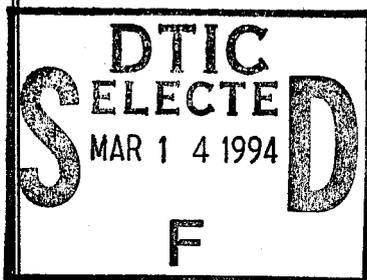


AOARD REPORT

International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments, Nagoya, Japan.

June 1993

Capt Paul A. McQuay
Science Liaison Officer



A summary of the "International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments," held in Nagoya, Japan, 1-2 June 1993. In addition to this symposium, a second symposium entitled "Japan-Europe Exchange on Composite Materials" was held concurrently. The primary sponsors of the symposia were the Japan Industrial Technology Association (JITA), and the R&D Institute of Metals and Composites for Future Industries (RIMCOF). Both conferences themes centered almost exclusively on advanced structural materials. In addition, some background information on RIMCOF, and the "High-Performance Materials for Severe Environments" project is given herein.

DISTRIBUTION STATEMENT A:
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

ASIAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

TOKYO, JAPAN
UNIT 45002
APO AP 96337-0007
DSN: (315) 229-3212
Comm: 81-3-5410-4409

19950309 043

DTIC QUARTERLY INDEXING



Background on RIMCOF

RIMCOF was established in 1981 by the Ministry of International Trade and Industry's (MITI) Agency of Industrial Science and Technology (AIST), under the New Energy and Industrial Technology Development Organization (NEDO). RIMCOF is an incorporated foundation with constitutional assets of ¥51.7 million (\$0.47M, where \$1=¥110), and an annual operating budget of ¥1.7 billion (\$15.5M) for fiscal year 1993. RIMCOF's major operations are from commissioned research and development projects, based on the Industrial Science and Technology Frontier Program planned by AIST. The current objectives of RIMCOF are to pursue "research and development of new metals and composites which have excellent characteristics, and disseminate(e) the achievements, contributing to the promotion and development of industry." To achieve these objectives, RIMCOF is conducting the following major operations (fiscal year 1993):

1. "R&D of High Performance Materials for Severe Environments" program, commissioned by NEDO.
2. Surveys commissioned by the Japan Machinery Foundation:
 - a. Technical trends in advanced new metals and their processing.
 - b. Application of intelligent composite system for aircraft.
 - c. Technical trends in material for space systems.

The management of RIMCOF includes a Board of Directors, with a Chairman and Vice-Chairman from industry, and a full-time Executive Director. In addition, a General Manager, who reports to the Executive Director, oversees three divisions: General Affairs, Metals, and Composites. *Membership in RIMCOF is not restricted to Japanese organizations. US members include Crucible Materials, Pratt & Whitney, and Rohr Industries.*

The current programs sponsored by RIMCOFF are summarized in the next section. Previous projects by RIMCOFF, lasting from 1991 to 1988 were "Advanced Alloys with Controlled Crystalline," and "Advanced Composite Materials." The former project expended approximately ¥4 billion (\$36.4 M). The materials developed on the project were a single-crystal Ni-based superalloy, a superplastic Ni-based superalloy, a superplastic Ti-based alloy, and a particle dispersion strengthened Ni-based superalloy. The later projects budget was approximately the same, and developed fiber reinforced plastic composite materials, and fiber reinforced metal composite materials.

Symposium Overview

The "International Symposium on Advanced Materials, 4th Symposium on High-Performance Materials for Severe Environments", was held in Nagoya, Japan, 1-2 June 1993. In addition to this symposium, a second symposium entitled "Japan-Europe Exchange on Composite Materials" was held concurrently. Both conferences themes centered almost exclusively on advanced structural materials, with the only exception being a session entitled "Recycling" under the Japan-Europe Exchange.

It should be noted that although the title of the conference claims that it is an "International Symposium," that almost without exception, the only foreign participants were invited speakers whose travel expenses were reimbursed, or local foreigners. This leads to fairly high registration fees for the participants, and also leads to most if not all of the talks to be given in English, in spite of the fact that over 90% of the audience are Japanese. However, the post-presentation questions and discussions are usually not translated into English. This style of meeting is very common in Japan, especially with MITI sponsored functions.

<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Codes

Dist	and/or Special
A-1	

All of the papers presented at the former symposium are technical status reports of R&D programs sponsored by the R&D Institute of Metals and Composites for Future Industries (RIMCOF). The efforts are part of a national program called "Industrial Science and Technology Frontier Program" formerly known as the "Basic Technologies for Future Industries". Participating in RIMCOF's projects are industry, universities, and government laboratories. Table 1 below lists the current research participants, and the project to which they are contributing.

