NOTICE

**CERTAIN DATA
CONTAINED IN THIS
DOCUMENT MAY BE
DIFFICULT TO READ
IN MICROFICHE
PRODUCTS.**

Rec-

OAK RIDGE NATIONAL LABORATORY

DE91 005973

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.
POST OFFICE BOX 2008, OAK RIDGE, TENNESSEE 37831-6285

JAN 10 1991

ORNL
FOREIGN TRIP REPORT
ORNL/FTR-3829

DATE: December 21, 1990

SUBJECT: Report of Foreign Travel of C. R. Kennedy, Research Staff, Metals and Ceramics Division

TO: Alvin W. Trivelpiece

FROM: C. R. Kennedy

PURPOSE: The main purpose of this trip was to present an invited paper, "Irradiation Creep of Graphite," at the International Symposium on Carbon held at Tsukuba, Japan, November 4-8, 1990.

SITES VISITED:	11/4-8/90	Conference	Tsukuba, Japan
	11/12-13/90	JAERI	Tokai-mura, Japan

ABSTRACT: The traveler attended the Conference, International Symposium on Carbon, to present an invited paper, "Irradiation Creep of Graphite," and chair one of the technical sessions. There were many papers of particular interest to ORNL and HTGR technology presented by the Japanese since they do not have a particular technology embargo and are quite open in describing their work and results. In particular, a paper describing the failure of Minor's law to predict the fatigue life of graphite was presented. Although the conference had an international flavor, it was dominated by the Japanese. This was primarily a result of geography; however, the work presented by the Japanese illustrated an internal program that is very comprehensive. This conference, a result of this program, was better than all other carbon conferences attended by the traveler. This conference emphasizes the need for U.S. participation in international conferences in order to stay abreast of the rapidly expanding HTGR and graphite technology throughout the world. The United States is no longer a leader in some emerging technologies. The traveler was surprised by the Japanese position in their HTGR development. Their reactor is licensed and the major problem in their graphite program is how to eliminate it with the least perturbation now that most of the work has been done.

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, makes 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.

MASTERDISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
js-

THE INTERNATIONAL SYMPOSIUM ON CARBON

The advance program for this conference indicated that the papers were all at the cutting edge of carbon and graphite technology. The actual presentations and papers confirmed the comprehensive and advanced work presented at this conference. It was one of the best Carbon Conferences I have experienced over the past 28 years in either the United States or Europe considering both content and organization. The comprehensive program of the conference is given in Appendix B.

There was an international presence at this conference; however, most of the papers, and in particular the better papers, were Japanese. The presentations were made by young and enthusiastic scientists who did a credible job even though the official language of the conference was English. It should be noted that there were about 20 participants at this conference whose native language was English. I suppose English will continue to be the official language at these conferences; not because of the dominance of English speaking participants, but to put every one at the same disadvantage of communicating in a foreign tongue.

One of the best sessions was a panel discussion led by representatives of each country describing the active interests and activities in carbon and graphite. These summaries are very informative and are given in Appendix C. Particular attention should be given to the comments of Peter Thrower representing the United States where he makes a special point to illustrate the significant decline in U.S. work presented in international conferences and the increase in foreign work. The focus of his comments is primarily in the more advanced field of carbon fibers and composites. It is clear from the various countries comments that the United States may have a slight edge considering the overall scope of carbon technology; however, various countries are beginning to emerge as leaders in specific areas. The Japanese are specifically investing large sums in the manufacture of advanced carbon fibers, the French are already licensing methods in the United States for rapid densification of carbon/carbon composites, and Formosa is producing and consuming about one-half of the non-aerospace carbon fibers made in the world. Russia is investing large sums in work on diamond and diamond-like materials and making significant progress. However, the Russians do not seem to be doing much work on their HTGRs as they are reporting the same work and plans now for the past 3 to 4 years. Good basic work was also reported from third-world countries such as Brazil, Korea, and India.

JAPAN ATOMIC ENERGY RESEARCH INSTITUTE

The Japanese have now obtained a license for their HTGR, the HTTR (High Temperature Engineering Test Reactor). The major problem in their graphite program is how to eliminate it and redirect personnel in an orderly manner. They have quietly completed all of the necessary work for their reactor to be licensed. The commitment to this program is easily seen in a visit to HENDEL (Helium Engineering Demonstration Loop). This loop and instrumentation is much more extensive than Ft. St. Vrain as a test bed to obtain a first iteration on the operation of a full-scale gas circulating loop without the problems of radiation. Problems with the French circulators have already been corrected before building the reactor, and new improvements using magnetic bearings are under way. The choice of Grade IG110 as their moderator fuel block and reflector graphite was made on a sound economic and feasibility basis for their system. Other grades such as Grade

PGX from UCAR will be used in the support structure. I initially thought that Grade IG110 was not an optimum material for nuclear use in that it was expensive and would not have a life expectancy equivalent of either the U.S. or German Grades H451 and ASR1RS. However, Grade IG110 is not required to have a long life, and its extraordinary dimensional stability over the required exposure virtually eliminates differential growth stresses except from thermal gradients. Resistance to thermal stress can be confirmed in HENDEL, which fully simulates the fuel element by using electrical heaters. The economics of the selection comes from material uniformity and ability to assure quality without excessive testing. The premium paid for Grade IG110 is easily made up by the reduced need for excessive testing to establish a data base and assure quality of a more variable material. This is an example of good engineering directed toward accomplishing overall goals with an extremely high level of assurance.

APPENDIX A

ITINERARY

1990

- 10/31 Travel from Oak Ridge, Tennessee, to San Antonio, Texas
- 10/31-11/1 Chairman of ASTM C5 Committee Meeting, San Antonio, Texas
- 11/2-3 Travel from San Antonio, Texas, to Tsukuba, Japan
- 11/4-8 Attend International Symposium on Carbon and present invited paper
- 11/9 Travel from Tsukuba, Japan, to Tokai-Muri, Japan
- 11/10-11 Weekend
- 11/12-13 Visit Japan Atomic Energy Research Institute for discussions with Dr. M. Eto on irradiation characteristics of graphite with emphasis on creep
- 11/13 Travel from Tokai-Muri, Japan, to San Diego, California
- 11/14 Discussions with R. Vollman, CEGA, San Diego, California, on irradiation characteristics of graphite
- 11/15 Travel from San Diego, California, to Oak Ridge, Tennessee

APPENDIX B

PROGRAM FOR INTERNATIONAL SYMPOSIUM ON CARBON

International Symposium on Carbon

New Processing and New Applications

炭 素

TSUKUBA

TAN SO

1990

November 4—8

Tsukuba, Japan

November 5th, Morning

Chairman: Y. Sanada
(Plenary A) Chemistry of the Transformation of
 Aromatic Hydrocarbons to Carbon
 J.C. Lewis
 Parma Technical Center, UCAR Carbon
 Co. (U.S.A.)

Chairman: I. Mochida
SA01* Pyrolytic Behaviors of Pitch Materials-Synthesis
 of Mesophase Pitch by Heterogeneous Nucleation
 Method
 J.D. Park and S.H. Yoon
 Res. Inst. Ind. Sci. & Tech. (Korea)

Chairman: B. Rand
SA02 Studies on Effect of Quinoline Insolubles on
 Pitch Properties
 R.L. Sethi, C. Lal, C.L. Verma and
 R.K. Maheshwari
 National Physical Lab. (India)

SA03 Surface Characteristics of the Mesophase of
 Coal-Tar Pitch as an Industrial Application
 Y.H. Lee, A.M. Liu and C.H. Shao
 Grad. Inst. of Mater. Eng., National Taiwan
 Univ. (Taiwan)

SA04 Controlling the Number of Disordered Molecules
 in Mesophase Pitch by Blending
 I. Mochida, H. Toshima, Y. Korai,
 K. Murakami* and T. Hino*
 Kyushu Univ. and *Tonen Co., Ltd. (Japan)

SA05 Preparing Mesophase Pitch from Ethylene Tar
 and Coal Tar Pitch by Two Stage Heat-treatment
 J.Q. Fei, Y. Korai and I. Mochida
 Kyushu Univ. (Japan)

Chairman: N. Akizawa
SB01 A New Synthetic Pathway to Insoluble
 Fluoride-Graphite Intercalation Compounds,
 Reversible Substitution Intercalation in
 Anhydrous HF Solutions
 H. Tanihara, K. Kadono* and H. Imoto**
 Shinshu Univ., *Ind. Res. Inst., Osaka and
 **Central Inst. of Sony Corp. (Japan)

SB02 Preparation and Characteristics of New Graphite
 Fluoride Composite
 Y. Chong, N. Watanabe, Y. Kirino*,
 M. Ohashi* and A. Tanaka*
 Applied Sci. Res. Inst. and *Doshisha Univ.
 (Japan)

SB03 Stage Formation of Metal Chloride-Graphite
 Intercalation Compounds in Molten Salts
 Z.D. Wang and M. Inagaki*
 Toyohashi Univ. of Tech. and *Hokkaido
 Univ. (Japan)

Chairman: H. Tanihara
SB04 Intercalation Reaction in the Molten Salt of
 FeCl₂-PbCl₂ System
 M. Ohira, N. Nakagami* and M. Inagaki*
 Hokkaido Univ. and *Toyohashi Univ. of
 Tech. (Japan)

SB05 Intercalation of Mg, Ca, Sr, Ba, Eu, Yb, and Y
 in Liquid Ammonia into Graphite
 E. Stump, M. Hoehne, Y.N. Wang*,
 H. Alheid and H.J. Hummel
 Technische Univ. Clausthal (I.R.G.) and
 *Central South Univ. Tech. (P.R.C.)

SB06 Synthesis, Structure and Reactivity of
 Potassium-Arsenic Intercalated Graphite
 P. Lagrange and J. Asquith
 Univ. de Nancy I. (France)

SB07 Potential Changes During Intercalation of
 Sulfuric Acid into Various Carbon Materials
 N. Inashita and M. Inagaki*
 Hokkaido Univ. (Japan)

* Invited lecture A
 ** Invited lecture B

Chairman: C.R. Kennedy
SC01 Measurements of Thermal Conductivity and
 Thermal Expansion of an Isotropic Graphite by
 Thermal Shock Method
 T. Arai, S. Miki*, H. Uguchi, T. Oku**
 T. Iizuka and Y. Honda
 Japan Atomic Energy Res. Inst., *Toyo Tanso
 Co. Ltd. and **Ibaraki Univ. (Japan)

SC02 Irradiation Creep Coefficients at Different
 Irradiation Temperatures of a Fine-Grained
 Isotropic Graphite
 T. Arai, H. Uguchi, T. Oku*, T. Kodaira and
 M. Eto
 Japan Atomic Energy Res. Inst. and *Ibaraki
 Univ. (Japan)

SC03 Neutron Irradiation Effects on Mechanical
 Properties of Carbon Fiber Carbon Composite
 Y. Tanabe, E. Yasuda, S. Kimura*, T. Ieki*
 T. Murayama** and T. Yano**
 Res. Lab. of Eng. Materials, *Fac. of Eng. and
 **Res. Lab. for Nuclear Reactors, Tokyo Inst.
 Tech. (Japan)

Chairman: S. Sato
SC04** Fracture Toughness of a Fine-Grained Nuclear
 Graphite by Means of Various Methods
 M. Eto, S. Ishiyama, Y. Nishiyama, T. Oku*
 and T.D. Burchell**
 Japan Atomic Energy Res. Inst., *Ibaraki
 Univ. (Japan) and **Oak Ridge National
 Lab. (U.S.A.)

Chairman: T. Oku
SC05* Irradiation Creep of Graphite
 C.R. Kennedy
 Oak Ridge National Lab. (U.S.A.)

November 5th, Afternoon

Chairman: P. Ehrburger
SA06 Modification of Coal Tar Pitch by Addition of
 Phenolic Resin
 I. Leno, T. Takekawa, H. Murotomi,
 Y. Morishita and Y. Okuyama
 NKK Co. (Japan)

SA07 Preparation of Mesophase-Pitch with Low
 Viscosity
 K. Yudaie, Y. Ohsugi and M. Kamishita
 Kawasaki Steel Co. (Japan)

SA08 The Use of Controlled Stress Rheology for the
 Characterization of Precursors for Carbon
 Materials
 B. Rand, M. Turpin and T. Cheung
 School of Materials, Univ. of Leeds (U.K.)

