

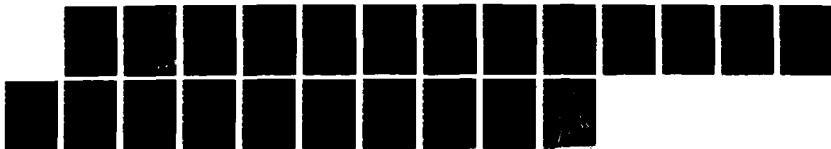
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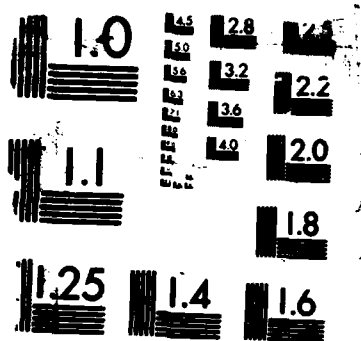
GORDON CONFERENCE ON INTERMETALLIC COMPOUNDS HELD AT
TILTON NEW HAMPSHIRE (U) RHODE ISLAND UNIV KINGSTON
PASTORE CHEMICAL LAB D P POPE ET AL 31 OCT 87
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The 1987 Gordon Conference in Physical Metallurgy concerned the subject of "Intermetallic Compounds". The Conference was held at Tilton School, Tilton, N.H., 20-24 July 1987. The Conference consisted of papers presented by authors outstanding in the field and of extensive discussion. The Conference was attended by 130 scientists and engineers from the USA and from seven other countries.			
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FINAL REPORT

**AFOSR GRANT (AFOSR-87-0195) FOR THE SUPPORT OF THE
1987 GORDON CONFERENCE ON PHYSICAL METALLURGY**

"INTERMETALLIC COMPOUNDS"

Submitted to

**Air Force Office of Scientific Research
Division of Research Grants, Building 410
Bolling AFB, Washington, D.C. 20332**

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October, 1987



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INTRODUCTION

The 1987 Gordon Research Conference on Physical Metallurgy was held 20-24 July 1987 at the Tilton School, Tilton, New Hampshire. The conference topic was "Intermetallic Compounds". U.S. Government Grants were made to the Gordon Research Conference to partially offset the travel and registration costs of many of the speakers and discussion leaders, a few attendees, and the co-chairmen. The grants totalled \$18,000.00. Of this total, \$6000.00 each was provided by AFOSR and ONR (AFOSR-87-0195), and DOE/ECUT (DEFG05-87CE90006). In addition, \$3000.00 was received from industry for this same purpose. Of this total, \$2000.00 was received from the Aluminum Company of America and \$1000.00 was received from the General Electric Corporation. In this report we give a brief description of the Conference and describe some of the highlights of the meeting.

CONFERENCE DESCRIPTION

The primary purpose of the Conference was to bring together three rather disparate groups: scientists and engineers concerned with the mechanical properties of intermetallic compounds, theoreticians interested in the problems of alloy stability and the calculation and prediction of the effects of chemical composition on alloy stability, and engineers interested in developing and producing new alloys based on intermetallic compounds for elevated temperature service. It is important that the effectiveness and progress of this last group depends critically on the results of the efforts of the first two groups. *to page VI*

The Conference was organized to allow each group the opportunity to present the status of current work in their respective areas and to discuss their current needs. For example, on one day the theoreticians described their approach and the sort of results that were developed by that approach. On the next day, the alloy designers described how useful

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alloys are really developed and indicated the type of information they believed the theoreticians should be producing so as to provide the maximum theoretical guidance to the alloy developers. The lengthy, animated discussions that followed indicated that much progress has been made to attune the theoreticians to the needs of the engineers and that considerable very useful information was emerging from the several existing collaborative areas. However, it continued to be clear that the most demanding needs of the engineers, i.e., predictive theories for the development of multiphase alloys, could not yet be met. It was equally clear that considerable dialogue had occurred between these groups and that the theoreticians were moving rapidly toward the goal of total group integration concerning these mutually challenging problems.