Table 1. Participants in "R&D of High Performance Materials for Severe Environments"

Laboratory Type	Organization	Project	
Corporate	Ishikawajima-Harima Heavy Industries	I	
	Ube Industries	C	
	Crucible Materials	I	
	Kobe Steel	I, C	
	Nippon Steel	I, C	
	Daido Steel	I	
	Nippon Carbon	C	
	Hitachi	I	
	Fuji Heavy Industries	C	
	Mitsui Engineering and Shipbuilding	I	
	Mitsubishi Materials	I	
	Mitsubishi Heavy Industries	I, C	
	Petroleum Energy Center	C	
	University	Faculty of Technology, University of Tokyo	S
		Faculty of Technology, University of Kyoto	S
		Faculty of Technology, Tohoku University	S
Institute for Materials, Tohoku University		S	
Faculty of Technology, Osaka Prefectural University		S	
Governmental	National Research Laboratory of Metrology, AIST	Q	
	Mechanical Engineering Laboratory, AIST	I, Q	
	Government Industrial Research Institute, Nagoya, AIST	I	
	National Institute of Materials and Chemical Research, AIST	C, Q	
	Government Industrial Research Institute, Kyushu, AIST	C	
	National Research Institute for Metals, Science and Technology Agency	I	

I: Intermetallic Compounds; C: Composite Materials; Q: Evaluation Technology;
S: Fundamental Technology

The current technical themes of the RIMCOF "R&D of High Performance Materials for Severe Environments" program are development of intermetallic compounds and advanced composite materials, and the development of evaluation technology and material evaluation. The two intermetallic compounds currently under study are TiAl, and, while high temperature carbon-carbon composites (C/C), and fiber reinforced intermetallic composites comprise the advanced composite portion of the program. All three research efforts are divided into two phases lasting four years each. The first phase of the programs began in 1989 and is just completed, and the second phase which just began will end in 1996.

In the C/C symposium, one of the speakers acknowledged that the key issue in the development of C/C materials for high temperature applications remains the lack of resistance to oxidation. He also observed that the Japanese C/C community lags approximately 5-10 years behind the US in coating and oxidation resistance technology.

In the area of intermetallic materials, the most interesting work on gamma TiAl in the program remains the isothermal rolling of gamma TiAl sheet. The experimental isothermal mill, which was fabricated for this program by Kobe Steel, has a maximum roll temperature of 1050°C, with an internal preheating unit with a maximum temperature of 1200°C. Although there may be issues associated with the scalability and cost effectiveness of isothermal rolling for TiAl, sheet has been successfully rolled from both single and two phase TiAl, with fairly good results. Also of potential interest is an experimental stirring synthesis process for producing cast gamma TiAl with a fine grain size, being developed by MITI's Mechanical Engineering Laboratory. Most of the work to date has been done on the Cu-Al model system, but the initial work on gamma TiAl looks promising, producing cast grain sizes on the order of 1-3 μm .

The research reported at the conference on Nb-Al intermetallic compounds indicated that although these alloys are less mature than gamma TiAl, considerable progress has been made in ingot and powder processing of Nb₃Al, as well as alloy development leading to enhanced strength up to 1500°C.

Within the metal-matrix composite symposium, the most notable results were related to developments in new SiC fibers. The most impressive results were from a new fiber developed by Ube Industries called the Tyranno fiber, a Si-Ti-C fiber synthesized from an organometallic polymer. The fiber reportedly has a strength of 2.3 GPa, tested in air at 1500°C. Due to its Ti content, the fiber also has better thermal and chemical stability with Ti alloys. Another new fiber developed by Nippon Carbon, also synthesized from an organometallic polymer, also looks promising for improved high temperature tensile strength and thermal stability.

The major themes of the "Japan-Europe Exchange on Composite Materials" were polymer-matrix composites (PMC), metal and ceramic matrix composites, and recycling. The majority of the papers were presented by authors from Japan, with some authors also from France, the United Kingdom, Belgium, the Netherlands, Denmark and Italy.

The table of contents for both of the conference proceedings are attached. Please contact AOARD if you are interested in receiving a copy of one of these papers.