Chairman: Y. Park
SA09 Glassy Behaviour and Mesophase Formation for
 a Petroleum Pitch
 P. Ehrburger, C. Raymond, J. Lahaye and J.L.
 Saint-Romain*
 CRPSS, CNRS and *NORSOLOR-Dept.
 HGD (France)

SA10 Structure of Isotropic and Mesophase Pitches
 Derived from C₁ Alkylbenzenes
 I. Mochida, Y. Korai, A. Sakanishi,
 K. Yanagida*, M. Noda* and K. Tate*
 Kyushu Univ. and *Inst. of Dept. Mitsubishi
 Oil Co. (Japan)

SA11 Comparative Study on Carbonization Behaviors
 of Coal Tar and Petroleum Pitches
 T. Oishi, S. Miwa, K. Miura and I. Mochida*
 Carbon Material Technical Center, Nippon
 Steel Chemical Co., Ltd. and *Kyushu Univ.
 (Japan)

Chairman: T. Nakajima
SB08 Reversible Storage of Saturated Hydrocarbons in
 Cesium Graphitides
 F. Beguin, H. Pilliere* and M. Goldmann
 CRISOIL and *ILL (France)

SB09 Structure of Cs-Adsorbed Surfaces of Graphite
 (0001)
 Y. Okuyama, T. Harui, Y. Kawashima and
 H. Yasunaga
 Univ. of Electro-Communications (Japan)

SB10 De-intercalation Phenomenon during the
 Reaction of Several Donor Reactants with
 Graphite
 D. Guerard and P. Lagrange
 Univ. de Nancy I. (France)

SB11 Isotope Separation of Hydrogen by
 Low-Temperature Absorption into Graphite
 Intercalation Compound
 T. Terai and Y. Takahashi
 Univ. of Tokyo (Japan)

Chairman: D. Guerard
SB12** Reaction of Alkali Metal-Graphite Intercalation
 Compounds with Oxygen, Nitrogen Oxides and
 Halogens by Gravimetry and Electrical
 Conductivity Measurement
 N. Akizawa, Y. Amari, Y. Tomita,
 M. Yamada and Y. Takahashi*
 Tokyo National College of Tech. and *Univ.
 of Tokyo (Japan)

Chairman: T. Maruyama
SC06 TEM Study of Interphase Phenomena in Silicon
 Carbide Composites
 Y. Maniette and A. Oberlin*
 Hokkaido Univ. (Japan) and *Lab. Marcel
 Mathieu (France)

SC07 Thermal Degradation Mechanisms of a Silicon
 Fiber as Deduced from TEM Observations
 P. Le Cloux, M. Montheux and
 A. Oberlin
 Lab. Marcel Mathieu (France)

SC08 Preparation of SiC Fiber Derived from
 Polycarbosilane by Radiation Curing and Its
 Thermal Stability
 M. Takeda, H. Ichikawa, T. Ishikawa*,
 T. Seguchi** and K. Okamura***
 Res. Lab. Nippon Carbon Co., Ltd., *Nippon
 Carbon Co. Ltd., **Takasaki Radiation
 Chem. Res. Establishment and ***Univ. of
 Osaka Prefecture (Japan)

Chairman: M. Seki
SC09 Thermal Evolutions of a Cured (Fibered) and
 Uncured PCS-Based Ceramic. Microstructural
 Aspect
 O. Delverdier, M. Montheux, A. Oberlin, and
 D. Mecer*
 Lab. Marcel Mathieu and *Lab. des
 Composites Thermostructuraux (France)

SC10 Dissolution of Hydrogen and Helium in
 Graphite
 H. Atsumi, M. Ieki*, T. Shikama** and
 M. Miyake***
 Kinki Univ., *Nagoya Univ., **Tohoku Univ.,
 and ***Osaka Univ. (Japan)

SC11 withdrawn

- Chairman: A. Tomita**
SA12 Study of Mesophases and Their Constituents by DMTA
*B. Rand and S. West**
 Univ. of Leeds and *Univ. of Sheffield (U.K.)
- SA13** The Nitrogen Containing Constituents of Coal-Tar Pitch: Molecular Weight Distribution, Chemical Structure and Role for the Carbonization Chemistry of Pitch
M. Zander and G. Collin
 Rütgerswerke AG (F.R.G.)
- SA14** Use of the Elbs Reaction for Preparation of Molecular-Designed Precursor with High Carbon Yield
E. Ota, S. Hagiwara and S. Otani
 Gunma Univ. (Japan)
- SA15** Carbonization Mechanism of Polyimide
H. Hatori, Y. Yamada and M. Shiraiishi
 National Res. Inst. for Pollution and Resources (Japan)
- SA16** Development of Microtexture in Thin Kapton Based Carbon Films
C. Bourgette and A. Oberlin
 Lab. M. Mathieu (France)

- Chairman: A. Oberlin**
SA17* Heat Treatment of Polysulfuryl Alcohol between the Lamellae of Tacholite
T. Kiyotani, H. Yamada, N. Sanohe and A. Tomita
 Tohoku Univ. (Japan)

- Chairman: F. Beguin**
SB13 Intercalated Graphite Fiber Composites as EMI Shields in Aerospace Structures
J.R. Gaiser
 NASA Lewis Res. Center (U.S.A.)
- SB14** Humidity Stability of Graphite Intercalation Compounds with Metal Chlorides
O. Tada, M. Ohira and M. Inagaki**
 Tohoku Alps Co., Ltd. and *Hokkaido Univ. (Japan)
- SB15** Synthesis, Electrical Conductivity and Electrochemical Behavior of Vanadium Fluoride and Vanadium Oxide Fluoride-Graphite Intercalation Compounds
T. Nakajima, Y. Nagai and R. Yazami
 Kyoto Univ. (Japan)
- SB16** CrO₂/GIC's as Cathode Materials in Lithium Secondary Batteries
P. Biensan, S. Flandrois and A. Fevrier-Bouvier
 Centre de Recherche Paul Pascal (France)
- Chairman: E. Stummpp**
SB17 Electrochemical Investigations on the Bi-Intercalation Process with the Cyclic Voltammetry Method
K. Totsuimi, H. Shioyama, S. Ikeda and I. Souma
 Gov. Ind. Res. Inst. Osaka (Japan)
- SB18** Energy Dispersive X-ray on Supported Metal Clusters Generated by Redox Processes on Graphite Intercalation Compounds
F. Beguin, R. Erre, A. Mestouidi, M. Inagaki* and M. Ohira**
 C.R.S.O.C.I. CNRS (France) and *Hokkaido Univ. (Japan)
- SB19** Study of FeCl₂-GIC Reduction by Atomic Anion Radical
*A. Mestouidi, M. Inagaki and F. Beguin**
 Hokkaido Univ. (Japan) and *C.R.S.O.C.I. (France)

- Chairman: A. Ota**
SC12* Some Tribological Aspects of PTFE/CF Compo.
J. Ono, B. Braunstein, F. Lednicki and J. Suchanek*
 National Res. Inst. for Materials and *Academy of Sci. (Czechoslovakia)

- Chairman: Y. Tanabe**
SC13 Biaxial Tensile Strengths of Isotropic and Near-Isotropic Graphites
Y. Nishitama and T. Arai
 Japan Atomic Energy Res. Inst. (Japan)
- SC14** Evaluation of Graphite and C-C Composite Materials Used as the Plasma First Wall Components of JT-60
M. Eto, K. Fukaya, T. Oku, Y. Honda, T. Isoraki, H. Takaisu*, T. Ando*, M. Yamamoto*, K. Kodama*, and M. Shimizu**
 Japan Atomic Energy Res. Inst., *Naka Fusion Res. Establishment, and **Ibaraki Univ. (Japan)
- SC15** High Heat Flux Experiments of CFC and Graphite Materials for Fusion Applications
M. Araki, M. Akiba, H. Ise, M. Dairaku, K. Yokoyama and M. Seki
 Japan Atomic Energy Res. Inst. (Japan)
- SC16** Evaluations of Thermal Shock Resistance and Fracture Toughness of Graphites and C-C-Composites as First Wall Components for Fusion Reactor Devices
*S. Sato, A. Kurumada, K. Kawamata and R. Ishida**
 Ibaraki Univ. and *Univ. of Osaka Prefecture (Japan)

November 6th, Morning

- Chairman: Y. Takahashi**
(Plenary B) Organic Ternary Graphite Intercalation Compounds
A.P. Legrand and M.F. Quinlan
 Lab. Phys. Quant. ESPCI (France)

- Chairman: O.P. Bahl**
6A01 In-situ Monitoring for Mesophase Formation Processes of Various Pitches by Means of High-Temperature ¹³C-NMR
K. Azumi, S. Yamamoto, T. Yokono and Y. Sanada**
 Central Tech. Res. Lab. Nippon Oil Co., Ltd. and *Hokkaido Univ. (Japan)
- 6A02** Structural Analysis of Mesophase Pitch by High Temperature ¹³C-NMR
A. Murakami, M. Okumura, T. Hino, Y. Mizuno, T. Yokono and Y. Sanada**
 Tonen Co., Ltd. and *Hokkaido Univ. (Japan)
- 6A03** Carbonization of Mesophase Pitch Fiber under Strain
I. Mochida, S.M. Zeng, Y. Kurae, T. Hino and H. Toshima**
 Kyushu Univ. and *Tonen Co., Ltd. (Japan)

- Chairman: T. Nishizawa**
6A04* Study of the Physical Properties and Microstructure of Stabilized Fibers During Carbonization
T.H. Ao and C.H. Lin
 Dept. of Mat. Sci., Feng Chia Univ. (Taiwan)

- Chairman: Y. Kori**
6A05 The Effect of Comonomers on the Amorphous Phase for Polyacrylonitrile Precursor
*J.S. Tsai and C.H. Lin**
 CTCI and Grad. Inst. of Textile Eng. Feng China Univ. (Taiwan)
- 6A06** Stabilization of PAN Precursor Under Oxidative and Inert Medium
A.K. Gupta, P. Bajaj and D.K. Paliwal
 Dept. Textile Tech., Indian Inst. Tech. (India)
- 6A07** Diffusion Depth in Oxygen Stabilization of Mesophase
K. Leung, R. Weitz and J. Zimmer
 Acurex Corp. (U.S.A.)

- Chairman: M. Endo**
6B01* The Preparation and Properties of a Large-Diameter Pyrolytic Carbon Filament by CVD
H. Yu, T. Liu and Z. Li
 Anshan Res. Inst. Thermo-Energy (P.R.C.)
- Chairman: K. Hosokawa**
6B02 ROMS for Super Grade Carbon Anisotropy
T. Takekawa, T. Shiode, H. Muratomi and T. Kaio
 Chem. Products Dept. Center, NKK Corp. (Japan)
- 6B03** Effect of Adsorbed Gases on Mechanical Properties of Nuclear Graphite
T. Maruyama, K. Motomiya, Y. Nishimura, T. Oku and T. Arai**
 Tokyo Inst. of Tech., *Ibaraki Univ. and **Japan Atomic Energy Res. Inst. (Japan)
- 6B04** Microstructural Studies of High Strength Monolithic Carbons from Mesophase Powders
B. Rand
 Univ. of Leeds (U.K.)

- Chairman: M. Nakamizo**
6B05* Boron in Graphite-Effects on Properties
P.A. Thrower and L.E. Jones
 Dept. of Mat. Sci. and Eng., Penn. State Univ. (U.S.A.)
- 6B06** Cumulative Fatigue Damage of Fine Grained Isotropic Graphite
S. Ishitama, T. Arai and M. Eto
 Japan Atomic Energy Res. Inst. (Japan)

- Chairman: J. Lahave**
6C01 The Effect of a Molecular Component on Coke Microtexture Formation
J.A. Rouzaud, F. Fortin, D. Cagniant, M. Dantl*, R. Gruber*, C. Lucordaire* and J.V. Weber**
 C.R.S.O.C.I. CNRS and *Lab. de Chim. Organique, Univ. de Metz (France)
- 6C02** Oxidation Kinetics of PAN-Based Carbon Fibres
A. Miyazaki and I. Tomizuka
 National Res. Inst. for Metals (Japan)
- 6C03** Stabilization and Carbonization of PAN-Based Carbon Fibers as Related to Mechanical Properties
A. Dourhergue and A. Oberlin
 Lab. M. Mathieu (France)
- 6C04** Magnetic Property and Microporosity of Activated Carbon Fibers
K. Kaneko, K. Yamaguchi, C. Ishii, S. Ozeki, S. Hagiwara and T. Suzuki**
 Chiba Univ. and *Univ. of Tokyo (Japan)
- Chairman: J. Rouzaud**
6C05 Reactivity of Surface-Modified Activated Carbon Fibers with NO
J. Imai, T. Suzuki and K. Kaneko
 Chiba Univ. (Japan)
- 6C06** Dynamic Change in Micrographitic Structure with Gas Adsorption
T. Suzuki and K. Kaneko
 Chiba Univ. (Japan)
- 6C07** The Relationship between Gas Permeability and Open Pore of Carbon
*M. Kamiyama and T. Sogabe**
 Titan Kasei Co., Ltd. and *Toyo Tanso Co., Ltd. (Japan)
- 6C08** Effects of the Oxidation on the Porous Network in Polymeric Carbons
J. Lahave, F. Ehrburger-Dolle and T. Fox
 C.R.C.S.S. CNRS (France)
- 6C09** Expression of Adsorption Isotherms of Organic Vapor on Activated Carbon with Heterogeneous Micropores
C. Yuan, K. Guo and W. Chen
 Res. Inst. of Chemical Defence (P.R.C.)

