Soboyejo, A.B.O. Soboyejo, Y. Ni, and C. Mercer*

**Deformation of Polysynthetically Twinned (PST) TiAl  
Crystals at High-Strain Rate and High Temperature ..... 189**  
*Zhe Jin, George T. Gray, III, and Masaharu Yamaguchi*

**Tensile Properties and Deformation Mechanisms in  
Two-Phase Titanium Aluminide Sheet Material ..... 195**  
*F. Appel, H. Clemens, W. Glatz, and R. Wagner*

**Microstructure of Massively-Transformed  $\gamma$ -TiAl Phase  
Studied by High-Resolution Electron Microscopy ..... 201**  
*E. Abe, T. Kumagai, S. Kajiwara, and M. Nakamura*

**Static and Dynamic Strain Aging in Two-Phase  $\gamma$ -Titanium  
Aluminides ..... 207**  
*U. Christoph, F. Appel, and R. Wagner*

**TEM Characterization of Planar Defects in a Massively-  
Transformed TiAl Alloy ..... 213**  
*X.D. Zhang, J.M.K. Wiezorek, M.J. Kaufman, M.H. Loretto,  
and H.L. Fraser*

**Ultrafine Fully-Lamellar Structures in Two-Phase  $\gamma$ -TiAl Alloys ..... 219**  
*P.J. Maziasz and C.T. Liu*

**Influence of Si and W Additions on High Temperature  
Oxidation of  $\gamma$ - $\alpha_2$  Ti-Al Alloys ..... 225**  
*A. Tomasi, C. Nosedà, M. Nazmy, and S. Gialanella*

**Shear Transmission in Lamellar Ti-48 at.% Al ..... 231**  
*J.M.K. Wiezorek, X.D. Zhang, W.A.T. Clark, and H.L. Fraser*

**Slip of  $c + a/2$  Dislocations in  $Ti_3Al$  Single Crystals Strained  
in Tension Along the  $c$ -Axis ..... 237**  
*Y. Minonishi, M. Legros, and D. Caillard*

**Texture Studies of Gamma-Titanium-Aluminide Sheets  
Produced by Melt Overflow Rapid Solidification ..... 243**  
*M.L. Weaver, H. Garmestani, and G. Das*

**Measurement of Twinning Elements in PST TiAl Single Crystal** ..... 249  
*Lei Lu and David P. Pope*

**PART III: CREEP AND FATIGUE OF TITANIUM ALUMINIDES**

**Microstructural Changes During Long-Term Tension Creep of Two-Phase  $\gamma$ -Titanium Aluminide Alloys** ..... 257  
*M. Oehring, P.J. Ennis, F. Appel, and R. Wagner*

**Transient Creep Behavior of  $\gamma$ -TiAl Polycrystals** ..... 263  
*B. Viguier, J. Bonneville, P. Spätig, and J.L. Martin*

**Monotonic and Transient Creep Experiments for Single-Phase Gamma TiAl at Intermediate Temperatures** ..... 269  
*Min Lu and K.J. Hemker*

**Deformation Mechanisms Responsible for the Creep Resistance of Ti-Al Alloys** ..... 275  
*M.A. Morris and T. Lipe*

**Effect of Interstitial Concentration and Heat Treatment on Microstructure and Primary Creep of Investment Cast Ti-47Al-2Nb-2Mn With 0.8v% TiB<sub>2</sub>** ..... 281  
*Dong Yi Seo, T.R. Bieler, and D.E. Larsen*

**Creep Deformation of Fully Lamellar Gamma-Based Titanium Aluminide Alloy** ..... 287  
*F. Herrouin, P. Bowen, and I.P. Jones*

**Effect of Stress on Creep of Lamellar Near  $\gamma$ -TiAl** ..... 293  
*J. Beddoes, J. Triantafyllou, and L. Zhao*

**PART IV: IRON ALUMINIDES**

**\*Microstructure Control in Iron Aluminides by Phase Decomposition or by Mechanical Alloying for Improved Strength and Ductility** ..... 301  
*D.G. Morris and S. Gunther*