次世代先進材料国際シンポジウム

INTERNATIONAL SYMPOSIUM ON ADVANCED MATERIALS

第4回 超耐環境性先進材料シンポジウム

講演集

PROCEEDINGS

OF

THE 4TH SYMPOSIUM ON HIGH-PERFORMANCE
MATERIALS FOR SEVERE ENVIRONMENTS

平成5年6月1日(火)～2日(水)

名古屋国際会議場 (白鳥センチュリープラザ)

June 1st (Tue.) to 2nd (Wed.), 1993

Nagoya Congress Center (Shirotori Century Plaza), Nagoya

財団法人 次世代金属・複合材料研究開発協会
財団法人 日本産業技術振興協会

R&D Institute of Metals and Composites for Future Industries (RIMCOF)
Japan Industrial Technology Association (JITA)

目 次 CONTENTS

特別講演 日本語

Special Presentation Japanese

- 高分解能電子顕微鏡の進歩とその先進材料開発への寄与 1
 Progress in High Resolution Electron Microscopy and Its Contribution to the
 Development of Advanced Materials

愛知工業大学教授

井村 徹

T. Imura

Professor, Aichi Institute of Technology

招待講演 英語

Invited Presentation English

- チタンアルミナイド基金属間化合物及び複合材料に関する科学技術の最近の進歩 10
 Recent Developments in the Science and Technology of Monolithic and Composite
 Materials Based on Titanium Aluminides

アイダホ大学教授 (アメリカ)

F. H. フローエス

F. H. Froes

Professor, University of Idaho (U.S.A.)

I - a C/C 複合材料 日本語
 C/C Composites Japanese

- I-1. PAN系織物C/C複合材料の超高温引張特性および室温引張強度に及
 ぼす切欠の影響 37
 Tensile Properties of Woven Fabric C/C Composites at Ultra-High Temper-
 ature and Effect of Notching on Tensile Strength at Room Temperature

(株)神戸製鋼所

木内 晃, 岩田育徳, 中尾 昇

A. Kiuchi, I. Iwata, N. Nakao

Kobe Steel, Ltd.

- I-2. C/C系複合材のマトリックスの耐酸化性付与 46
 Oxi-Resistance of Matrix on C/C Composite Material

九州工業技術試験所

山田泰弘, 今村 健, 西久保桂子

Y. Yamada, K. Imamura, K. Nishikubo

Government Industrial Research Institute, Kyushu

- I-3. 石油ピッチ系C/C複合材料の開発と耐酸化技術 54
 Development of Petroleum Pitch-Based Carbon Fiber/Carbon Matrix
 Composite and Anti-Oxidation System for C/C Composites

(財)石油産業活性化センター 川越研究室

山内 宏, 岡本久夫, 小坂勝明

H. Yamauchi, H. Okamoto, K. Kosaka

Kawagoe Laboratory of Petroleum Energy Center

- I-4. Si系耐酸化多層被膜C/Cの力学特性への影響 63
 The Influence on Mechanical Properties of Si Based Anti-Oxidation
 Multi-Layer Coated C/C Composite

富士重工業(株)

菅原 憲明, 神山隆之, 小田晴信, 柴崎 修

N. Sugahara, T. Kamiyama, H. Oda, O. Shibazaki

Fuji Heavy Industries Ltd.

1-5. C/C複合材料用HfCコーティング条件の探索 Coating Process of HfC on C/C Composites	73
(財)石油産業活性化センター-名古屋研究室 田尻桂介, 関川貴洋 K. Tajiri, T. Sekigawa Nagoya Laboratory of Petroleum Energy Center	
I-b C/C複合材料 英語 C/C Composites English	
1-6. 超耐環境性先進材料(複合材料)の研究開発状況 Status of R & D of High-Performance Materials for Severe Environments (Composite Materials)	85
物質工学工業技術研究所 林 龍一 R. Hayashi National Institute of Materials and Chemical Research	
1-7. C/C複合材料における繊維とマトリックスの適合性 Mechanical Properties and Microstructure Correlations in C/C Composites	88
東京大学 香山 晃 A. Kohyama The University of Tokyo	
1-8. スパッタ法によるIrの成膜と熱安定性 Structure and Thermal Stability of Sputtered Ir Films	96
東北大学 越後谷淳一, K. ムンタズ J. Echigoya, K. Mumtaz Tohoku University	
1-9. ランダム構造炭素繊維の開発と高温耐熱材料への応用 Development of Random Structure Carbon Fiber and Its Application to High Thermal Resistive Materials	105
(財)石油産業活性化センター-鹿島研究室 江尻 宏, 高井康之, 森川 茂, 高島 稔, 永田芳和 H. Ejiri, Y. Takai, S. Morikawa, M. Takabatake, Y. Nagata Kashima Laboratory of Petroleum Energy Center	
1-10. 高性能炭素繊維を用いたC/C複合材料 Carbon/Carbon Composites Using High Performance Carbon Fibers	113
(財)石油産業活性化センター-横浜研究室 久手幸徳 Y. Kude Yokohama Laboratory of Petroleum Energy Center	
1-11. ピッチ/樹脂混合系マトリックスプリカーサーを用いる C/C複合材料の開発 Physical Properties of Pitch-Based Carbon-Fiber Reinforced Carbon Composites Using Pitch-Powder and Phenolic-Resin Mixture as Matrix Precursor	115
(財)石油産業活性化センター-大井研究室 津島栄樹, 高安 潤, 谷口硯土, 小林裕子, 進藤昭男 E. Tsushima, J. Takayasu, K. Taniguchi, H. Kobayashi, A. Shindo Ohi Laboratory of Petroleum Energy Center	