Chairman: E. Yasuda and M. Shiraishi
Recent Topics in Japan (See RT01 ~ RT07)

Chairman: E. Yasuda
Poster Preview (See 6PA01 ~ 6PA17)

Chairman: T. Yokono

7A01* Domain Structure in Some High-Modulus, Mesophase-Pitch Based Carbon Fibres
J.D. Fitz Gerald, G.M. Pennock and G.H. Taylor
Australian National Univ. (Australia)

Chairman: P. Throver

7A02 Texture and Microtexture of As-Spun and Oxidized Radial with Wedge and Radial Carbon Fibres (Part I)
K. Lafdi, S. Bonnamy* and A. Oberlin
Lab. Marcel Mathieu and *CRSOC (France)

7A03 Texture and Microtexture of Carbonized and Graphitized Radial with Wedge and Radial Carbon Fibres (Part II)
K. Lafdi, S. Bonnamy* and A. Oberlin
Lab. Marcel Mathieu and *CRSOC (France)

7A04 The Role of Disclinations in the Structure of Mesophase Pitch-based Carbon Fiber
N.M. Bourral, E.J. Roche* and J.G. Lavin*
Lab. Marcel Mathieu (France) and *E.I. Du Pont de Nemours & Co. (U.S.A.)

Chairman: J. Fitz Gerald

7A05 Mechanism of Anisotropy Occurrence in Pitches Precursors of Carbon Fibres
K. Lafdi, S. Bonnamy* and A. Oberlin
Lab. Marcel Mathieu and *CRSOC (France)

7A06 Carbon Fiber from Lignin of Exploded Wood
A. Yokoyama, N. Nakajima, H. Ichikawa, H. Teranishi, K. Sudo* and K. Shimizu*
Nippon Carbon Co. Ltd., and *Forestry and Forest Products Res. Inst. (Japan)

7A07 withdrawn

Chairman: A. Aojima

7A08* Some Aspects of Glassy Carbon Production and Its Application in Bioengineering
C. Oiani, M.C. Rezende, H.A. Polidoro, H.P. de Magalhães* and G.R.S. Weyne**
Centro Tecnico Aeroespacial, *Fac. de Medicina São Amaro and **Dep. Eng. Química (Brazil)

7A09 Microtexture and Magnetoresistance of Glass-like Carbon
Y. Hishiyama, A. Yoshida and Y. Kaburagi
Musashi Inst. of Tech. (Japan)

Chairman: M. Inoraki
Panel Discussion "Promotion of International Cooperation"

Chairman: T. Oki
Poster Preview (See 7PA01 ~ 7PA17)

Chairman: Y. Hishiyama
Poster Preview (See 6PB01 ~ 6PB17)

November 7th, Morning

Chairman: P. Vast

7B01 Optical Texture Variations of Carbons Derived from Mesophase Blended with Organo-Silicon Polymers and Nitroated Mesophase Colloid
B. Rand and B. Anwarjvedi
Univ. of Leeds (U.K.)

7B02 The FEM for Thermal Stress of Siliciferous Carbon
M. Orita, N. Tsuji, K. Mukai and K. Fujimoto
R&D Lab.-I, Nippon Steel Corp. (Japan)

7B03 Structural Study of Low Temperature Carbons by Solid-State ¹³C-NMR Spectroscopy
M. Nakamizo and Y. Adachi
Gov. Ind. Res. Inst. of Kyushu (Japan)

Chairman: B. McEnaney

7B04 Formation and Heat Treatment of Graphite Oxide-Metal Complexes
K. Suzuki, T. Kyotani, H. Yamashita, M. Nomura* and A. Tomita
Tohoku Univ. and *Nat. Lab. for High Energy Physics (Japan)

7B05 Assessment of Calcium Specific Activity in Carbon Gasification
D. Cazola-Amorós, C. Salinas-Martínez de Lecea, A. Linares-Solano and A. Marcilla-Gomis
Univ. de Alicante (Spain)

7B06 The Development of Oxidation Resistant Carbon-Carbon Composite for High Temperature Applications
I. Kuroyanagi, S. Morita and T. Sedaka
Fuji Res. Lab., Tokai Carbon Co. Ltd. (Japan)

Chairman: Y. Chong

7B07* New Carbon Antioxidation Process Using Organosilicon Compounds with Hypervalent Silicon
P. Vast
Univ. des Sciences et Technique de Lille (France)

Chairman: Y. Yamada

7B08* Surface Modification of Carbon Materials to Inhibit Oxidation - A Review -
L. Depine de Castro* and B. McEnaney
Univ. of Bath (U.K.) and *Centro Tecnológico do Exercito (Brazil)

7B09 Enhancement of Hydrophilicity of Carbon Fiber with Direct Fluorination
H. Ohara, Y.B. Chong and N. Watanabe
Applied Sci. Res. Inst. (Japan)

Chairman: T. Nakajima
Poster Preview (See 7PB01 ~ 7PB17)

Chairman: M. Sakai

7C01 Influences of Grain Size and Porosity on Mechanical Properties and Thermal Shock Resistance of Graphite of Mesophase Coke
S. Sato, T. Suzuki, M. Sakai* and K. Fujimoto**
Ibaraki Univ., *Toyohashi Univ. and **Nippon Steel Corp. (Japan)

7C02 Evaluation of the Critical Current Density of Carbon Brush by Thermal Shock Tests
S. Sato, A. Kurumada, J. Lee* and Y. Shou**
Ibaraki Univ., *Diesel Kiki Co., Ltd. and **Hitachi Chemical Co., Ltd. (Japan)

7C03 Wear Mechanism of Carbon Brush by Commutation Sparks
K. Okubo, S. Aoki and K. Miyachi
Nippon Inst. of Tech. (Japan)

7C04 Friction Mechanism of C-C Composites
Y. Varia, K. Kurosaki and T. Hara
R&D Laboratories-I, Nippon Steel Corp. (Japan)

Chairman: A. Kurumada

7C05** Microfracture Processes and Toughness of C-fiber-C-matrix Composites
T. Miyajima, M. Sakai and M. Inagaki*
Toyohashi Univ. of Tech. and *Hokkaido Univ. (Japan)

Chairman: M. Eto

7C06 "Oxidation Creep" and "Oxidation Creep Rupture" of a C-C Composite Material
S. Nakazawa, A. Miyazaki and I. Tomizuka
Nat. Res. Inst. for Metals (Japan)

7C07 Indentation-Induced Microcracks in Glassy Carbons
M. Sakai, H. Hanyu and M. Inagaki*
Toyohashi Univ. of Tech. and *Hokkaido Univ. (Japan)

7C08 Surface Damage and Deformation of Carbon SiC-Composite Ceramics
M. Sakai, H. Ichikawa and M. Inagaki*
Toyohashi Univ. of Tech. and *Hokkaido Univ. (Japan)

Chairman: T. Terai

7C09 Novel Electrode Impregnated with the Eutectic Mixture of a Fluoride in a Fluorine Cell
T. Tojo, J. Hiraiwa, Y. Chong, N. Watanabe, K. Kuroda and M. Okada*
Appl. Sci. Res. Inst. and *Toyo Tanso Co., Ltd. (Japan)

7C10 Characteristics of Carbon Fiber Electrodes for Redox Flow Battery
K. Nizaki, A. Negishi and H. Kaneko
Electrotechnical Lab. (Japan)

7C11 Infrared Photoresponse of Carbon Films Prepared by Plasma Decomposition of Propylene
J. Ozaki and Y. Nishiyama
Tohoku Univ. (Japan)

7C12 Novel Synthesis of Carbon Composites Containing Ultrafine Metal Particles and Their Unique Functions
H. Yasuda, H. Hiwara*, S. Miyazawa* and A. Nakamura*
Hiroshima Univ. and *Osaka Univ. (Japan)

November 7th Afternoon

Chairman: S. Kimura
(Plenary C) Carbon Carbon - A Family of
Materials
R. Weiss
Schunk Kohlenstofftechnik GmbH (F.R.G.)

Chairman: R. Weiss
8A01* Microstructure Development in Carbon Carbon
Composites
L.M. Manocha
National Physical Lab. (India)

Chairman: C. Lin
8A02 C-C Composite of Chopped Carbon Fiber with
a Mesophase Pitch Derived from Naphthalene
I. Mochida, Y. Kori and R. Fujitani*
Kyushu Univ. and *Mitsubishi Gas-Chemical
Co., Inc. (Japan)

8A03 Carbon Carbon Composites Using Pitch-Based
Carbon Fibers
Y. Kohda, Y. Ido, S. Uemura, T. Suemitsu*,
J. Fujitani* and S. Minakata*
Nippon Oil Co., Ltd. and *Kawasaki Heavy
Ind. Ltd. (Japan)

8A04 Effect of Fiber Orientation on Bending Strength
of C-D-C-C Composite
H. Horikawa, Y. Tanabe, R. Chikuya,
T. Hirakawa, Y. Matsuo and E. Yasuda
Tokyo Inst. of Tech., *Toyo Tanso Co., Ltd.
(Japan)

Chairman: I. Souma
8A05 Mechanical and Electrical Properties of Metal
Fiber Carbon Composites
K. Sudani, M. Kano and Y. Sumami
Advanced Tech. Res. Lab., Sumitomo Metal
Ind. Ltd. (Japan)

8A06 Thermal Properties of Carbon Carbon
Composites
L. Manocha, O. Bahl and P. Jain
National Physical Lab. (India)

8A07 Preparation and Mechanical Properties of CFRP
with Surface Modified Carbon Fiber by
Photo-Oxygenation
T. Yoshikawa, A. Kojima* and S. Otsu**
Railway Technical Res. Inst., *Gunma
College of Tech. and **Gunma Univ. (Japan)

Chairman: J. Iisi
8B01 Electron Channeling Contrast Imaging for
Highly Oriented Graphites
A. Yoshida and Y. Hishiyama
Musashi Inst. of Tech. (Japan)

8B02 Characterization of Graphite Structure by Means
of TEM, X-ray, Positron Annihilation and Laser
Raman Spectroscopy
T. Tanabe, K. Niwase*, N. Tsukuda** and
E. Kuramoto**
Osaka Univ. *Hyogo Univ. and **Kyushu
Univ. (Japan)

8B03 Low Temperature Anomalies in the
Thermoelectric Power of Highly Oriented
Graphite
K. Sugihara, A. Ono* and Y. Hishiyama*
Nihon Univ. and *Musashi Inst. of Tech.
(Japan)

Chairman: Y. Ohashi
8B04 Magnon Drag Thermoelectric Power in Magnetic
GICs
K. Sugihara, K. Kobayashi and H. Oshima
Nihon Univ. (Japan)

8B05 ESR of Graphite at Low Temperatures
K. Matsubara, K. Sugihara and T. Tsuzuku
Nihon Univ. (Japan)

8B06 Quasi Two-Dimensional Nature of Pregraphitic
Carbon Solids
K. Matsubara, K. Kawamura and T. Tsuzuku
Nihon Univ. (Japan)

Chairman: Y. Hishiyama
8B07* Thermal Conductivity Measurements on Carbon
Fibers: Experimental Techniques and Structural
Studies
J.-P. Iisi and B. Nysten
Univ. Catholique de Louvain (Belgium)

Chairman: A. Fein
8C01 New Recovery Process of Kish Carbon
T. Ena, A. Kitahara and M. Kitamura*
Kansai Coke & Chem. Co., Ltd. and
*Kobe Steel Ltd. (Japan)

8C02 Selective Preparation of Carbonaceous Spheres
from the Pitch Materials by Suspension System
S. Yoon and Y. Park
Res. Inst. of Ind. Sci. and Tech. (Korea)

8C03 Development of Porous Glassy Carbon and its
Applications
K. Sugihara, K. Haino and Y. Suzuki
Tokai Carbon Co., Ltd. (Japan)

Chairman: A. Okuyama
8C04 A Remarkable Support Effect in Preparation of
Organic Ferromagnets from Vinyl Resins
K. Murata, T. Masuda and H. Ueda
National Chem. Lab. for Ind. (Japan)

8C05 Structural Characterization of
Naphthalene-Derived Mesophase Pitches by High
Temperature ¹³C-NMR Spectroscopy
M. Hanaguchi, T. Suzuki, T. Nishizawa and
Y. Sakai*
Kobe Steel Ltd. and *Mitsubishi Gas-Chem.
Co., Inc. (Japan)