Following the tradition of previous Gordon Conferences, a relatively small number of speakers were invited to make presentations to the Conference. The primary purpose of these talks was to describe recent progress and to set the stage for thought and discussion. A copy of the program of speakers and discussion leaders is appended to this report.

A poster session was also held during the Conference so that some of the participants could present their research results. This was a well attended session that provided the basis for broad exposure of very new results and stimulated a great deal of excitement that continued past midnight. A list of the poster presentations is also appended to this report.

The Conference attracted participants from a wide variety of institutions and backgrounds. The list of attendees appended to this report shows that a total of 130 scientists and engineers participated in the Conference. Of these, only 32 were on the program as speakers and discussion leaders! The attendees included 109 from the United States and

21 from foreign countries. Of these, 65 were from universities, 35 from government laboratories or offices, and 30 from industry. Finally, it is worth noting that the number of applicants for this Conference exceeded the number of places available.

PROGRAM HIGHLIGHTS

The major opportunity at a Gordon Conference is the opportunity to interact on an informal level with a large number of scientists interested and knowledgeable in a given subject. The facilities at the Tilton School catered to this aspect in a number of ways. The main lounge, the game/clubroom, pool area, and the grounds were outstanding sites for informal discussion. These facilities were in use throughout the day and night for many, many small group discussions which led to the development of new research ideas, to several future small group research interactions, and to the development of two research plans to be submitted for Government support. Thus, the informal aspect of this Gordon Conference was a rousing success.

In the more formal program, Lipsitt set the tone for the first two sessions with a critical review of the nature of the changes in mechanical properties accompanying ordering and by pointing out those areas where our understanding was weakest. Vitek described the complex structure of the dislocation core in intermetallics as well as the mechanisms by which core geometry affects deformation behavior. Yoo, building on the understanding generated by Vitek and others, introduced a totally new "mechanics" concept of the strengthening caused by dislocations in intermetallic compounds. This exciting concept provoked much thought and discussion. Later, Stoloff described recent results on fatigue, while Yamaguchi reviewed his recent experiments aimed at introducing ductility into one class of intermetallic alloys.

On the second day, Dimiduk showed that considerable understanding of ductile-brittle behavior could be gained by considering the presence or absence of a second phase in the grain boundaries, in antiphase domain boundaries, and perhaps even dispersed in the structure. This was a new concept for intermetallics with immediate effects on potential alloy development! The papers by Taub and by Izumi described a number of studies related to the atomic structure of grain boundaries and its effect on ductility. Taub's studies were very carefully done and the results cast doubt on a number of previous elementary explanations of the role of grain boundaries on deformation in intermetallics. The results presented by Williams and by Schulson were exciting because they showed how important microstructural manipulation could be as an effective way to alter mechanical behavior in these materials.

The third day belonged to the theoreticians. It was their opportunity to present the advantages and disadvantages of their individual approaches to intermetallic structures and properties. In this session, Freeman presented a particularly valuable paper showing how his ab initio ground state calculations could predict structural stability and alloying effects in intermetallics. Later, two very different (and heretical) approaches were presented by Vvedensky and by Pettifor. These two papers were the subject of the most intense discussion of the Conference. The theoretical presentations at this Conference created considerable excitement because they were given following the presentation of considerable background and because many in the audience were aware that theoretical guidance is sorely needed in the development of intermetallics for use as structural materials.

Next, several prominent engineers outlined their individual approaches to the determination of how intermetallics may best be selected for study

and modified for service. Finally, three groups that had actual experience developing intermetallic alloys described their approaches and results. The final paper of the Conference, presented by Blackburn, was the first public report on the approaches used for development of alloys based on the titanium aluminides. Since these alloys are soon to enter turbine engine service in military engines and are also prime candidates for the structure of the National Aerospace Plane, this was another paper that generated considerable interest. By actual count, 90 delegates were present to hear this final paper of the Conference.