- I-12. 石炭ピッチ系C/C複合材料の機械的特性及びその支配的因子の検討 124
Development of High-Performance Coal Tar Pitch Based C/C Composites

新日本製鐵(株)
平野兼次, 成田暢彦, 向井幸一郎
K. Hirano, N. Narita, K. Mukai
Nippon Steel Corporation

I-C C/C複合材料 日本語
C/C Composites Japanese

- I-13. パルスCVI法によるC/C複合材料の複合化・成形技術の開発 135
Development of Advanced Carbon-Carbon Composites by Pulse
Chemical Vapor Infiltration Technique

(財)石油産業活性化センター岐阜研究室
中山裕敏, 伊牟田守, 酒井昭仁, 北森直樹, 西一洋
H. Nakayama, M. Imuta, A. Sakai, N. Kitamori, K. Nishi
Gifu Laboratory of Petroleum Energy Center

- I-14. 気相/液相複合含浸による複合材料製造プロセスの開発 144
Development of Gas Infiltration / Liquid Infiltration Hybrid
Process for Carbon / Carbon Composites

(財)石油産業活性化センター豊洲研究室
石崎雅人, 関谷裕次, 大塚隆志, 佐々正
M. Ishizaki, Y. Sekiya, T. Onami, T. Sasa
Toyosu Laboratory of Petroleum Energy Center

- I-15. C/C複合ロッド成形条件及び特性評価 153
Processing and Mechanical Properties of C/C Rods

(財)石油産業活性化センター相模原研究室
尾崎毅志, 寺本浩行, 奥村光弘, 菅野俊行, 高田良雄
T. Ozaki, H. Teramoto, M. Okumura, T. Sugano, Y. Takada
Sagamihara Laboratory of Petroleum Energy Center

III-a 金属間化合物 英語
Intermetallic Compounds English

- III-1. 超耐環境性先進材料(金属間化合物)の研究開発状況 165
Status of R & D of High-Performance Materials for Severe Environments
(Intermetallics)

機械技術研究所
中澤克紀
Y. Nakazawa
Mechanical Engineering Laboratory

- III-2. 金属間化合物TiAlの圧延加工のための基礎研究 169
A Basic Study of the Rolling of TiAl Compounds with the γ/α_2
Lamellar Microstructure

京都大学
山口正治, 乾晴行
M. Yamaguchi, H. Inui
Kyoto University

- III-3. 射出成型法によるTiAl系金属間化合物の粉末冶金 178
Powder Metallurgy of Ti-Al Intermetallic Compound by Injection Molding

名古屋工業技術試験所
加藤清隆, 松本章宏, 野崎佳彦
K. Kato, A. Matsumoto, Y. Nozaki
Government Industrial Research Institute, Nagoya