**\*Yield Stress Anomaly in B2 FeAl** ..... 313  
*K. Yoshimi, S. Hanada, and M.H. Yoo*

**The Effect of Heat Treatment on the Microstructure and Properties of FeAl+Cr** ..... 325  
*P.R. Munroe and C.H. Kong*

**A New Tetragonal Boride Phase in FeAl+B Type Alloys** ..... 331  
*Xavier Pierron and Ian Baker*

\*Invited Paper

**Plasticity, Dislocation Structures, and Antiphase Boundary  
Energies in Fe<sub>3</sub>Al Single Crystals With Chromium ..... 337**  
*Fillip Král, Peter Schwander, and Gernot Kosterz*

**The Charpy Impact Behavior of Fe<sub>3</sub>Al and Fe<sub>3</sub>Al-20 at.%  
Mn Alloys ..... 343**  
*J.N. Liu, W. Yan, J.L. Ma, and K.H. Wu*

**The Effect of Ti Addition on Oxidation Behavior of FeAl  
Intermetallic Alloy ..... 349**  
*Dingqiang Li and Dongliang Lin*

**On the Mechanism of Milling-Induced Disordering in AlFe ..... 355**  
*M.T. Clavaguera-Mora, J. Zhu, M. Meyer, L. Mendoza-Zelis,  
F.H. Sanchez, and N. Clavaguera*

**Low Cycle Fatigue of FeAl (42 at.% Al) at Room  
Temperature ..... 361**  
*D.B. Hanes and R. Gibala*

**Annealing of Cold-Rolled Fe-40Al Single Crystals ..... 367**  
*Y. Yang and I. Baker*

**A Model for the Yield Strength Anomaly in FeAl ..... 373**  
*I. Baker and E.P. George*

**Strength, Thermal Defects, and Solid-Solution Hardening in  
Nickel-Containing B2 Iron Aluminides ..... 379**  
*J.H. Schneibel, P.R. Munroe, and L.M. Pike*

**PART V: NICKEL ALUMINIDES**

**Examination of Dislocation Structures Near Crack Tip  
Region of B2 NiAl Alloys ..... 387**  
*B-C. Ng, B. Simkin, and M.A. Crimp*

**Effect of Prestraining on the Brittle-to-Ductile Transition of  
NiAl Single Crystals ..... 393**  
*S. Shrivastava and F. Ebrahimi*

**Atomistic Aspects of Crack Propagation Along High  
Angle Grain Boundaries ..... 399**  
*Diana Farkas*

**Preparation, Deformation, and Fracture of Stoichiometric  
NiAl Single Crystals ..... 407**  
*W. Löser, A. Köthe, G. Vaerst, and A. Güth*

**Microstructure and Strengthening of Creep-Tested  
Cryomilled NiAl-AlN ..... 413**  
*Anita Garg, J. Daniel Whittenberger, and Michael J. Luton*

**Mechanical Properties of Binary Ni<sub>3</sub>Al Single Crystals** ..... 419  
*J. Bonneville, J-L. Martin, P. Spätig, B. Viguier, and B. Matterstock*

**The Ductility of Stoichiometric and Ni-Rich Polycrystals of Ni<sub>3</sub>Al: The Effect of Strain Rate** ..... 425  
*E.M. Schulson and Y. Xu*

**Orientation Dependence of High-Temperature Creep Strength and Internal Stress in Ni<sub>3</sub>Al Alloy Single Crystals** ..... 431  
*Seiji Miura, Zhi-Lun Peng, and Yoshinao Mishima*

**Primary Creep of Ni<sub>3</sub>(Al, Ta) Single Crystals at Room Temperature** ..... 437  
*M.D. Uchic and W.D. Nix*

**Atomistic Simulations of Ti Additions to NiAl** ..... 443  
*Guillermo Bozzolo, Ronald D. Noebe, Anita Garg, John Ferrante, and Carlos Amador*