1987 GORDON CONFERENCE ON PHYSICAL METALLURGY

July 20-24, 1987, Tilton School, Tilton, NH

TOPIC: INTERMETALLIC COMPOUNDS

H. Lipsitt and D. Pope, Co-chairs

Monday, July 20
Morning session

Session Chair:
G. Sauthoff
Max-Planck Institut fur Eisenforschung

8:45-9:00

WELCOME

9:00-9:40

→ OVERVIEW OF STRENGTH AND DUCTILITY OF INTERMETALLIC
COMPOUNDS,
H. Lipsitt
Wright State University

9:40-10:00

DISCUSSION

10:00-10:30

BREAK and PHOTO SESSION

10:30-11:10

→ DISLOCATION CORE STRUCTURE AND SLIP SYSTEMS IN
INTERMETALLIC COMPOUNDS,
V. Vitek
University of Pennsylvania

11:10-11:30

DISCUSSION

11:30-12:10

→ STRENGTHENING MECHANISMS IN INTERMETALLIC COMPOUNDS
M. Yoo
Oak Ridge National Laboratory

12:10-12:30

DISCUSSION

Monday, July 20
Evening session

Session Chair:
T. Suzuki
Tokyo Institute of Technology

(ANNOUNCEMENT OF NOMINATING COMMITTEE FOR CHAIR OF
1989 CONFERENCE)

7:30-8:10

→ CREEP AND FATIGUE OF INTERMETALLIC COMPOUNDS,
N. S. Stoloff
Rensselaer Polytechnic Institute

8:10-8:30

DISCUSSION

8:30-9:10

→ DEFORMATION OF NON-CUBIC INTERMETALLIC COMPOUNDS
M. Yamaguchi
Kyoto University

9:10-9:30

DISCUSSION

Tuesday, July 21
Morning session

Session Chair:
L. A. Johnson
General Electric Corporation

9:00-9:40

> OVERVIEW OF BRITTLE-DUCTILE TRANSITION MECHANISMS,
D. Dimiduk
Wright Patterson Air Force Base

9:40-10:00

DISCUSSION

10:00-10:15

BREAK

10:15-10:55

> MECHANISMS OF DUCTILITY IMPROVEMENT IN Li_2 COMPOUNDS
O. Izumi
Tohoku University

10:55-11:15

DISCUSSION

11:15-11:55

> EFFECTS OF COMPOSITION ON THE TENDENCY FOR INTERGRANULAR FRACTURE IN Li_2 COMPOUNDS
A. I. Taub and C. L. Bryant
General Electric Corporation

11:55-12:15

DISCUSSION

Tuesday, July 21
Evening session

Session Chair:
P. Veyssiere
Universite de Poitiers

(NOMINATING COMMITTEE PRESENTS NOMINEES AND
NOMINATIONS FROM FLOOR)

7:30-8:05

MICROSTRUCTURAL EFFECTS ON THE DUCTILITY OF INTERMETALLIC COMPOUNDS
J. C. Williams
Carnegie Mellon University

8:05-8:20

DISCUSSION

8:20-8:55

> GRAIN BOUNDARY ACCOMODATION OF SLIP,
E. M. Schulson
Dartmouth College

8:55-9:10

DISCUSSION

9:10-9:45

> GRAIN BOUNDARY MODELLING
D. Srolovitz and S.-P. Chen
Los Alamos National Laboratory