- III-4. 金属間化合物の攪拌合成技術 186
 Stirring Synthesis Process of Intermetallic Alloys
 機械技術研究所
 市川 冽
 K. Ichikawa
 Mechanical Engineering Laboratory
- III-5. TiAl 基金属間化合物材料の組織と特性 197
 Microstructure and Mechanical Properties of TiAl Base Alloys
 金属材料技術研究所
 中村森彦
 M. Nakamura
 National Research Institute for Metals
- III-6. 三元系状態図を基礎としたチタンアルミニドの合金開発 207
 Alloy Developments of Titanium Aluminides Based on Ternary Phase Diagrams
 新日本製鐵(株)
 橋本敬三, 木村正雄
 K. Hashimoto, M. Kimura
 Nippon Steel Corporation
- III-7. TiAl 系金属間化合物薄板の恒温圧延 215
 Isothermal Rolling of TiAl Sheet
 (株)神戸製鋼所
 森田章靖, 藤綱宣之, 服部重夫
 A. Morita, N. Fujitsuna, S. Hattori
 Kobe Steel, Ltd.
- III-8. 微細粒化したTiAl系金属間化合物の塑性変形特性 224
 Plastic Deformation of Fine Grain TiAl Intermetallic Compounds
 三菱重工業(株)
 佐藤広明, 都筑隆之
 H. Sato, T. Tsuzuku
 Mitsubishi Heavy Industries, Ltd.
- III-b 金属間化合物 日本語
 Intermetallic Compounds Japanese
- III-9. Nb₃Al 基合金の組織制御 237
 Microstructural Control in Nb₃Al Base Alloys
 東北大学
 花田修治
 S. Hanada
 Tohoku University
- III-10. Nb-Al系およびNb-Al-X系の高Nb側の組織ならびに酸化挙動 245
 Structure and Oxidation Behavior of Nb-Rich Alloys of Nb-Al
 and Nb-Al-X Systems
 金属材料技術研究所
 冨塚 功
 I. Tomizuka
 National Research Institute for Metals
- III-11. 第三元素の添加によるNb₃Alの機械的特性の向上 255
 Improvements of Mechanical Properties in Nb₃Al by Addition
 of Third Elements
 新日本製鐵(株)
 壽山竜之, 橋本敬三
 R. Suyama, K. Hashimoto
 Nippon Steel Corporation

- III-12. Nb - Al 系金属間化合物の溶解・鋳造技術と機械的特性 264
 Recent Development of Melting and Casting Process for Nb - Al
 Intermetallic Compounds and Mechanical Properties
 三井造船(株)
 出川 通, 鎌田勤也
 T. Degawa, K. Kamata
 Mitsui Engineering & Shipbuilding Co., Ltd.
- III-13. プラズマ溶解ガスアトマイズ法による Nb₃Al 急冷凝固粉末の製造 274
 Plasma-Melt-Gas Atomization Process for Producing Rapidly
 Solidified Powders of Nb₃Al Intermetallic Compounds
 三菱マテリアル(株)
 甲元宏明, 村橋紀昭, 河野 通
 H. Kohmoto, N. Murahashi, T. Kohno
 Mitsubishi Materials Corporation
- III-14. Nb - Al 系粉末の通電粉末圧延による板成形 283
 Sheet Forming of Nb - Al Powders by Isothermal Powder Rolling
 石川島播磨重工業(株)
 望月智俊, 大澤瑞城, 美野和明, 大友 暁
 C. Mochizuki, M. Ohsawa, K. Mino, A. Ohtomo
 Ishikawajima Harima Heavy Industries Co., Ltd.
- V-a 金属基複合材料 英語
 Metal Matrix Composites English
- V-1. 電子線照射硬化による超耐熱 SiC 繊維 295
 Ultrahigh Heat-Resistant SiC Fiber by Electron Beam Irradiation Curing
 日本カーボン(株)
 今井義一, 武田道夫, 市川 宏
 Y. Imai, M. Takeda, H. Ichikawa
 Nippon Carbon Co., Ltd.
- V-3. 高温で優れた機械的性質の SiTiC (PC) 繊維の開発 307
 Development of SiTiC(PC) Fiber with High Mechanical Properties
 and Excellent Heat Resistance
 宇部興産(株)
 山村武民, 佐藤光彦, 渋谷昌樹, 熊川 清, 長澤俊夫
 T. Yamamura, M. Sato, M. Shibuya, K. Kumagawa, T. Nagasawa
 Ube Industries, Ltd.
- V-b 金属基複合材料 英語
 Metal Matrix Composites English
- V-9. TiAl 金属間化合物のフィルム及び複合材料の製造 317
 Synthesis of TiAl Intermetallic Films and the Composites
 物質工学工業技術研究所
 鈴木孝和, 梅原博行, 林 龍一
 T. Suzuki, H. Umehara, R. Hayashi
 Institute of Materials and Chemical Research
- V-11. SiC (CVD) / TiAl 複合材料の製造技術 325
 Fabrication of SiC(CVD) TiAl Composites
 三菱重工業(株)
 藤原 力
 C. Fujiwara
 Mitsubishi Heavy Industries, Ltd.