**Microstructural Stability of Directionally-Solidified Eutectic NiAl-Mo Under Static and Thermal Cycling Conditions** ..... 449  
*M.T. Kush, J.W. Holmes, and R. Gibala*

**In situ TEM Observations of Cross-Slip Mechanisms in NiAl With a Soft Orientation** ..... 455  
*C. Vailhe, J. Douin, and D. Caillard*

**Investigation of Superplastic Behavior of NiAl and Ni<sub>3</sub>Al Duplex Alloy** ..... 461  
*Liu Zhenyun, Dongliang Lin, Gu Yuefeng, and Shan Aidang*

**TEM In situ Study of Dislocation Motion in B2 NiAl Single Crystals** ..... 467  
*B. Ghosh and M.A. Crimp*

**Comparison of the Creep Properties of Cast and Powder Metallurgy-Extruded Binary NiAl** ..... 473  
*S.V. Raj, Anita Garg, and Thomas R. Bieler*

**The Solid-Solution Alloying Effects of Ti on the High-Temperature Deformation Behavior of NiAl Single Crystals** ..... 479  
*P.H. Kitabjian, A. Garg, R. Noebe, and W.D. Nix*

**Powder Processing of NiAl for Elevated Temperature Strength** ..... 487  
*J. Daniel Whittenberger, Peter Grahle, Eduard Arzt, Robert Behr, Klaus Zöltzer, and Mohan Hebsur*

**Dislocation Substructure in NiAl Single Crystals Deformed at Ambient Temperature** ..... 493  
*X. Shi, T.M. Pollock, S. Mahajan, and V.S. Arunachalam*

Cambridge University Press  
978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII  
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner  
Frontmatter  
[More information](#)

|                                                                                                                                |            |
|--------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Strain Aging Behavior in NiAl Microalloyed With Interstitial and Substitutional Solutes .....</b>                           | <b>499</b> |
| <i>M.L. Weaver, R.D. Noebe, and M.J. Kaufman</i>                                                                               |            |
| <b>Slip Transition and Dislocation Structures in Off-Stoichiometric NiAl Single Crystals .....</b>                             | <b>505</b> |
| <i>R. Srinivasan, M.F. Savage, M.S. Daw, R.D. Noebe, and M.J. Mills</i>                                                        |            |
| <b>Ductility Response of Ni<sub>3</sub>Al-Zr-B-Base Alloys With Ternary Elements to Strain Rate and High Temperature .....</b> | <b>511</b> |
| <i>Yinmin Wang, Dongliang Lin, and Yun Zhang</i>                                                                               |            |
| <b>Practical Design of Ni<sub>3</sub>Al With High Hot Workability .....</b>                                                    | <b>517</b> |
| <i>Yinmin Wang, Dongliang Lin, and Yun Zhang</i>                                                                               |            |
| <b>An Explanation of the Small Strain-Rate Sensitivity of Ni<sub>3</sub>Al .....</b>                                           | <b>523</b> |
| <i>Y.Q. Sun</i>                                                                                                                |            |
| <b>Dislocation Structures in Ni<sub>3</sub>(Al, Hf) .....</b>                                                                  | <b>529</b> |
| <i>T. Kruml, B. Viguier, J. Bonneville, P. Spätig, and J.L. Martin</i>                                                         |            |
| <b>Modeling of the Dislocation Dynamics in Ni<sub>3</sub>Al and the Flow Stress Anomaly .....</b>                              | <b>535</b> |
| <i>B. Devincere, P. Veyssiere, L. Kubin, and G. Saada</i>                                                                      |            |
| <b>An Analysis of the Slip of Screw Dislocations in L1<sub>2</sub> Alloys .....</b>                                            | <b>541</b> |
| <i>Patrick Veyssière</i>                                                                                                       |            |
| <b>Stress Response by the Strain-Rate Change in Binary, Stoichiometric Ni<sub>3</sub>Al Single Crystal .....</b>               | <b>549</b> |
| <i>M. Demura and T. Hirano</i>                                                                                                 |            |
| <b>Notch-Tip Deformation of Ni<sub>3</sub>Al Single Crystals .....</b>                                                         | <b>555</b> |
| <i>E.M. Schulson and Y. Xu</i>                                                                                                 |            |
| <b>Fabrication of NiAl Intermetallic From Dense Elemental Powder Blends Via Solid State Reactions .....</b>                    | <b>561</b> |
| <i>L. Farber, I. Gotman, and E.Y. Gutmanas</i>                                                                                 |            |
| <b>Creep in Single Crystal Ni<sub>3</sub>Al .....</b>                                                                          | <b>567</b> |
| <i>W. Zhu, I.P. Jones, D. Fort, and R.E. Smallman</i>                                                                          |            |
| <br><b>PART VI: REFRACTORY METAL-BASED AND OTHER INTERMETALLICS</b>                                                            |            |
| <b>*Recent Work on Environmental Embrittlement in Silicides .....</b>                                                          | <b>575</b> |
| <i>Guoliang Chen, Jihua Peng, and Xitao Wang</i>                                                                               |            |
| <b>Lattice Defects Affecting Moisture-Induced Embrittlement of Ni-Based L1<sub>2</sub>-Ordered Intermetallics .....</b>        | <b>587</b> |
| <i>T. Takasugi and S. Hanada</i>                                                                                               |            |