8C06 Ordering of Carbonaceous
Mesophase in Magnetic Field
M. Sawa, T. Suzuki and T. Nishizawa
Kobe Steel Ltd. (Japan)

Chairman: M. Shirashi
8C07 Pyrolysis of Potato Starch γ-ray Irradiated
Under Controlled Temperature and Oxygen
Concentration
Y. Nakayama, S. Imajyo and K. Hosokawa*
Ehime Univ. and *Kyoto Prefectural Univ.
(Japan)

8C08 Pyrolysis of Propylene on Microporous Carbons
S. Verma and Y. Nakayama*
Calgon Carbon Corp. (U.S.A.) and *Ehime
Univ. (Japan)

8C09 Initial Carbonization of Oxidized Pitches
A. Yanagisawa and T. Suzuki
Kobe Steel Ltd. (Japan)

November 8th, Afternoon

Chairman: L. Manocha
8A08 The Mechanical Properties and Failure
Characteristics of Braided Carbon Epoxy Composite
Tubes in Longitudinal and Hoop Tensile Tests
J. Chen and C. Lin
Graduate Inst. of Textile Eng., Feng Chia
Univ. (Taiwan)

8A09 Carbon Fibres and Their Composites in
Czechoslovakia
J. Orli
National Res. Inst. for Materials
(Czechoslovakia)

Chairman: J. Orli
8A10* Preparation of Flexible Graphite Sheet Cement
Composites with Electromagnetic Shielding
Effect
A. Kojima, S. Otsu*, K. Yamada** and
A. Fujita**
Gunma College of Tech., *Gunma Univ. and
**Hitachi Chem. Co., Ltd. (Japan)

8A11 Electrical Properties and Applications of Carbon
Fiber Reinforced Cement
M. Endo, Y. Matsuda, T. Sugiura,
S. Morimoto* and S. Kubo**
Shinshu Univ., *Showa Denko Co., Ltd. and
**Industrial Res. Inst. of Nagano (Japan)

8A12 The Mechanism of the PTC Effect in Filled
Polymers
F. Carmona and E. Valot*
(RPP. and *C.R. du Carbone Lorraine
(France)

Chairman: T. Tsuzuku
8B08* Structural Features and Physical Properties of
Carbon Fibres
A. Kotosonov
State Res. Inst. of Graphite (U.S.S.R.)

Chairman: H. Oshima
8B09 Development of Testing Method for Tensile
Properties of VGC Fibers
A. Sudoh, H. Daioh* and S. Morimoto
Eng. Res. Center, Showa Denko K.K. and
*Res. and Development Center, Showa Denko
Silicon K.K. (Japan)

8B10 Radiation Damage of Graphite
K. Niwase and T. Tanabe*
Hyogo Univ. and *Osaka Univ. (Japan)

8B11 Disorder Induced Raman Scattering of Graphite
Irradiated with an Electron Beam
K. Nakamura, M. Fujisaka and
M. Kitajima
National Res. Inst. for Metals (Japan)

Chairman: H. Yu
8C10 Adsorption and Recovery of Ammonia on
Activated Carbon Fiber Acidified with Sulfuric
Acid
I. Mochida, S. Kawano, S. Hisatsune and
H. Fujitsu
Kyushu Univ. (Japan)

8C11 Low Temperature Selective Catalytic Reduction
(SCR) of NO with NH₃ Over Carbon Supported
Manganese Catalysts
L. Singoredjo, R. Korte, F. Kapteijn and
J.A. Moulijn
Dept. of Chem. Eng., Univ. of Amsterdam
(Netherlands)

8C12 A New Approach to Thermal Stabilization of
Pan Fibres
R. Muthur, J. Mittal, O. Bahl and K. Naypal
National Physical Lab. (India)

8C13 The Mechanical Properties and Structures of
Pitch Based Hollow Carbon Fibers
B. Rhee, S. Ryu, S. In and J. Kim
Chungnam National Univ. (Korea)

8C14 Preparation of Spinnable Mesophase Pitch
through the Multi-Stage Heat Treatment
S.H. Oh, S.H. Yoon, G.D. Lee and Y.D. Park
Res. Inst. of Ind. Sci. and Tech. (Korea)

Chairman: S. Morimoto

- 8A13 Affinity Between Methanogenic Bacteria and Carbon Material
A. Oya, H. Watanabe, S. Oami, Y. Sakakibara and M. Kuroda
Gunma Univ. (Japan)

- 8A14 Impact Testing of C-C Composite Plates
J. Ogawa, R. Hashimoto, Y. Satue, K. Matsue, E. Yasuda, H. Mitsuma**, T. Kobayashi** and H. Tamura**
National Aerospace Lab., *Tokyo Inst. of Tech., and **NASDA (Japan)

- 8A15 Investigation of Shear Strength of 3D-C-C
T. Tanamiura, Y. Nakunishi, K. Tsumi* and S. Ikeda*
Shikishima Canvas Co., Ltd. and *Gov. Ind. Res. Inst. Osaka (Japan)

Chairman: F. Carnona

- 8A16 The Application of Ultrasonic Technique to the Mechanical Properties of C-C Composites
M. Narisawa, M. Adachi, I. Souma and T. Tanamiura*
Gov. Ind. Res. Inst. Osaka and *Shikishima Canvas Co., Ltd. (Japan)

- 8A17 The Influence of Heat Treatment Temperature on the Fracture Behavior of 3D-C-C
T. Tanamiura, M. Narisawa*, H. Shioyama*, M. Adachi* and I. Souma*
Shikishima Canvas Co., Ltd. and *Gov. Ind. Res. Inst. Osaka (Japan)

- 8A18 withdrawn

Chairman: K. Sugihara

- 8B12* Electrical Conductivity and Magnetoresistance in Non-Crystalline Carbons
F. Kahuragi and Y. Hishiyama
Musashi Inst. of Tech. (Japan)

Chairman: A. Kotosonov

- 8B13 Thermal Diffusivity of Neutron-Irradiated Carbon-Carbon Composites
H. Matsuo
Japan Atomic Energy Res. Inst. (Japan)

- 8B14 Bending Deformation and Fracture Behavior of Unirradiated and Irradiated Fine-Grained Isotropic Graphite Specimens
H. Ugachi, T. Arai and T. Isozaki
Japan Atomic Energy Res. Inst. (Japan)

- 8B15 Evaluation of Thermodynamic Activity of Carbons with Various Degrees of Graphitization
M. Katsura, K. Humada* and M. Miyake
Osaka Univ. and *Nippon Steel Corp. (Japan)

- 8B16 The Structure and Chemical Characteristics Variation of Wood Tar Pitch During Its Carbonization
C. Oiani, V. Pasa* and F. Carazza**
Centro Técnico Aeroespacial, *ACESITA-ED and **Depto. de Química (Brazil)

Chairman: T. Takekawa

- 8C15* Carbonization Properties of Coal-Tar Pitches and Their Solvent Fractions
A. Feng and S. Lu*
East China Inst. of Metallurgy and *Anshan Res. Inst. (P.R.C.)

Chairman: E. Oia

- 8C16 Fabrication of Carbon Solids from Dormant Mesophase Pitch and Coke
J. Kim, S. Lee, J. Choi, C. Kim and Y. Park
Res. Inst. of Ind. Sci. and Tec. (Korea)

- 8C17 Structure of Amorphous Hydrogenated Carbon Thin Film Prepared from CH₄ Plasma
Y. Yoshizawa, T. Furuta and M. Shiraiishi
National Res. Inst. for Pollution and Resources (Japan)

- 8C18 Thermal Plasma CVD of Diamond
T. Kobayashi and S. Oino
Tokai Carbon Co., Ltd. (Japan)

Recent Topics in Japan (6th Room A)

- RT-1 Precursor Design for New Carbon Products
S. Oami, E. Oia and M. Oia*
Gunma Univ. and *Gunma College of Tech. (Japan)
- RT-2 Characterization by SEM
Y. Huhisawa
Musashi Inst. of Tech. (Japan)
- RT-3 Mechanical Properties of Carbon Fiber Reinforced Concrete
S. Akihama, T. Suenaga*, H. Nakagawa* and Y. Taniguchi*
FRC Co. and Kajima Inst. of Construction Tech. (Japan)
- RT-4 Microbiological Utilization of Charcoals in Agriculture Forestry
M. Ogawa
Forestry and Forest Products Res. Inst. (Japan)
- RT-5 Carbon as A Plasma Facing Material
M. Seki and T. Ando
Japan Atomic Energy Res. Inst. (Japan)
- RT-6 Development of Electric Double-Layer Capacitors with Activated Carbon Fibers and Sprayed Aluminum Electrodes
A. Yoshida and A. Nishino
Matsushita Electric Ind. Co., Ltd. (Japan)
- RT-7 Carbon Ceramic Composite - High Oxidation Resistance and Friction-Wear Properties -
H. Yoshida, K. Miyazaki, I. Oyawa, T. Hase, E. Maeda and K. Kobayashi*
Gov. Ind. Res. Inst., Kyushu and *Nagasaki Univ. (Japan)

Industrial Poster Papers (6 and 7th)

- IP01 Standardization of the Testing Methods for Carbon Fiber Products
Y. Hosoi, H. Morita, M. Kakuta, A. Okuda, T. Ikeda, Y. Matsuka, T. Naitake, M. Mohri, T. Tomoka, H. Kawachi, M. Nakajima, T. Yamauchi, M. Uemura and H. Hirose
Tanaka Sen-i Kyokai (Japan)
- IP02 Recent Activities of New Carbon Forum
I. Naitume and M. Kakuta
New Carbon Forum (Japan)
- IP03 Paper Type Heat Generator
K. Sugihara
Tokai Carbon Co., Ltd. (Japan)
- IP04 Carbonaceous Granular Heat Insulator "MONA BEADS"
H. Jindo, K. Tamada, F. Takemura and M. Ishiwata
Tokai Carbon Co., Ltd. (Japan)
- IP05 Invention of a New Series of Carbon Black Having Unique Characteristics on Their Morphology
K. Nakai, M. Mito and A. Miura
Chita Res. Inst., Tokai Carbon Co., Ltd. (Japan)
- IP06 Carbon-Resin Composite Resistor for Potentiometer
M. Saitoh
Tohoku Alps Co., Ltd. (Japan)
- IP07 Carbonaceous Powder with Self-sinterability for High Density Isotropic Carbon Blocks
A. Nagayama, N. Fukuda and M. Honma
Kawasaki Steel Co. (Japan)
- IP08 Separation Mechanism for Carbonaceous Mesophase Spheres from Pitch Matrix
K. Goto, K. Yano and H. Marsh*
Nippon Mining Co., Ltd. (Japan) and *Univ. Newcastle upon Tyne (U.K.)
- IP09 Development of Carbon Products by the PEC Process
T. Kawakubo, Y. Nishimoto, Y. Suda, H. Kaneko* and Y. Higo**
Mitsubishi Pencil Co., Ltd., *Electrotechnical Lab., and **Tokyo Inst. of Tech. (Japan)
- IP10 Sponge-Like Carbon and C-C Composite using New Manufacturing Processes
K. Kutsuki, S. Yamasaki and M. Takehara*
Nippon Steel Co. and *Nippon Steel Chem. Co., Ltd. (Japan)
- IP11 Supersized Isotropic Graphite "IG-11X"
H. Ogura, T. Ishikawa, S. Okazaki and T. Hoshikawa
Toyo Tanso Co., Ltd. (Japan)
- IP12 Carbon and Silicon Carbide Composite (C/ARBO-SiC)
J. Yamamoto and H. Izawa
Adv. Mat. Res. Lab. and Osaka Cement Co., Ltd. (Japan)
- IP13 Preparation of Foliated Fine Graphite Particles with Ultrasonic Waves
K. Sakaguchi, Y. Yosemoto, Y. Yamashita and K. Kuba
Kyushu R&D Lab., Mitsui Mining Co., Ltd. (Japan)
- IP14 Investigation and Manufacturing of Equipment for Carbon Fibre Production
S. Chaplinski, L. Pidilok, M. Maiboroda and P. Cherednichenko
NPO "Chimsvetmash" (U.S.S.R.)
- IP15 Japanese Art Charcoal (Black Flower)
J. Nakamichi, K. Fujii, Y. Sawada and H. Shioyama
Gov. Ind. Res. Inst. Osaka (Japan)

Poster Papers

(bth, Room A)