- VI-1. 熱的性能の評価技術の開発 337
Evaluation of Thermal Properties of High-Performance Materials
for Severe Environments
計量研究所
井土正也, 泰勝一郎, 馬場哲也, 小野 晃
M. Izuchi, S. Shin, T. Baba, A. Ono
National Research Laboratory of Metrology
- VI-2. 超耐環境性先進材料の損傷許容性評価 347
Damage Tolerance Behavior of High Performance Materials for
Severe Environments
機械技術研究所
平野一美, 鈴木隆之
K. Hirano, T. Suzuki
Mechanical Engineering Laboratory
- VI-3. 先進耐熱材料のクリープ・強度特性 357
Creep Behavior and Strength of Advanced Materials in Adverse Environment
物質工学工業技術研究所
高橋 淳, 劔持 潔, 小笠達夫, 奥田 敏, 林 龍一
J. Takahashi, K. Kemmochi, T. Ogasa, O. Okuda, R. Hayashi
National Institute of Materials and Chemical Research
- VI-4. TiAl 金属間化合物の耐酸化性及び耐食性 366
Oxidation and Corrosion Resistance of TiAl Intermetallic Compounds
物質工学工業技術研究所
尾形幹夫, 梅原博行, 林 龍一
M. Ogata, H. Umehara, R. Hayashi
National Institute of Materials and Chemical Research
- VI-5. 超耐環境性先進材料データベースの構築 375
Development of Database of High-Performance Materials for
Severe Environments
大阪府立大学
三木光範
(財)次世代金属・複合材料研究開発協会
長峯 朗
M. Miki
University of Osaka Prefecture
A. Nagamine
R & D Institute of Metals and Composites for Future Industries

KEIRIN



このシンポジウムは、競輪の補助金を受けて開催いたします。

INTERNATIONAL SYMPOSIUM ON ADVANCED MATERIALS

PROCEEDINGS
OF
JAPAN - EUROPE SYMPOSIUM
ON
COMPOSITE MATERIALS

June 1st (Tue.) to 2nd (Wed.), 1993
Nagoya Congress Center (Shirotori Century Plaza), Nagoya

Japan Industrial Technology Association (JITA)
R&D Institute of Metals and Composites for Future Industries (RIMCOF)

CONTENTS

Special Presentation	
Progress in High Resolution Electron Microscopy and Its Contribution to the Development of Advanced Materials	1
T.Imura Professor,Aichi Institute of Technology	
Key Note Speeches	
CMC Parts Development	4
P.Lamicq Societe Europeenne de Propulsion, France	
Recent Progress in Research of C/C Composite in Japan	10
S.Kimura,E.Yasuda Tokyo Institute of Technology	
Session II -a Polymer Matrix Composites	
II -1 Effective Use of Polymer Blends in Polymer Matrix Composites	17
I.K.Partridge Cranfield Institute of Technology	
II -2 A Unique Process for the Production of Randomly Oriented Fiber Reinforced Thermoplastic Composites	23
T. Kitano, Y. Nagatsuka National Institute of Materials and Chemical Research	
II -3 Polymer Matrix Composites for Aircraft and Engine Applications	29
J.F.Sthor ONERA	
II -4 Control of Interlaminar Damage in Quasi-Isotropic Carbon/Epoxy Laminates by Use of Interleaf Films	31
T. Tanimoto, T. Morii Shonan Institute of Technology	
II -5 Vibration Characteristics of Fiber Composite Laminates with Shape Memory Polymer Film	37
T. Fukuda, N. Ohshima, Osaka City University K. Hourai, Sanyo Chemical Industries, Ltd.	
Session II -b Polymer Matrix Composites	
II -6 A FEM Approach for Compression Failure Mechanism of Orthotropic Composite Materials	45
T.Hayashi, T.Sakurai, H.Kaneda Research Center of Computational Mechanics (RCCM)	
II -7 Evaluation of the Scatter or Tensile Strength on Unidirectional Carbon Fiber Reinforced Composites	51
Z. Maekawa, K. Lee Kyoto Institute of Technology	
II -8 Progress on Non-Destructive Testing and Observation Methods for Composite Materials	56
C. Bathias, C. Le Niniven, D. Wu Conservatoire National des Arts et Metiers	