\*Invited Paper

**Effect of Microstructure on the Properties of MoSi<sub>2</sub> and Its Composites** ..... 593  
*A. Newman, T. Jewett, S. Sampath, and H. Herman*

**Stacking Faults on (001) in Transition-Metal Disilicides With the C11<sub>b</sub> Structure** ..... 599  
*K. Ito, T. Nakamoto, H. Inui, and M. Yamaguchi*

**Plastic Deformation of Mo(Si,Al)<sub>2</sub> Single Crystals With the C40 Structure** ..... 605  
*M. Moriwaki, K. Ito, H. Inui, and M. Yamaguchi*

**Preparation, Structure, and Mechanical Properties of RuAl and (Ru,Ni)Al Alloys** ..... 611  
*A.L.R. Sabariz and G. Taylor*

**Site Occupancies in Ternary C15-Ordered Laves Phases** ..... 617  
*P.G. Kotula, I.M. Anderson, F. Chu, D.J. Thoma, J. Bentley, and T.E. Mitchell*

**Elastic Constants of a Laves Phase Compound: C15 NbCr<sub>2</sub>** ..... 623  
*Alim Ornecl, F. Chu, John M. Wills, S.P. Chen, R.C. Albers, D.J. Thoma, and T.E. Mitchell*

**Creep of Anomalous Ni<sub>3</sub>Ga** ..... 629  
*M.J. Lunt and Y.Q. Sun*

**Anomalous Temperature Dependence of Yield Stress and Work-Hardening Coefficient of B2-Stabilized NITI Alloys** ..... 635  
*Hideki Hosoda, Yoshinao Mishima, and Tomoo Suzuki*

**Relating Mechanical Properties With Dislocation Cores in Ni<sub>3</sub>Ge-Fe<sub>3</sub>Ge Intermetallic Alloys** ..... 641  
*T. John Balk, Mukul Kumar, and Kevin J. Hemker*

**Chemistry, Bonding, and Fracture of Grain Boundaries in Ni<sub>3</sub>Si** ..... 647  
*Shanthi Subramanian, David A. Muller, John Silcox, and Stephen L. Sass*

**Yield-Point Phenomenon and Serrated Yielding in Nb-40Ti-15Al** ..... 653  
*S. Perungulam, R. Wheeler, D.H. Hou, R.J. Grylls, S. Banerjee, and H.L. Fraser*

**Phase Relation and Microstructure of NbCr<sub>2</sub> Laves Intermetallics in Ternary Nb-Cr-X Alloy Systems** ..... 659  
*M. Yoshida and T. Takasugi*