- 6PA01 Carbonization of γ -ray Irradiated Almond Shell
F. Rodriguez-Reinos^{**}, F. Nakayama,
M. Aono, M. Wachi and K. Hosokawa^{*}
Ehime Univ., *Kyoto Prefectural Univ.
(Japan) and
^{**}Univ. de Alicante (Spain)
- 6PA02 Potato Starch Spherule Carbon
F. Nakayama, W. Tabuchi and
K. Hosokawa^{*}
Ehime Univ. and *Kyoto Prefectural Univ.
(Japan)
- 6PA03 Carbonization and Characterization of γ -ray
Irradiated Starch Relative Materials
K. Hosokawa, Y. Nakayama and T. Suzuki^{**}
Kyoto Prefectural Univ., *Ehime Univ. and
^{**}Kansai Univ. (Japan)
- 6PA04 The Mesophase Formation and Carbonization
Characteristics of Brazilian Coal Tar Pitches
C. Oiani, S. Otani, H. Poldoski^{*} and
S. Weyne^{**}
Centro Técnico Aeroespacial - IPD PMR and
^{*}Depo Eng. Química da USP (Brazil)
- 6PA05 Initial Carbonization Process of Acenaphthylene,
Acenaphthene, p-Quaterphenyl, and Naphthalene
Y. Nakayama, M. Kutsu, M. Takamizawa
and K. Hosokawa^{*}
Ehime Univ. and *Kyoto Prefectural Univ.
(Japan)
- 6PA06 Properties of Carbons Obtained from Organic
Compounds of Coal Liquid Vacuum Residues
T. Furuta, K. Maruyama, Y. Yamada and
M. Shirashi
National Res. Inst. for Pollution and
Resources (Japan)

- 6PA07 Carbonized Conditions Controlling Size and Size
Distribution of Carbonaceous Mesophase
K. Goto^{*}, K. Yano and H. Marsh^{*}
Nippon Mining Co., Ltd. (Japan) and *Univ.
Newcastle upon Tyne (U.K.)
- 6PA08 Electrical and Magnetic Characteristics of Coal
Pitch-Based Carbon Fibers
K. Matsubara, K. Kuwamura and T. Tsuruku
Nihon Univ. (Japan)
- 6PA09 Preparation and Characterization of Regularly
Coiled Carbon Fibers
M. Kawaguchi, K. Nozaki, S. Motojima^{*} and
H. Iwanaga^{**}
The Research Center, Central Glass Co., Ltd.,
*Gifu Univ. and ^{**}Nagasaki Univ. (Japan)
- 6PA10 Studies on Oxidation Process of Coal-Tar Pitch
Fibers by a Numerical Reaction Model
Y. Arai, T. Iwashita and T. Tomioka
R&D Lab.-I Nippon Steel Co. (Japan)
- 6PA11 Electrical Properties of Heat-Treated
Poly-Peri-Naphthylene Fiber
M. Murakami, M. Yasujima^{*} and
S. Yoshimura
Matsushita Res. Inst. Tokyo Inc.
*Central Res. Lab. Toppan Printing Co., Ltd.
(Japan)
- 6PA12 Mesophase Pitch-Based Carbon Fibers:
Graphitization
X.M. Bourrat and A. Oberlin
Lab. Marcel Mathieu (France)

- 6PA13 Stabilization of Isotropic Pitch Fiber by Sulfuric
Acid Vapor
J.K. Lee, S.J. In, H.S. Rhee and S.K. Ryu
Chungnam National Univ. (Korea)
- 6PA14 What Information can NMR Provide about
Mesophase Pitch?
T. Suzuki, M. Hamaguchi, M. Sawa and
T. Nishizawa
Chemical Tech. Res. Lab., Kobe Steel Ltd.
(Japan)
- 6PA15 NMR ¹³C Comparison between Three Polish
Coals and Their Macerals or Extracted Derived
Products
D. Sderi, P. Touge, A.P. Legend,
M.F. Quintan, D. Cognant^{*}, R. Grüber^{*}
and C. Lucardere^{*}
ESPCI and *Univ. de Metz (France)
- 6PA16 An XPS Analysis of the Carbon Films Obtained
by Heat Treatment of Polymeric Precursors
R. Erre, R. Benoit, F. Beguin and
M. Inagaki^{*}
CRSOCI-CNRS (France) and *Hokkaido
Univ. (Japan)
- 6PA17 Far-Infrared Characterization of μ -Carbon Films
M. Watanabe and N. Okuyama^{*}
Tokai Univ. and *Univ. Electro-
Communications (Japan)

Poster Papers

(bth, Room B)

- 6PB01 Photochemical Effect on Intercalation of Ferric
Chloride into Graphite from Chloroform
Solution
Y. Sonezu and M. Inagaki
Hokkaido Univ. (Japan)
- 6PB02 Preparation, Structure and Properties of
ZnBr₂-Graphite Intercalation Compounds
M. Fujimori
Gov. Ind. Res. Inst. Osaka (Japan)
- 6PB03 Temperature Dependence of Specific Heat in
Graphite-ICI Intercalation Compound
K. Tashiro and T. Tsuruku^{*}
School of Medicine, Nihon Univ. and *
College of Sci. and Tech., Nihon Univ.
(Japan)
- 6PB04 Sorption of Aliphatic Hydrocarbons by
Cesium-Graphite Intercalation Compounds
K. Oi, T. Terai and Y. Takahashi
Univ. of Tokyo (Japan)
- 6PB05 Absorption of Ammonia on Alkali
Metal-Graphite Intercalation Compounds
Prepared from Vapor-Grown Carbon Filament
N. Akuzawa, H. Sakuno, T. Kasuga,
S. Hashimoto^{*} and Y. Takahashi^{**}
Tokyo National College of Tech., *Yazaki
Co. and ^{**}Univ. of Tokyo (Japan)
- 6PB06 Graphite Bi-Intercalation Compounds with Metal
Fluorides
R. Yazami and T. Nakajima
Kyoto Univ. (Japan)

- 6PB07 Supported Metals Prepared Through Graphite
Intercalation Compounds and Their Use in
Organic Chemistry
F. Beguin, P. Murceau, A. Mesnoudi and
G. Guillaumet^{*}
CRSOCI-CNRS and *LCBA LRA (France)
- 6PB08 Swelling Behavior of Polyfurfuryl Alcohol
Carbon Prepared between the Lamellae of
Saponite
T. Kyotani, N. Sunobe and A. Tomita
Tohoku Univ. (Japan)
- 6PB09 An Improved Apparatus for Studying Adsorption
Characteristics of Activated Carbon
Z. Xie, K. Guo, X. Cheng, C. Yuan and L.
Ma
Res. Inst. of Chem. Defence (P.R.C.)
- 6PB10 A Study on the Rate of Adsorption of Gases by
Porous Solids
H. Oda, A. Kohno and C. Yokokawa
Kansai Univ. (Japan)
- 6PB11 Removal of Organic and Inorganic Pollutants
from Water by Activated Carbon Beds
C. Moreno-Castilla, J. Rivera-Utrilla, M.
Ferreiro-Garcia and I. Bautista Toledo
Dept. Química Inorg., Univ. de Granada
(Spain)
- 6PB12 Micropore Filling of Supercritical NO by Binary
Oxide-Dispersed Activated Carbon Fibers
Z. Wang, S. Ozeki, T. Suzuki and K. Kaneko
Chiba Univ. (Japan)

- 6PB13 Synthetic Active Carbons as Matrices for
Immobilization of Biotrans
V. Sirelko (U.S.S.R.)
- 6PB14 Polymer-Pyrolyzed Active Carbons Porous
Structure and Physico-Chemical Properties
V. Sirelko (U.S.S.R.)
- 6PB15 Real Surface Observation of Carbon Fibers with
an Ultrahigh Resolution Scanning Electron
Microscope
K. Ogura and A. Ono
JEOL Ltd. (Japan)
- 6PB16 A High Fidelity SEM Imaging of Carbon
Materials by FE-SEM
R. Tamochi, M. Yamada and T. Nagatani
Hitachi Inst. Eng. Co., Ltd. (Japan)
- 6PB17 High Resolution Transmission Electron
Microscopy of Graphite (002) Structures after
keV-Hydrogen Ion Implantations
Y. Gotoh, H. Shimizu and S. Suganuma
Hitachi Res. Lab., Hitachi Ltd. (Japan)

Poster Papers (7th. Room A)

- 7PA01 Fiber-Matrix Interface and Physical Properties of Carbon-Carbon Composites
L. Manocha
National Physical Lab (India)
- 7PA02 Material Characteristics of Graphite First Wall and C-C Composite Divertor Plate for JT-60U
T. Aida, H. Takatsu, M. Yamamoto, M. Shimizu, T. Arai, K. Kodama, H. Horike, K. Teruyama*, T. Kuchi* and Y. Goto*
Japan Atomic Energy Res. Inst. and *Hitachi Ltd. (Japan)
- 7PA03 Surface Modification of Carbons in CF₄ Plasma
K. Otsuka, T. Yokono and Y. Sanada
Hokkaido Univ. (Japan)
- 7PA04 Surface Grafting of Polymers from Carbon Whisker: Graft Polymerization Initiated by Potassium Carboxylate or Acylium Perchlorate Groups on Carbon Whisker
T. Toshihara and N. Tsubokawa
Niigata Univ. (Japan)
- 7PA05 Surface Grafting of Polymers from Carbon Black: Graft Polymerization Initiated by a Redox System Consisting of Ceric Ion and Reducing Groups on Carbon Black
A. Fujiki, K. Yanadori* and N. Tsubokawa*
Graduate School of Sci. and Tech. Niigata Univ. and *Fac. Eng. Niigata Univ. (Japan)
- 7PA06 Development of Bulk-Boronized Graphites for Fusion Reactor Applications
T. Sogabe, T. Matsuda, H. Ogura, Y. Hirooka*, M. Khandagale* and R.W. Conn*
Toyo Tanso Co. Ltd. (Japan) and *Inst. Plasma and Fusion Res., Univ. of California (U.S.A.)

- 7PA07 Evaluation of Bulk-Boronized Graphite as a Plasma-Facing Material in Magnetic Fusion Devices
Y. Hirooka, R.W. Conn, T. Sogabe*, T. Matsuda* and H. Ogura*
Univ. of California Los Angeles (U.S.A.) and *Toyo Tanso Co. Ltd. (Japan)
- 7PA08 Grafting of Silatrane on Carbon Substrate for Antioxidation Process
J. Ph. Kosnet, G. Palavit, P. Lati, J.L. Bouliez, M.P. Bacos* and Tissier**
Univ. des Sciences et Techniques de Lille*, ONERA and **INRA-LGIA (France)
- 7PA09 Oxidation Protection for Industrial Carbon by Polyphosphate Way
P. Lati, G. Palavit and L. Montagne
Univ. des Sciences et Techniques de Lille (France)
- 7PA10 Investigation of Oxidation and Carbonization Processes of Polyacrylonitrile (PAN)
A. Gubertov, V. Zagorskii, L. Dambrovskii and M. Maiboroda
NPO "Chimtestilmash" (U.S.S.R.)
- 7PA11 Study of Nicalon Based Ceramic Fibres by Solid State NMR
J.L. Miguel, H. Hommel and A.P. Leerdand
Lab. de Physique Quantique ESPCI (France)
- 7PA12 Porous SiC Ceramics from Rice Hulls
M. Komatsu, M. Nakamizo and Y. Adachi
Gov. Ind. Res. Inst., Kyushu (Japan)

- 7PA13 The Adhesion of Carbon Materials Using Silicon
H. Arizawa, H. Shirasawa, S. Ikeda, I. Suima and T. Tanamura*
Gov. Ind. Res. Inst. of Osaka and *Shikishima Canvas Co. Ltd. (Japan)
- 7PA14 Electron Beam Tests of Sintered C-B-Ti Composite Materials
H. Shino, M. Fujisaka, and T. Tanabe
National Res. Inst. for Metals (Japan)
- 7PA15 Properties of Swelling Porous Carbon Beads Made by a Replica Method
K. Kamigaito and H. Yoshida
Gov. Ind. Res. Inst., Kyushu (Japan)
- 7PA16 Refractory Rate Metal Coatings on Carbon Materials
H.S. Yoon, M. Tava and D.B. Fischback
Univ. Washington (U.S.A.)
- 7PA17 Behaviour of Carbon and Boron-Carbon Materials under Disruption Heat Loads in Tokamak-Electron Beam Simulation Experiments
H. Bolt, J. Linke* and M. Akiba**
Univ. of Tokyo (Japan), *Res. Centre Jülich (F.R.G.) and **Japan Atomic Energy Res. (Japan)

Poster Papers (7th. Room B)