II - 9 Present Status of Nondestructive Evaluation of Advanced Polymeric Composite Materials and Possibility of Its Standardization	61
I. Kimpara The University of Tokyo	
II - 10 Long Term Damage of Glass-Fibre Composite Pipes Under Internal Pressure	70
J. Pabiot, P. Krawczak, C. Monnier Ecole des Mines de DOUAI	
II - 11 Mechanical Properties of Bolts Made by CFRP	76
G. Mizushima Kawasaki Heavy Industries, Ltd.	
Session IV - a Recycling	
IV - 1 A Common European Waste Management Approach: New Developments for Recycling and Incineration of Polymers and Composites	85
P. Beutin EUREKA	
IV - 2 Thermal Decomposition of FRP and Utilization of Residue	91
T. Kitamura, J. Hosokawa, Y. Kobayashi Government Industrial Research Institute, Shikoku	
IV - 3 Challenge for Recovery of Synthetic Materials from End-of-Life Vehicles	97
M. Costes Rhone-Poulenc	
IV - 4 Examples of FRP Recycling in Japan	102
Y. Fukuda, K. Akiyama Takeda Chemical Industries, Ltd	
Session IV - b Recycling	
IV - 5 Powder Technology in FRP	111
A. Hamamoto, R. Yoshioka Ishikawajima Harima Heavy Industries Co., Ltd	
IV - 6 Current European Progress in the Valorization of Ground Scrap from Reinforced Plastics into Newer Products	116
G. F.G. Mavel E x M	
IV - 7 Challenge for Recycling Technologies of FRP in Japan	121
T. Kitamura The Japan Reinforced Plastics Society (JRPS)	
Session V - a Metal Matrix Composites	
V - 2 Alpha Al ₂ O ₃ Hexagonal Platelets, Their Preforms and Composites	129
J. Mace Elf Atochem	
V - 4 Investigation of Melt-Preform Interactions in Aluminium Alloy Based MMC Incorporating Alumina Fibres	136
S. Fox, H.M. Flower, D.R.F. West Imperial College	

V - 5	Mesomechanical Approach to Deformation and Fracture Behaviour of Unidirectional Metal Matrix Composites	142
	S. Ochiai, M. Hojo, K. Osamura Kyoto University	
V - 6	The Elastic Limit in Discontinuous Reinforced Metal Matrix Composites	148
	R. Fougères, E. Maire, G. Lormand, P.-F. Gobin INSA	
Session V - b Metal Matrix Composites		
V - 7	High Strain Rate Superplasticity of Discontinuous Fiber Reinforced Aluminium Alloy Composites	157
	T. Imai, N. Izawa, Y. Nishida, M. Mabuchi Government Industrial Research Institute, Nagoya	
V - 8	Velocity Accommodation in Composite/Metal Contacts	163
	C. Turki, A. Chateauminois, M. Daoud, M. Salvia, L. Vincent Ecole Centrale de Lyon	
V - 10	Composite Coatings with Metallic Matrix Inconel 625 or TA6V against Fretting Corrosion and Wear in Sea Water	169
	J. L. Heuze, DGA/DCN Indret/Cesman R. Baccino, CEA/CEREM	
V - 12	High Temperature Deformation and Fracture of Fibre Reinforced Composites - Continuum Damage Mechanics Modelling	176
	M. McLean Imperial College	
Session VII C/C and CMC		
VII - 1	Mechanical Properties of Oxidation Resistant Si - Ti - C - O Fiber Reinforced 3D Woven Ceramic Composites	185
	T. Ishikawa, National Aerospace Laboratory M. Shibuya, Ube Industries, Ltd T. Hirokawa, Shikibo Ltd.	
VII - 2	Recent Progress in Carbon-Carbon Technologies	191
	J. F. Jamet, A. Hordonneau AEROSPATIALE	
VII - 3	Fabrication and Properties of SiC Whisker Reinforced TiC Matrix Composites	197
	A. Kamiya, K. Nakano Government Industrial Research Institute, Nagoya	
VII - 4	Ceramic-Matrix Composites for Applications in Severe Environments	203
	M. K. Hossain, R. Morrell National Physical Laboratory	
VII - 5	Material Design for Self-Diagnostic CFGFRP Used in Reinforced Concrete Structures	209
	M. Sugita, Shimizu Corporation H. Yanagida, The University of Tokyo N. Muto, Sogo Security Services, Co., Ltd.	
Poster Session		
P - 1	Fabrication of Carbon Fiber Reinforced Composites under Centrifugal Force	217
	M. Funabashi, T. Kitano National Institute of Materials and Chemical Research	