**Creep Behavior of MoSi<sub>2</sub> with Si<sub>3</sub>N<sub>4</sub> Reinforcements** ..... 665  
*C.R. Feng and K. Sadananda*

**The Mechanical Behavior and Deformation Mechanisms of Nb-Al-V Alloys** ..... 671  
*D.K. Tappin, D.N. Horspool, L.S. Smith, and M. Aindow*

**\*Laves Phase-Based Materials: Microstructure, Deformation Modes, and Properties** ..... 677  
*K.S. Kumar*

**Comparison of NbCr<sub>2</sub> and HfV<sub>2</sub> C15 Laves Phases** ..... 689  
*D.J. Thoma, F. Chu, J.M. Wills, and T.E. Mitchell*

**Assessment of the Compositional Influences on the Toughness of TiCr<sub>2</sub>-Base Laves Phase Alloys** ..... 695  
*Katherine C. Chen, Samuel M. Allen, and James D. Livingston*

**Platinum Group Metals-Base Refractory Superalloys** ..... 701  
*Y. Yamabe-Mitarai, Y. Koizumi, H. Murakami, Y. Ro, T. Maruko, and H. Harada*

**High-Temperature Mechanical Behavior of B2 Type IrAl Doped With Ni** ..... 707  
*A. Chiba, T. Ono, X.G. Li, and S. Takahashi*

**PART VII: COMPOSITES**

**\*Ti-Modified Niobium-Silicide-Based Directionally Solidified In situ Composites** ..... 715  
*B.P. Bewlay, M.R. Jackson, and H.A. Lipsitt*

**\*Mechanical Behavior of Molybdenum-Modified Cr<sub>3</sub>Si/Cr<sub>5</sub>Si<sub>3</sub> Intermetallics** ..... 727  
*M. Nazmy, C. Nosedá, S. Augustin, P. Lipetzky, and N.S. Stoloff*

**Reactive Infiltration Processing of Bulk and Fiber-Reinforced NiAl** ..... 737  
*T.A. Venkatesh, C.W. Sanmarchi, A. Mortensen, and D.C. Dunand*

**\*Effects of Rhenium Alloying on the Microstructures and Mechanical Properties of Directionally-Solidified NiAl-Mo Eutectic Alloy** ..... 743  
*A. Misra, Z.L. Wu, and R. Gibala*

**Mechanical Behavior of Reactively Hot-Pressed Aluminide Matrix Composites** ..... 755  
*M. Inoue, K. Suganuma, and K. Niihara*

**Al<sub>2</sub>O<sub>3</sub> Composites Containing Fe, Nb, and Zr Aluminides** ..... 761  
*D.E. García, S. Schicker, J. Bruhn, A. Krupp, R. Janssen, and N. Claussen*

\*Invited Paper

Cambridge University Press  
978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII  
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner  
Frontmatter  
[More information](#)

**Y<sub>2</sub>O<sub>3</sub> Morphology in an Oxide Dispersion-Strengthened  
FeAl Alloy Prepared by Mechanical Alloying ..... 767**  
*B.J. Inkson and P.L. Threadgill*

**Author Index ..... 773**

**Subject Index ..... 777**

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)

## PREFACE

Many advances in research and development have been made since the first Materials Research Society symposium on high-temperature ordered intermetallic alloys, held in Boston, MA, November 26–28, 1984. That conference demonstrated a resurgence of interest in potential uses of intermetallic alloys for structural applications. This interest was stimulated by success in toughening of TiAl alloys and the dramatic influence of boron additions on the ductility of polycrystalline Ni<sub>3</sub>Al. The blossoming of this research field has resulted in this series of MRS symposia, with these proceedings representing the written record of the seventh in the series. Interest in the series has grown over the years such that the sixth symposium required parallel sessions, as well as poster sessions, to handle the large number of submitted papers. In an attempt to manage the size of the seventh symposium, the organizers limited the scope to processing and micro-structural control, alloy design, mechanical properties, and industrial applications. Excellent work on the theory of phase stability, dislocation modeling, and other fundamental issues was purposely deleted to allow for a smaller symposium and to emphasize the applications of this maturing field. While we first planned for a three-day symposium, in spite of the above restrictions we were forced to have a four-day symposium (with eight oral sessions and three poster sessions) because of the large number of contributions received. This response suggests that intermetallic alloys remain a vibrant field of research and development.