- 7PB01 Laser Interaction with Diamond and Diamondlike Carbon Films
V. Ageev, V. Armev, A. Chapler, T. Kononenko, A. Kuzmichev, V. Konov, S. Pionov, V. Ralchenko, A. Smolin and B. Spitsyn
Inst. of General Physics, U.S.S.R. Academy of Sci. (U.S.S.R.)
- 7PB02 The Effect of the Composition of the Gaseous Phase on Electric Properties of Diamond Films
G. Sokolova, L. Bouilov, I. Teremetskaya and O. Lazareva
Inst. of Phys., Chem. of the U.S.S.R. Academy of Sci. (U.S.S.R.)
- 7PB03 Carbon Cluster on the Diamond Surface
S. Mitlin and P.A. Nicolaevich
Independent Scientist (U.S.S.R.)
- 7PB04 Mechanism of Catalysed Oxidation of Graphite (GR) and Diamond (DM) by O₂ in the Presence of Hydroxides of Alkali Metals
S. Mitlin and P.A. Nicolaevich
Independent Scientist (U.S.S.R.)
- 7PB05 Synthesis of Diamond by Hydrogen Plasma Jet
A. Maruyama, M. Makino, N. Kikukawa and M. Shirashi
National Res. Inst. for Pollution and Resources (Japan)
- 7PB06 Nucleation of Diamond by Micro-Wave Plasma (VD) under Electric Fields
S. Yugo, T. Kanai, T. Kimura and A. Ono*
Univ. of Electro-Communications and *Musashi Inst. of Tech. (Japan)

- 7PB07 Commensurability between 2D Superstructure Unit Cells and Graphite Lattice
D. Guerd, P. Luytange and H. Fuzellier
Univ. de Nancy I (France)
- 7PB08 The Graphite Sulfate Lamellar Compounds: Intensity Variations of the 001 X-Ray Diffraction Lines
H. Fuzellier and B. Bouvard
Univ. de Nancy I (France)
- 7PB09 Degree of Graphitization of Carbons Formed by the Reaction of Uranium Carbides with Nitrogen
K. Takahashi, K. Hamada*, M. Katsura and M. Miyake
Osaka Univ. and *Nippon Steel Co. (Japan)
- 7PB10 Approaches to Enhancing the Thermal Shock Resistance of Graphite
J. Liyi
Jilin Carbon Plant (P.R.C.)
- 7PB11 Methods for Evaluation of the Microstructure of Carbon and Graphite Products
L. Zhaoju
Jilin Carbon Plant (P.R.C.)
- 7PB12 New PFC (Plastic Formed Carbon) Microelectrode for Voltammetric and Biochemical Measurements
H. Kaneko, T. Kawakubo*, Y. Suda*, M. Yamada, A. Negishi and K. Aoki**
Electrotechnical Lab., *Mitsubishi Pencil Co. Ltd. and **Fukui Univ. (Japan)

- 7PB13 GRC (graphite reinforcement carbon) Electrode for Voltammetry
H. Kaneko, A. Negishi, K. Nozaki and T. Kawakubo*
Electrotechnical Lab. and *Mitsubishi Pencil Co. Ltd. (Japan)
- 7PB14 High-Quality Graphite for Speaker Diaphragms
M. Murakami, K. Nakamura, N. Nishiki*, I. Tajima, M. Okazaki and S. Yoshimura
Matsushita Res. Inst. Tokyo Inc. and *Matsushita Electronic Components Co. Ltd. (Japan)
- 7PB15 Development of Ultra-High-Temperature HIP and its Application to Carbon Materials
Y. Sakashita, T. Kanda, K. Muramatsu* and H. Nagata*
Mech. Eng. Res. Lab. Kobe Steel, Ltd. and *New Business Division, Kobe Steel, Ltd. (Japan)
- 7PB16 Diamagnetism of Carbon Fibers
A. Kutsunov
State Res. Inst. Graphite (U.S.S.R.)
- 7PB17 The Stability of Alkali Metals in the Interlayer Spacing of Graphite
H. Shioyama, K. Tsumi, M. Adachi and I. Suima
Gov. Ind. Res. Inst., Osaka (Japan)

APPENDIX C
INTERNATIONAL SYMPOSIUM ON CARBON
PANEL DISCUSSION SUMMARIES

CARBON RESEARCH IN AUSTRALIA

Alan N BUCKLEY

CSIRO Division of Coal and Energy Technology
PO Box 136, North Ryde, NSW, 2113 AUSTRALIA

1. INTRODUCTION

Carbon-related research in Australia is currently carried out within five Divisions of the CSIRO (Commonwealth Scientific and Industrial Research Organisation), universities and industry. Industrial activity is primarily in the areas of metallurgical coke and other reductants. Most industrial carbon materials involving new processing or applications are imported into Australia at present.

2. ACTIVATED CARBONS

Activated carbon is of major importance in gold hydro-metallurgy. In the carbon-in-pulp (CIP) gold recovery process, dissolved $\text{Au}(\text{CN})_2^-$ from the pulp is adsorbed by coarse particles of activated carbon and recovered as gold by screening and high temperature elution of the carbon followed by electrowinning. CSIRO has recently established that the adsorption-desorption of $\text{Au}(\text{CN})_2^-$ is fully reversible and involves interaction with the graphitic planes of the carbon rather than C-O functionalities present on the edges of these planes. As the carbon surface is unaltered in the adsorption, thermal reactivation should be unnecessary.

All aspects of the use of activated carbon in the CIP process, including fouling of the carbon, carbon-catalysed cyanide degradation, the optimum conditions for stripping the gold from the carbon, and thermal regeneration have been studied by an industry-funded project based at Murdoch University in Perth. Problems faced in extension of the CIP process to treat more complex ores with significant levels of copper or reactive sulfides are currently under examination.

CSIRO has developed an activated carbon from the residues of the wood-based products industry. Trials of the product at a CIP gold recovery operation have shown the wood-based carbon performs well compared with commercial activated carbon. The fluidised bed

process developed for the production of the carbon optimises the utilisation of wood feedstock.

Research is proceeding at the BHP Central Research Laboratories in Newcastle into the production of activated carbons. As a major producer of coal, BHP is well placed in terms of access to raw materials to become a producer of both powdered and granular forms of activated carbon.

The impregnation of activated carbons with metals and metal oxides is being investigated at the South Australian Institute of Technology. These 'second-generation' tailored activated carbons, which are more useful than the basic activated carbons because of their specific, rather than general, adsorptive capabilities, should find application in catalysts and membrane technology.

Activated carbons to increase the capacity of natural gas storage cylinders are being developed by CSIRO. By adding adsorbent to storage cylinders, it is possible to increase their capacity without any increase in pressure. The carbon used must have a high density as well as a high surface area, and ways in which the density can be maximised are currently being investigated.

The production of activated carbons from brown coal is being investigated by the Research Facility of the Coal Corporation of Victoria. Victorian brown coal is suitable for the production of industrial carbons because of its extremely low ash yield, however it is inherently a very soft material. Recent research has been directed towards increasing the hardness, or attrition resistance, of these activated carbons, a requirement for most applications involving a carbon regeneration step. By combining a kneading/shearing pretreatment step with the addition of KOH, a dense, non-porous, colloidal gel is produced upon drying, which when subsequently carbonised, produces hard activated carbons comparable to those currently used in gold recovery. By varying the alkali/coal ratio and the carbonisation conditions, controlled changes may be made to the physical properties of the carbons.

3. CARBON ELECTRODES

A research project, involving a consortium of companies from the aluminium and coal industries together with CSIRO, has recently been established to develop carbonisation technology for

the production of substitute anode coke from ultra-clean coal for use in aluminium smelting. Currently anode coke is imported into Australia in the form of petroleum coke. Previous attempts to produce a substitute coke from coal were limited to coals that were naturally low in mineral matter, and were not successful. Technology developed by CSIRO now allows the demineralisation of most coals to the required low ash yield providing an opportunity to select coals with appropriate properties for anode coke production.

Supported electrocatalysts, predominantly those involving noble metal alloys, are currently being studied at the University of Sydney. High surface area carbons are ideal as supports for a range of electrocatalytic reactions including the oxygen evolution reaction and in low temperature fuel cells or sensors. Their high conductivity means that insulating metal oxides can be utilised as well as more conventional metal catalysts. Altering the surface composition of the carbon particles can have dramatic effects on the observed electrochemical response.

4. CARBON FIBRES

CSIRO has been active for a number of years in the utilisation of coal- and petroleum-derived pitches for making carbon fibres. CSIRO pioneered the determination of the mesophase characteristics of pitches which now form the basis of commercial production of pitch-based carbon fibres. Extensive laboratory work has provided a reasonable understanding of structure/property relationships of carbon fibres derived from various precursors. Techniques to quantify the mesophase formation with pitches were developed, notably those based on the decay of nuclear magnetic resonance signals. Work is continuing in order to further understand the structure/process/property relationships. Recently, CSIRO has also been studying the vapour deposition of carbon fibres from hydrogen/hydrocarbon mixtures.

A small group at the Australian National University works on structural aspects of carbons. Most of their research makes extensive use of transmission electron microscopy (including electron diffraction), scanning electron microscopy and light microscopy, and has been focused on carbon fibres of various kinds. Detailed studies have been made of commercial mesophase

pitch-based carbon fibres and PAN-based fibres. These studies, covering all scales from lattice images to whole filaments, have led to a more complete picture of the structural elements which affect physical properties, especially tensile strength and modulus. Attention is now being directed to the processes which determine the structure of mesophase pitch-based carbons.

5. DIAMOND-LIKE CARBON AND DIAMOND FILMS

CSIRO has used a number of methods to produce diamond-like carbon and diamond films. Diamond-like carbon films have been produced using magnetron sputtering, ion beam sputtering and arc evaporation. Currently, efforts are concentrated on arc evaporation which may have the capability of producing optical quality film with hardness comparable to crystal diamond. Diamond films have been produced using plasma-assisted chemical vapour deposition. Properties under investigation include growth mechanisms, structure and adhesion, and stress of the films. The surface modification of carbon is also being investigated. The technology makes use of ion beams as a surface modification tool to generate layers of increased hardness at the surface of machined carbon components. A hardness increase to near diamond levels, as measured by diamond polishing, scratch and ruby-ball-on-disc testing, is produced at the surface of a range of carbon materials including electrode, glassy, fibre, pyrolytic and carbon fibre reinforced carbon. It is therefore a generic hardening response in carbon, originating in the atomic displacement produced by the ion beam. CSIRO pioneered the use of ion beams for this purpose and is currently pursuing applications where the generation of near diamond hardness layers at the surface of solid carbon components is likely to be advantageous.

PROMOTION OF INTERNATIONAL COOPERATION

CHOYU OTANI

Centro Técnico Aeroespacial - IPD/PMR
12.225 - São José dos Campos - SP - Brazil

1. INTRODUCTION

As far as the Brazilian industries are concerned, many basic raw materials for advanced technology are still scarce. Despite reasonable Brazilian infrastructure, our industries are basically devoted to the extractive and also primary transforming products areas. Therefore the production of all kinds of advanced materials is extremely reduced including that concerning to special carbon materials.

Nevertheless one can see an intention from both Brazilian Government and private industries for the establishment of a R&D policy regarding to the development of advanced materials technology within the country. One great drawback is the small internal consumption and, on the other hand, the unavailability of such advanced materials. These facts don't allow the formation of a real market.

The overall view of the country shows the reason for the small number of researches dealing with carbon materials. The Carbon Group of Centro Técnico Aeroespacial is practically the only one with defined objectives in carbon materials research.

2. THE CARBON GROUP AT CTA

The Carbon Group at CTA started his tasks during the 70's within the cooperation of Professor Gwin Morgan Jenkins from Swansea University, UK. The foreseen objective was the development of materials for Bioengineering applications. Furthermore the aerospace applications of carbon materials were added as the second objective, that is: R&D in carbon fibres, glassy carbon, graphite and carbon-carbon technologies.

The Carbon Group is actually composed by 11 researches and 12 technicians.

There are also capabilities for both processing and characterization of carbon materials. The purpose is the development of bio and mechanically compatible carbon materials for oral, orthopaedic and cardiovascular implants. The objective may be achieved together with physicians and dentists from other organizations.

Basic research on pitches from both mineral and vegetal origins is being carried out.

3. INTERNATIONAL COOPERATION

The project "Development of Carbon Fibres" conducted at CTA with the financial support from UNIDO has brought many profits in terms of training from foreign experts and also the facilities on equipments and special chemicals purchasing. Whereas this activity is finished and the maintenance of the above mentioned technical cooperation is quite difficult nowadays.

Despite the actual material and financial limitations we look forward to establish an effective cooperation from the international scientific community again regarding to technical advices in both processing and characterization areas of the novel forms of carbon. Within this new foreseen cooperation program we may enhance our contribution potential in breaking the existing vicious cycle between production and consumption profile of advanced materials in Brazilian market sphere. As a counterpart we can help anybody working in the interface area between materials engineering and medicine.