9:45-10:00

DISCUSSION

1-2-211

Wednesday, July 22
Morning session

Session Chair:
A. Gonis
Northwestern University

8:45-9:25

*** LIMITATIONS AND APPROXIMATIONS OF ELECTRONIC
STRUCTURE CALCULATIONS,**
A. Shere
SRI International

9:25-9:45

DISCUSSION

9:45-10:00

BREAK

10:00-10:40

AB-INITIO GROUND STATE CALCULATIONS
A. J. Freeman
Northwestern University

10:40-11:00

DISCUSSION

11:00-11:40

*** THE THERMODYNAMICS OF EXTENDED DEFECTS IN
INTERMETALLIC COMPOUNDS,**
J. M. Sanchez
Columbia University

11:40-12:00

DISCUSSION

12:00-12:30

ELECTION OF CHAIR OF 1989 GORDON CONFERENCE

Wednesday, July 22
Afternoon session

4:30-6:00

POSTER SESSION

Wednesday, July 22
Evening session

Session Chair:
A. Sutton
University of Oxford

7:30-8:10

*** QUANTUM MECHANICS AND FRACTURE** 
D. D. Vvedensky
Imperial College

8:10-8:30

DISCUSSION

8:30-9:10

QUANTUM MECHANICS AND ALLOY DESIGN
D. Pettifor
Imperial College

9:10-9:30

DISCUSSION

Thursday, July 23
Morning session

Session Chair:
J. Tien
Columbia University

9:00-9:40

**ALLOY DESIGN: WHAT EXPERIMENTALISTS NEED FROM
THEORETICIANS**

S. K. Das
Allied Chemical Corporation

9:40-10:00

DISCUSSION

10:00-10:15

BREAK

10:15-10:55

SELECTION AND EVALUATION OF INTERMETALLIC ALLOYS

D. M. Shah
Pratt and Whitney Aircraft

10:55-11:15

DISCUSSION

11:15-11:55

THE SEARCH FOR HIGH STRENGTH AT HIGH TEMPERATURES

R. L. Fleischer
General Electric Corporation

11:55-12:15

DISCUSSION

Thursday, July 23
Evening session

Session Chair:
D. P. Pope
University of Pennsylvania

8:30-9:30

CORROSION AND ART

J. E. Harris
Berkeley Nuclear Laboratories

9:30-10:00

DISCUSSION

Friday, July 24
Morning session

Session Chair:
C. C. Koch
North Carolina State University

8:45-9:25

DUCTILE NI-ALUMINIDE ALLOYS
C. T. Liu
Oak Ridge National Laboratory

9:25-9:45

DISCUSSION

9:45-10:00

BREAK

10:00-10:40

B2-BASE MATERIALS AND COMPOSITES
K. Vedula
Case Western Reserve University

10:40-11:00

DISCUSSION

11:00-11:40

NIAl AND TAl-BASE ALLOYS
M. J. Blackburn
Pratt and Whitney Aircraft

11:40-12:00

DISCUSSION

POSTER SESSION CONTRIBUTIONS

1. "Physical Metallurgy and Creep Properties of a Beta-NiAl + 4.5 at/o Ta Alloy", V.M. Pathare, G.M. Michal, and K.M. Vedula, Case-Western Reserve University, Cleveland.
2. Rapid Solidification of TiAl Intermetallic Compounds", J.M. Graves and J.H. Perepezko, University of Wisconsin, Madison.
3. Mechanical Properties and Microstructure of a Ni-Base Alloy Single Crystal", M. Mills, N. Baluc, J. Bonneville, and J. Stolber, Ecole Polytechnic, Lausanne.
4. "Sigma Distribution and Relative Energy Determinations of Grain Boundaries in Ductile and Brittle Ni₃Al", Diana Farkas, M.O. Lewis, and R. Venkataraman, Virginia Polytechnic Institute, Blacksburg.
5. "Influence of Grain Boundaries on the Crack Development in Thin Foils of Ni₃Al", R. Maurer, Max Planck Inst. fur Metallforschung, Stuttgart.
6. "Strengthening of Ni₃Al by Ternary Additions", F. Heredia and D. Pope, University of Pennsylvania, Philadelphia.
7. "Dislocation Structure in Gamma Prime Strengthened Superalloy", Y.Q. Sun and P.M. Hazzledine, Oxford University, England.
8. "Plastic Deformation and Ductility Improvement of Al₃X Type Compounds of Al with the DO₁₉ Structure", Y. Umakoshi, M. Yamaguchi, and T. Yamane, Tokyo.
9. "Oscillatory Relaxations in (111) Planar Defects in Ni₃Al", D. Farkas, E.J. Savino, and F. Chidambaram, Virginia Polytechnic Inst., Blacksburg.

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