While the symposium illustrated that considerable attention is still being devoted to a basic understanding of deformation mechanisms in intermetallics, the field has matured to the point where processing and heat-treatment innovations are supplanting alloy-development approaches to improved properties. Research continues to lag in key areas such as impact properties, fatigue behavior and oxidation resistance. However, more examples of structural applications of the “mature” intermetallics, TiAl and Ni<sub>3</sub>Al, were presented. High-melting-temperature refractory or platinum group metal-based intermetallics described in the symposium are still in the “exotic” category, but perhaps represent the best potential for a breakthrough in high-temperature performance.

C.C. Koch  
C.T. Liu  
N.S. Stoloff  
A. Wanner

March 1997

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)

---

Cambridge University Press  
978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII  
C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner  
Frontmatter  
[More information](#)

---

## ACKNOWLEDGMENTS

All of the papers appearing in this proceedings were reviewed following MRS procedures. Many of the session chairs assisted in the review process by serving as key readers for the manuscripts. These were:

H. Clemens  
B.P. Bewlay  
H.L. Fraser

R. Gibala  
M.H. Loretto  
J. Mundy

We thank all of the reviewers for their time and effort in assuring the quality and relevance of the papers. We also thank T. Malow and T. Smith for their assistance in developing the author and subject indices.

We also gratefully acknowledge the financial support for the symposium by Oak Ridge National Laboratory and Kyoto University, Japan.

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)**MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS**