PROMOTION OF INTERNATIONAL COOPERATION - CZECHOSLOVAKIA

Jan Uhl
National Research Institute for Materials
Upletalova 25, 113 12 Praha 1, CZECHOSLOVAKIA

Carbon fibres from PAN

Monokrystal, Turnov:
Precursor conditioning, preoxidation, carbonization and gaseous products liquidation, graphitization, surface treatment, sizing.
Pilot plant for 1 t/year at present, production plant with capacity about 100 t/year designed.

Institute of Theoretical and Applied Mechanics, Academy of Science
Institute of Thermomechanics, Academy of Science, Praha
University of Mechanical and Textile Engineering, Liberec:
Physical properties of Cf and their composites, micro- and macro-mechanics of composites, mainly epoxy/Cf.

Research Institute of Chemical Equipment, Praha
AERO, Czechoslovak enterprises for airplanes production, Praha:
Analysis and design of CFRP composites and parts, technology of their production, machining, joining.

National Research Institute for Materials, Praha
Aeronautic Research and Test Institute, Praha
Research Institute of Synthetic Resins and Lacquers, Pardubice:
Design and development of production technologies (mainly autolave, RIM and filament winding) of CFRP parts. Inspection methods during processing. R&D methods of finished parts. R&D of matrices and prepreg preparation.

Research Institute of Motor Vehicles, Praha:
Design and development of CFRP and hybrid composite parts for automotive industry, testing under working conditions.

Carbon fibres from pitch

Research Institute for Man-made Fibres, Svit
Petrochemical Research Institute, Prievidza:
Petroleum pitch treatment, spinning, thermosetting and carbonization of isotropic Cf. study of their structure and properties.
Pilot plant for 1 t/year at present, production plant with capacity 20 t/year designed for ninefold. R&D of anisotropic Cf from hydrocrack oil processing.

Prague Institute of Chemical Technology, Dept. of coke and gas tech.
Analysis of pitch precursor before and after treatment, analysis of by-products from thermosetting and carbonization of Cf. Analysis of surrounding air by spinning process. Liquidation of undetectable aerosols.

Research Institute for Organic Synthesis, Pardubice:
Cf surface treatment and R&D of sizing agents for Cf in various matrices, methods of application.

National Research Institute for Materials, Praha:
R&D of tribological materials with Cf, processing and application of CFRP, inspection and test methods. Corrosion problems of CFRP.

Carbon materials

Institute of Geotechnics, Academy of Science, Dept. of Industrial Carbon, Praha:

Glassy carbon - selection of raw materials, conditions of curing and carbonization.

Flexible graphite - study of raw materials, conditions of intercalation and expansion.

Study of mesophase on the base of coal-tar pitch for fibre spinning and microbeds processing.

Investigation of needle-like structure of electrode carbon, and of its changes during calcination and graphitization.

Investigation of selective sorbents on the base of natural carbon blacks and their carbonizations products.

Study of surface properties and porous texture of carbonaceous materials, with special attention paid to microporous structure.

Thermal properties of different rank's coal's coal and texture characteristic of resulting cokes. Porous systems of different rank's coal and resulting cokes. Carbon-carbon composites and isotropic carbon.

The J. Heyrovsky Institute of Physical Chemistry and Electrochemistry, Dept. of Physical Adsorption, Academy of Science, Praha:

Development of the theory of adsorption of gases and vapours on micro-, supermicro- and mesoporous solids. The properties of adsorbed and capillary condensed fluids are studied by means of the thermodynamics of small objects in the field of external adsorption forces. This enables to derive the equations of adsorption isotherms, and also to elaborate the more sophisticated methods of analysis of the porous solids.

The study of preparation and properties of microporous carbon.

First in the world the carbon molecular sieves have been prepared with are able to separate oxygen and nitrogen and extremely high dispersed carbon ($S_{\text{sp}} 2-5000 \text{ m}^2 \cdot \text{g}^{-1}$) by the chemical reaction of perfluorocarbons (perfluorobenzene, perfluorohexane, perfluoropolyethylene) with lithium amalgam. The results are used by gas desulfurization and denitification (theory: adsorption of supercritical fluids), gas storage, catalysis, water treatment, medicine (haemoperfusion).

Comenius University, Faculty of Natural Sciences, Dept. of Inorganic Chemistry, Bratislava:

Organic-montmorillonites as the reaction products of the clay mineral montmorillonite and alkylamine cations. Preparation and study of organic-activated montmorillonites from diluted dispersions of Ca-montmorillonite (Czechoslovak locality) by addition of alkylammonium salts. I has been found that the properties of organomontmorillonites depend mainly on sorbate concentration, the length and orientation of alkyl chains, the amount of water in samples and on negative layer charge. Hydrophobic montmorillonites are used as gelling agents for lubricants, as additives to putties, paints and cosmetic preparations.

Prague Institute of Chemical Technology, Dept. of coke and gas Technical University of Mining, the college of metallurgy and coke, Ostrava:

Pretreatment of coal and petroleum pitch, pitch and tar rheology and analysis, methods of removing non-soluble in quinoline substances. Pitch coke, study of needle-like structure, production technology of electrodes and anode masses.

Elektrokarbon, Interprice for carbon materials, production, technology:

R+D of isostatic pressured carbon materials for continuous casting of metals, Carbon compounds: metal-infiltrated packings and sliding materials. Carbon-carbon materials technology.

Production program: carbon brushes for electric machines, battery carbons and electrodes, spectral carbons and dust for analysis, carbon contacts and trolley collectors, welding electrodes, sealing and packing materials, piston rings, bearings, carbon products for glass industry, graphodur for chemical industry-heat exchangers, coolers, absorbers, compressor blades, jet-cones, brake linings.

Aluminium Works, Ziar nad Hronom:

R+D of anode and electrode masses for aluminium manufacturing, self-baking electrodes for ferro-alloy and calcium carbide production, heart lining of the blast and steel making furnaces, tapholes of the ferro-alloy furnaces, masses from coal-tar and petroleum pitch, anthracite and electric graphite.

CARBON ACTIVITY IN FRANCE

J. LAHAYE, Président du Groupe Français d'Etude des Carbones
C.N.R.S., 24, Avenue du Président Kennedy, 68200 MULHOUSE (France)

The French carbon activity is developed on the national territory as well as abroad especially in U.S.A., United Kingdom, Germany, Spain, Japan and India. French companies [Aérospatiale, Aluminium Féchiney, C.E.A. (Nuclear Establishment), le Carbone Lorraine, Norsolor, Société Européenne de Propulsion, Société des Electrodes et Réfractaires de Savoie], control more than 10 % of the world production in carbon as a material. If one considers carbon materials without including anodes for aluminum, French companies are in the 3rd or 4th position in the world. When anodes for aluminum are included the turn-over of French technology reaches the second position. It is interesting to note that half of the production on French territory is exported.

The significant activity of France in aeronautics and airspace led to the development of a strong activity in the domain of composites : carbon/polymer, carbon/carbon and carbon/ceramics.

Of course such an activity requires an efficient interaction with research laboratories. Besides internal interactions, carbon industry has a tight collaboration with laboratories of the National Center for Scientific Research (CNRS) and University.

The collaboration between producers and research laboratories are made easier and efficient through the Groupe Français d'Etude des Carbones (the G.F.E.C.). All people involved in carbon science and technology encounters at the G.F.E.C. created in 1960. The G.F.E.C. meets twice a year : a one day meeting in January and a one week meeting in September. At the September meeting the participants (80 to 100) present their results, some thematic sessions are organized and, which is very useful, industrial people and academic researchers have the opportunity to interact and to define research projects.

Academic research is mainly carried out in nine laboratories listed below in the alphabetic order of the city where they are located.

(42)

- 1) **Bordeaux** (Research Center Paul Pascal)
Domaine Universitaire, 33405 TALENCE.
- chemical vapour deposition (including diamond like carbons and BNC alloys)
- stable intercalation compounds
- carbon - polymer systems.
- 2) **Grenoble** (Surface Science and Carbon Materials)
Domaine Universitaire, BP 75, 38402 ST MARTIN D'HERES.
- filamentous carbons by CVD
- diamond like carbons (plasma)
- oxidation - gasification
- intercalation compounds.
- 3) **Lille** (Laboratory of Applied Chemistry)
Université des Sciences et Techniques, BP 36, 59650 VILLENEUVE D'ASCO
- protection of carbons against oxidation
- intercalation mechanisms
- 4) **Mulhouse** (Research Center on the Physical Chemistry of Solid Surfaces)
24, Avenue du Président Kennedy, 68200 MULHOUSE.
- interfacial reactions of carbons and ceramics (fibres, composites, particulate carbons, supported metallic derivatives)
- formation and oxidation of carbon in flames
- physical-chemistry of carbon precursors.
- 5) **Nancy** (Laboratory of the Chemistry of the Inorganic Solid Mineral)
BP 239, 54506 VANDEUVRE LES NANCY.
- intercalation in 2D structures
- electroactive polymers including the fibre/carbon systems
- carbonization and graphitization of tars
- 6) **Nancy** (Laboratory of Industrial Chemistry)
E.N.S.I.C., 1, rue Grandville, 54042 NANCY Cedex.
- chemistry and catalysis of the gasification of carbons
- 7) **Orléans** (Research Center on Surfaces with Imperfect Crystalline Organisation)
C.N.R.S., 1a, rue de la Ferrière, 45071 ORLEANS Cedex 2.
(Laboratory of Crystallography)
Faculté des Sciences, 45067 ORLEANS Cedex

(41)

- intercalation
 - supported metallic particles
 - oxidation of carbons
 - structure and microstructure of carbons and carbonaceous materials
- 8) **Paris** (Laboratory of Quantum Physics of the Superior School of Physics and Industrial Chemistry)
10, rue Vauquelin, 75231 PARIS Cedex 05.
- ^{13}C NMR and ESR of carbons and carbon/polymer systems
 - intercalation
- 9) **Pau** (Laboratory Marcel Mathieu)
Université de Pau, 2, Avenue du Pt Pierre Angot, 64000 PAU.
- electron microscopy of industrial carbonaceous materials : fibres, composites, etc...)

The Chinese Carbon Industry and its Activities

Yang Guo Hua

The Vice President of The Carbon Material Society
Shanghai Carbon Plant, Vice Chief Engineer, Senior Engineer

I. Outline

It was after the Jilin Carbon Plant had been put into production that the Chinese carbon industry came into being. Through thirty-five years constant development, now there are four large carbon plants located in Jilin, Lanzhou, Shanghai, Nantong respectively as well as many smaller ones. So we have a good supply of carbon products to be used in various industries, such as steel-making, aluminum smelting ferro alloy as well as calcium carbide production.

At present, the main products of carbon plants in China are graphite electrodes, graphite anodes, carbon block and paste. Besides we also produce graphite heat exchanger, fine-grained graphite of high strength, high density and high purity, a number of pyrolytic graphite, carbon fibre and its textile, carbon fibre composite and bio carbon products.

In China, the aluminum smelting plant are subordinate to the Nonferrous Metal Corporation, most of which are capable of making the anode paste or prebaked anode, moreover a few, such as Guizhou Aluminum Plant even the carbon blocks for aluminum electrolysis.

Some small carbon and graphite products such as Carbon brush, graphite sealing ring etc are produced by electrical carbon factories run by The Ministry of Mechanical and Electrical Industry.

In China, the carbon plants are supervised by The Ministry of Metallurgical Industry. The Carbon Material Society affiliated to The Chinese Society of Metals is a special learning society of carbon materials which regularly sponsors a nationwide academic discussion on carbon materials for every two years, the attendants being from the departments engaged in the producing, research and developing, designing and user of carbon materials. Moreover some local society of metals in the provinces and cities, such as The Shanghai Society of Metals have founded the Carbon Material Academic Commission. Just to carry out the special academic discussion on carbon and graphite materials locally.

Acting as the design institute in Chinese carbon industry. The Aluminum and Magnesium Engineering and Research Institute in Shenyang

GG1

and Guiyang take up the task of designing and technical renovation for the carbon plant.

With the expansion in the scope of carbon and graphite materials application, more and more scientific research units are being engaged in the study of carbon graphite materials. Besides the carbon plants, the institute engaged in the research on carbon materials mainly are:

- The Shenyang Institute of Metals, Academia Sinica being engaged in the research on CVD technology and mechanism related to the pyrolytic graphite.
- The Shanxi Institute of Coal Chemistry, Academia Sinica being engaged in the research on carbon fibre.
- The Anshan Research Institute of Thermo-Energy being engaged in the research on pitch based carbon fibre and the technology of the coal tar pitch based needle coke.
- The Beijing Petroleum Scientific Research Institute being engaged in the research on the technology of petroleum-based needle coke. Still, there are research institute of the electrical carbon industry dealing with the developing of the electrical carbon products, and the ones of the aluminum doing the developing of carbon product for aluminum electrolysis.