P-2	Dependence of Mechanical Properties of Commingled Yarn Composites on Processing Conditions	221
	G.O Shonaike, M.Masaou, H.Hamada, Z.Maekawa, T.Matsuo Kyoto Institute of Technology M.Yamane, Toyobo Co.,Ltd.	
P-3	Bending and Damping Properties of 2.5 D Knitted Fabric Composites	226
	S.Ramakrishna, W.L.Wu, M.Kotaki, M.Inoda, H.Hamada, Z.Maekawa Kyoto Institute of Technology R.Kanamura, T.Sanae, Toyama Prefectural Industrial Research Institute	
P-4	Research and Development of 3D-Fabric Reinforced Composites	232
	K. Fukuda, M. Kimbara, H. Tamaki Three-D Composites Research Corporation	
P-5	Flexural Fatigue of GFRP: Testing and Modelling	236
	F.Fournier, M.Salvia, L.Vincent, Ecole Center de Lyon A.Van Veele, J.J.Elmendorp, Shell Research Center	
P-6	Microstructure Change in C/C Composites during Graphitization Process	242
	K.Hamada, H.Tsunakawa, S.Sato, A.Kohyama The University of Tokyo	
P-7	Young's Modulus and Internal Friction in C/C Composites at Elevated Temperature	245
	H.Serizawa, S.Sato, A.Kohyama The University of Tokyo	
P-8	Localized Deformation and Fracture Seen in Compressive Testing of C/C Composites	248
	S.Sato, A.Kohyama The University of Tokyo	
P-9	High Temperature Structural Materials for HOPE	250
	H.Yamao, M.Taguchi, M.Yamashita Mitsubishi Heavy Industries, Ltd	
P-10	Mechanical Properties of Alumina Whisker/Zirconia Composites	252
	N.Tamari, T.Tanaka, I.Kondoh Government Industrial Research Institute, Osaka	
P-11	Processing and Microstructure of Pressure-Sintered SiC Platelet Reinforced Ce-TZP Composites	257
	A.Seleuk, U.Klein, C.A.Leach, R.D.Rawlings, Imperial College of Science	
P-12	Wear-Resistant Solid Lubricants of Surface Engineered Graphite Coatings on Ceramics and Composites	263
	G.Sorensen Aarhus University	
P-13	Newer Metallo-Ceramic Products	269
	J.Demit and G.F.G.Mavel COSMAL and ExM	
P-15	Mechanical Properties for Discontinuous Fiber Reinforced Aluminum Matrix Composites	270
	C.Masuda, Y.Tanaka, J.J.Balette-Pape National Research Institute for Metals	

P-16	Superplastic Forming of SiCw/Al Sheets	278
	T. Tsuzuku, H. Satoh, C. Fujiwara Mitsubishi Heavy Industries, Ltd.	
P-18	Enhancing Interface Bonding in Al ₂ O ₃ /Al-Alloy Composites for Improving Their High Temperature Mechanical Properties	280
	X.C.Liu, C. Bathias, P. Lefrancois ITMA, CNAM	
P-19	Effect of Coating Process on Weibull Parameters of Carbon Fiber Bundles for M.M.C.	286
	M.R.Mili, S.Mallet, S.Cardinal, P.Merle, P.F.Gobin G.E.M.P.P.M	
P-20	In-Situ Observation of Thermal Dry Reaction of TiAl-and Nb ₃ Al-Based Intermetallics	292
	A.Miyazaki, M.Okamoto, I.Tomizuka National Research Institute for Metals	
P-21	Analysis-Assisted Fabrication of TiAl-Based Thermal Barrier FGM and Its Performance in Supersonic Hot Gas Flow	294
	Y.Matsuzaki, J.Fujioaka, S.Okazaki Kawasaki Heavy Industries., Ltd	
P-22	Study on the Fasteners Made of MA.ODS Alloys to Hot Structures	301
	H.Hira Kawasaki Heavy Industries., Ltd. K.Tsukuta Daido Steel Co.,Ltd.	
P-23	In-Situ Observation Study of Failure Mechanisms in MMC Using a Stereographic Method	306
	J.J.Balette-Pape C.Masuda, Y.Tanaka National Research Institute for Metals	
P-24	Introduction of JUTEM Activities	313
	M. Fujikura Japan Ultra-high Temperature Materials Research Center Ltd.	
P-25	Mechanical Characterisation of Fibre Reinforced Ceramics by Indentation Testing	318
	P.Kapsa, L.Carpentier, Ecole Centrale de Lyon N Chavent, Soretrib	

This work was subsidized by the Japan Keirin Association through its Promotion funds from KEIRIN RACE.