- Volume 420— Amorphous Silicon Technology—1996, M. Hack, E.A. Schiff, S. Wagner, R. Schropp, A. Matsuda 1996, ISBN: 1-55899-323-1
- Volume 421— Compound Semiconductor Electronics and Photonics, R.J. Shul, S.J. Pearton, F. Ren, C-S. Wu, 1996, ISBN: 1-55899-324-X
- Volume 422— Rare-Earth Doped Semiconductors II, S. Coffa, A. Polman, R.N. Schwartz, 1996, ISBN: 1-55899-325-8
- Volume 423— III-Nitride, SiC, and Diamond Materials for Electronic Devices, D.K. Gaskill, C.D. Brandt, R.J. Nemanich, 1996, ISBN: 1-55899-326-6
- Volume 424— Flat Panel Display Materials II, M. Hatalis, J. Kanicki, C.J. Summers, F. Funada, 1997, ISBN: 1-55899-327-4
- Volume 425— Liquid Crystals for Advanced Technologies, T.J. Bunning, S.H. Chen, W. Hawthorne, T. Kajiyama, N. Koide, 1996, ISBN: 1-55899-328-2
- Volume 426— Thin Films for Photovoltaic and Related Device Applications, D. Ginley, A. Catalano, H.W. Schock, C. Eberspacher, T.M. Peterson, T. Wada, 1996, ISBN: 1-55899-329-0
- Volume 427— Advanced Metallization for Future ULSI, K.N. Tu, J.W. Mayer, J.M. Poate, L.J. Chen, 1996, ISBN: 1-55899-330-4
- Volume 428— Materials Reliability in Microelectronics VI, W.F. Filter, J.J. Clement, A.S. Oates, R. Rosenberg, P.M. Lenahan, 1996, ISBN: 1-55899-331-2
- Volume 429— Rapid Thermal and Integrated Processing V, J.C. Gelpey, M.C. Öztürk, R.P.S. Thakur, A.T. Fiory, F. Roozeboom, 1996, ISBN: 1-55899-332-0
- Volume 430— Microwave Processing of Materials V, M.F. Iskander, J.O. Kiggans, Jr., J.Ch. Bolomey, 1996, ISBN: 1-55899-333-9
- Volume 431— Microporous and Macroporous Materials, R.F. Lobo, J.S. Beck, S.L. Suib, D.R. Corbin, M.E. Davis, L.E. Iton, S.I. Zones, 1996, ISBN: 1-55899-334-7
- Volume 432— Aqueous Chemistry and Geochemistry of Oxides, Oxyhydroxides, and Related Materials, J.A. Voight, T.E. Wood, B.C. Bunker, W.H. Casey, L.J. Crosse, 1997, ISBN: 1-55899-335-5
- Volume 433— Ferroelectric Thin Films V, S.B. Desu, R. Ramesh, B.A. Tuttle, R.E. Jones, I.K. Yoo, 1996, ISBN: 1-55899-336-3
- Volume 434— Layered Materials for Structural Applications, J.J. Lewandowski, C.H. Ward, M.R. Jackson, W.H. Hunt, Jr., 1996, ISBN: 1-55899-337-1
- Volume 435— Better Ceramics Through Chemistry VII—Organic/Inorganic Hybrid Materials, B.K. Coltrain, C. Sanchez, D.W. Schaefer, G.L. Wilkes, 1996, ISBN: 1-55899-338-X
- Volume 436— Thin Films: Stresses and Mechanical Properties VI, W.W. Gerberich, H. Gao, J-E. Sundgren, S.P. Baker 1997, ISBN: 1-55899-339-8
- Volume 437— Applications of Synchrotron Radiation to Materials Science III, L. Terminello, S. Mini, H. Ade, D.L. Perry, 1996, ISBN: 1-55899-340-1
- Volume 438— Materials Modification and Synthesis by Ion Beam Processing, D.E. Alexander, N.W. Cheung, B. Park, W. Skorupa, 1997, ISBN: 1-55899-342-8
- Volume 439— Microstructure Evolution During Irradiation, I.M. Robertson, G.S. Was, L.W. Hobbs, T. Diaz de la Rubia, 1997, ISBN: 1-55899-343-6
- Volume 440— Structure and Evolution of Surfaces, R.C. Cammarata, E.H. Chason, T.L. Einstein, E.D. Williams, 1997, ISBN: 1-55899-344-4
- Volume 441— Thin Films—Structure and Morphology, R.C. Cammarata, E.H. Chason, S.C. Moss, D. Ila, 1997, ISBN: 1-55899-345-2
- Volume 442— Defects in Electronic Materials II, J. Michel, T.A. Kennedy, K. Wada, K. Thonke, 1997, ISBN: 1-55899-346-0
- Volume 443— Low-Dielectric Constant Materials II, K. Uram, H. Treichel, A.C. Jones, A. Lagendijk, 1997, ISBN: 1-55899-347-9

Cambridge University Press

978-1-558-99364-8 - High-Temperature Ordered Intermetallic Alloys VII

C.C. Koch, C.T. Liu, N.S. Stoloff and A. Wanner

Frontmatter

[More information](#)**MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS**

- Volume 444— Materials for Mechanical and Optical Microsystems, M.L. Reed, M. Elwenspoek, S. Johansson, E. Obermeier, H. Fujita, Y. Uenishi, 1997, ISBN: 1-55899-348-7
- Volume 445— Electronic Packaging Materials Science IX, P.S. Ho, S.K. Groothuis, K. Ishida, T. Wu, 1997, ISBN: 1-55899-349-5
- Volume 446— Amorphous and Crystalline Insulating Thin Films—1996, W.L. Warren, J. Kanicki, R.A.B. Devine, M. Matsumura, S. Cristoloveanu, Y. Homma, 1997, ISBN: 1-55899-350-9
- Volume 447— Environmental, Safety, and Health Issues in IC Production, R. Reif, A. Bowling, A. Tonti, M. Heyns, 1997, ISBN: 1-55899-351-7
- Volume 448— Control of Semiconductor Surfaces and Interfaces, S.M. Prokes, O.J. Glemboki, S.K. Brierley, J.M. Woodall, J.M. Gibson, 1997, ISBN: 1-55899-352-5
- Volume 449— III-V Nitrides, F.A. Ponce, T.D. Moustakas, I. Akasaki, B.A. Monemar, 1997, ISBN: 1-55899-353-3
- Volume 450— Infrared Applications of Semiconductors—Materials, Processing and Devices, M.O. Manasreh, T.H. Myers, F.H. Julien, 1997, ISBN: 1-55899-354-1
- Volume 451— Electrochemical Synthesis and Modification of Materials, S.G. Corcoran, P.C. Searson, T.P. Moffat, P.C. Andricacos, J.L. Deplancke, 1997, ISBN: 1-55899-355-X
- Volume 452— Advances in Microcrystalline and Nanocrystalline Semiconductors—1996, R.W. Collins, P.M. Fauchet, I. Shimizu, J.-C. Vial, T. Shimada, A.P. Alvisatos, 1997, ISBN: 1-55899-356-8
- Volume 453— Solid-State Chemistry of Inorganic Materials, A. Jacobson, P. Davies, T. Vanderah, C. Torardi, 1997, ISBN: 1-55899-357-6
- Volume 454— Advanced Catalytic Materials—1996, M.J. Ledoux, P.W. Lednor, D.A. Nagaki, L.T. Thompson, 1997, ISBN: 1-55899-358-4
- Volume 455— Structure and Dynamics of Glasses and Glass Formers, C.A. Angell, T. Egami, J. Kieffer, U. Nienhaus, K.L. Ngai, 1997, ISBN: 1-55899-359-2
- Volume 456— Recent Advances in Biomaterials and Biologically-Inspired Materials: Surfaces, Thin Films and Bulk, D.F. Williams, M. Spector, A. Bellare, 1997, ISBN: 1-55899-360-6
- Volume 457— Nanophase and Nanocomposite Materials II, S. Komarneni, J.C. Parker, H.J. Wollenberger, 1997, ISBN: 1-55899-361-4
- Volume 458— Interfacial Engineering for Optimized Properties, C.L. Briant, C.B. Carter, E.L. Hall, 1997, ISBN: 1-55899-362-2
- Volume 459— Materials for Smart Systems II, E.P. George, R. Gotthardt, K. Otsuka, S. Troler-McKinstry, M. Wun-Fogle, 1997, ISBN: 1-55899-363-0
- Volume 460— High-Temperature Ordered Intermetallic Alloys VII, C.C. Koch, N.S. Stoloff, C.T. Liu, A. Wanner, 1997, ISBN: 1-55899-364-9
- Volume 461— Morphological Control in Multiphase Polymer Mixtures, R.M. Briber, D.G. Peiffer, C.C. Han, 1997, ISBN: 1-55899-365-7
- Volume 462— Materials Issues in Art and Archaeology V, P.B. Vandiver, J.R. Druzik, J. Merkel, J. Stewart, 1997, ISBN: 1-55899-366-5
- Volume 463— Statistical Mechanics in Physics and Biology, D. Wirtz, T.C. Halsey, J. van Zanten, 1997, ISBN: 1-55899-367-3
- Volume 464— Dynamics in Small Confining Systems III, J.M. Drake, J. Klafter, R. Kopelman, 1997, ISBN: 1-55899-368-1
- Volume 465— Scientific Basis for Nuclear Waste Management XX, W.J. Gray, I.R. Triay, 1997, ISBN: 1-55899-369-X
- Volume 466— Atomic Resolution Microscopy of Surfaces and Interfaces, D.J. Smith, R.J. Hamers, 1997, ISBN: 1-55899-370-3

*Prior Materials Research Society Symposium Proceedings available by contacting Materials Research Society*