II. The Research Topics in last ten years

- The manufacturing of needle coke and ultra high power electrode.
- The manufacturing and application of carbon fibre (PAN based and rayon based) and its textile.
- The manufacturing of pitch-based carbon fibre.
- The study of CVD technology and mechanism and its applications.
- The study of the technology and mechanism of CVD in fluid bed for making carbon cardiac valve and small artificial carbon articulations.
- The study on C-C depositing mechanism and its application for making filter.
- The study of CVI technology.
- The study of technology of isostatic press for making isotropic graphite.

GG5

TAIWAN'S CARBON FIBER INDUSTRY TODAY AND PROSPECTS

Prof. Chung-Hua Lin

Graduate Institute of Textile Engineering Feng Chia University
Taichung, Taiwan, R.O.C.
Nov. 07, 1990

Carbon fiber is a term used to describe over 90 percent of the fibers used in industrial applications. The production of carbon fiber requires organic materials that can be carbonized into fiber without losing its form. In 1959, the first carbon fibers were developed in Osaka, Japan by using polyacrylonitrile as a precursor. Another way was developed also in Japan by using pitch which the residue from the distillation of crude oil. Methods of production vary and the properties and uses are affected.

The fibers are used where high strength, no elasticity, and heat resistance are required. The fibers are used to reinforce resins and metals used in golf-club shafts, archery crossbows, skis, bicycle parts, keels for canoes, rotor blades for helicopters, and compressor blades in jet engines. Fabrics of carbon fibers are used in the construction of cars and spaceships. In Taiwan, carbon fiber is used widely in production of racket so as to win the name of "The king of racket manufacture".

The first carbon fiber industry in Taiwan was introduced by "Kwang-Han Co." specially for the manufacturing racket in 1979. In 1981, one of the best acrylic fiber manufacturer in Taiwan, "Taiwan Plastic Co.", established a carbon fiber pilot plant for R&D. In 1987 was the first plant built by its own technology, and access a local market.

In Taiwan over the last few years, carbon fibers have become increasingly important. After expanding production in 1990, the monopoly producer "Taiwan Plastic Co." is with a capacity of 130 t per year. At present, the year consumption of carbon fiber in Taiwan is about 220 t.

624

The prospect for the Taiwan's carbon fiber industry is optimistic. The direction of industry here in Taiwan has been moving away from a labor-intensive and energy-intensive level to a more skill-intensive and technology-intensive industry base. The Government in Taiwan gives generous incentives for investment especially those that deal with high technology. The best prospects for growth in Taiwan today are in the electronics and information industry. The aircraft industry which closed connected to the carbon fiber industry is the next hot-growth industry in Taiwan. The Government are taking measures to strengthen its own technological capacity so as to acquire an endogenous capability in the choice, transfer, adaptation, development and application of carbon fiber technology in the light of local assessments and priorities. In the future, more and more Taiwan companies with the help of national institutes could be researching and developing their own technology. The advantage and abundance of petrochemical products can also makes the Taiwan carbon fiber industry to improve the international competitions.

The future holds a bright promise for Taiwan. If we take its past record as a basis for judgement, we can expect Taiwan will continue its surge towards growth and stability.

The following tables shows the year consumption of carbon fiber market in Taiwan, the trends in the international carbon fiber market, worldwide year consumption of PAN-based carbon fiber market and the world productivity of carbon fiber.

Taiwan's carbon fiber Import/Production for Years

Tabel 2.1

The year consumption of PAN-based carbon fiber in 1987
(in ton)

	Janpan	Americal	Europe	Taiwan	Others	Amount
Sport industry	540 (63%)	180 (9%)	160 (20%)	550 (100%)	180 (90%)	1610 (36%)
Aircraft industry	20 (2%)	1605 (81%)	440 (55%)	0	0	2065 (46%)
Others industry	300 (35%)	255 (10%)	200 (25%)	0	20 (10%)	775 (18%)
Amount	860	2040	800	550	200	4450

Tabel 2.2

The prediction of PAN carbon fiber market in USA

1987	1992	average growth rate per year
2040 t	4300 t	19.5%

Tabel 2.3

The prediction of PAN carbon fiber market in Europe

1988	1991	1992	average growth rate per year
935 t	1710 t	4300 t	20%

(Source: JEIL. vol.37 No.3)

Table 3
Worldwide year consumption of PAN carbon fiber market
(in ton)

	1987	1988	1989	1990
America	2040	2300	2680	3040
Europe	800	900	1035	1190
Japan	860	950	1050	1160
Taiwan	550	600	700	750
Others	200	200	150	190
Amount	4450	5010	5610	6330
Growth rate	24%	13%	12%	13%

(source: TOHO prediction)

World Consumption of Carbon Fiber

Table 4

Table 5
The World Productivity of carbon fiber

1. PAN carbon fiber: Total 8290 ton/year + 3510 ton/year(planning)

Area	Producer	Plant Location	Brand Name	Capacity (ton/year)	Precursor Supplier
Asia (45%)	Toray Industries Toho Rayon Asahi Kasei Carbon Fiber Mitsubishi Rayon Nippon Carbon Formosa Plastic Korea Steel Chemical	Enisei, Japan Mitsushima, Japan Fuji, Japan Ohtake, Japan Yokohama, Japan Kachialung, Taiwan Pohang, Korea	TONYCA BESFIGHT MI-Carbonlon Pyrofil Carbonlon Tairafil KOSCA	1500(+750/'90) 1420(+800/'90) 380(+150/'89) 380(+330/'85) 80 100(+130/'90) 150	In-house In-house In-house In-house Asahi In-house Courtaulds-Grafil
5760t (+2010t)	AFION Carbon	Hayarden, Israel	ACIF	100	Courtaulds-Grafil
USA	Hercules BASF Structural Materials Amoco Performance Products AlZO Courtaulds-Grafil BPAC Zoltek	Bacchus, UT Rockhill, SC Greenville, SC Rockwood, TN Sacramento, CA Gardena, CA Lowell, MA	Magnaforce Cation Thornel Fortafil Grafil NITEX PANEX	1715 453(+900/'90) 380(+450/'90) 455 400 125 113	Susikz-Hercules Toho Rayon In-house Du Pont Courtaulds-Grafil Mitsubishi Rayon Courtaulds-Grafil
Europe (14%) 1300t SICRI	Courtaulds-Grafil ENKA SOFICAR SICRI	Coventry, UK Oberbruch, Germany Abidos, France Augsburg, Germany	Grafil TENAK FILKAR Sigrafil	250 500 300(+150/'90) 220	In-house Toho Rayon Toray Courtaulds-Grafil
(+150t) 150t	R. K. Carbon	Muir of Ord, UK		150	Courtaulds-Grafil

2. Pitch Fiber: Total 2106 ton/year +50 ton/year (Planning)

Area	Producer	Plant Location	Brand Name	Capacity (ton/year)	Precursor Supplier
Asia	Kureha Chemical Mitsubishi Kasei DONAC Nippon Petrochemicals Nippon Carbon	Isaki, Japan Sakaide, Japan Osaka, Japan Yokohama, Japan Yokohama, Japan	Kureca Diallead Donacarbo Granoc Carbonlon-P	900 500 250 50('89) 35	Petro Coal Coal Petrolse Coal
USA	Amoco Performance Products Textron Inc. Ashland Petroleum Company	Greenville Lowell, MA Ashland, KY	Thornel Panex Carbiflex	230 50 140	Petrol Petrol Petrol

(Source: 1990 Fiber Handbook Japan)

THE BRITISH CARBON GROUPS

Frían McEnaney

School of Materials Science, University of Bath, Bath PA2 7AY, UK

1 ORGANIZATION OF THE GROUPS

Formal arrangements for coordinating work on carbon and graphite materials in the United Kingdom were created in the mid 1960s. At that time a decision was made to create two carbon groups, the Industrial Carbon and Graphite Group (ICGG) of the Society of Industrial Carbon and Graphite (SICG) and the Carbon Group of the Institute of Chemical Industry (SCI) and the Carbon Group became a joint one Physics (IoP). Subsequently, the latter group became known as the Joint with the Royal Society of Chemistry (RSC) now known as the Joint Carbon Group (JCG). The original intention was that the ICGG would serve the interests of industrial users of carbon materials and the RCG would serve the interests of academics. Thus both Groups are specialist subject Groups of scientific societies, who can provide some administrative support. A leading figure in creating these Groups was the late Professor A P P Ubbelohde, formerly of Imperial College, London. Professor Ubbelohde was for many years Chairman of both Groups thus ensuring good coordination of the scientific programs on carbon materials. Subsequent to him relinquishing his Chairmanships, this was not always the case, and so a British Carbon Council (BCC) was created with representation from both Groups to ensure effective coordination of their programs. In recent years there has been very good liaison between the two Groups, so that the RCG has operated on an informal basis. It is debatable whether the historical reasons for creating two Groups apply in the 1990s and there are arguments for merging them. Discussions on this question are in progress.

The total membership of the two Groups is about 400 with the ICGG having about 100 members and the JCG having about 200 members. Subject to approval at the 1990 Joint Annual General Meeting of the two Groups, the principal officers in 1991 will be: ICGG Chairman: Professor R Band, University of Leeds; Secretary: Dr F M Thomas,

University of Newcastle upon Tyne; JCG Chairman: Dr J W Patrick, University of Loughborough; Secretary: Dr A J Wickham, Berkeley Nuclear Laboratories, Nuclear Electric plc. The addresses of the Secretaries of the two Groups are given at the end of this paper.

The financial requirements to run the two Groups are modest, being confined mainly to expenses for holding Committee meetings. These are provided by a small capitation fee paid by members of the scientific societies who subscribe to the Groups. Non-members of the societies may also participate in the activities of the Groups by becoming Group Subscribers. Group Subscribers, particularly from outside the United Kingdom, are very welcome and details for joining the Groups can be obtained from the Secretaries.

2. PRINCIPAL ACTIVITIES

The principal activities of the British Carbon Groups are (a) to organize scientific meetings, (b) to promote contacts with Carbon Groups from other countries and (c) to represent the interests of carbon scientists in their parent scientific societies.

The general pattern of scientific meetings organized by the Groups in recent years has been to hold two- or three- day meetings once or twice each year on specialist carbon subjects. Brief details of meetings held in the United Kingdom since 1985 are given in Table 1, which shows that the task of organizing meetings has been shared between the two Groups. Table 1 also shows that for the majority of the British Carbon Group meetings papers presented are published in appropriate scientific journals. The Groups feel strongly that this is a powerful incentive for attracting high quality papers to the meetings, which in turn attracts a large number of delegates. Indeed, many of the recent meetings of the Groups have attracted a high proportion of delegates from other countries.

Meetings are hosted on a break-even basis. However, if attendance exceeds the estimated break-even number, then a useful surplus will accrue. These surpluses are used to provide bursaries to enable postgraduate research students to attend Group meetings and the ICGG has recently created two travel Fellowships to enable

Junior and senior scientists to attend international carbon conferences. These Fellowships are financed from profits from the last international carbon conference held in Britain, "Carbon 88". Members of the Carbon Groups also benefit from discounted registration fees from meetings of the Groups.

Table 1. Recent and Future Meetings of the British Carbon Groups

Date	Topic	Organizing Group	Papers published
1985	Structure and Reactivity of Coal	ICGG	Fuel
1985	Strength and Structure in Carbons	JCG	Carbon
1986	Carbon Fibres-Properties & Applications	JCG	J.Phys.D
1987	Pitch - The Science of a Future Material	ICGG	Fuel
1987	Porosity in Carbon Materials	JCG	Carbon
1988	CARBON 88	Both	ICG
1988	Growth and Properties of Carbons*	JCG	Catal. Today
1989	Carbons and Catalysis*	ICGG	
1989	Young Scientists' Meeting	Both	
1990	Interfacial Phenomena in Carbons	JCG	
1990	Carbon in Extreme Environments*	ICGG	
1991	New Carbon Systems	JCG	
1991	Pros & Application of Molecular Sieves*	JCG	
1992	Advanced Carbon Materials	ICGG	

* Joint Meetings with other Subject Groups of the RSC, IOP or SCI.

In addition to holding specialist meetings, the British carbon Groups have played their part in organizing the annual international conferences on carbon, as part of the cycle of meetings between Europe and the USA. Indeed, the organization of international conferences on carbon pre-dates the formation of the Carbon Groups. The first British conference on "Industrial Carbon and Graphite" was held in 1957 and "Carbon 88" was the seventh of the series to be held in Britain.

3. THE CARBON NEWSLETTER

Another service to members is the production of a Carbon Newsletter which is published at approximately six-monthly intervals. The Carbon Newsletter contains reviews of recent national and international meetings on carbon, notices of future meetings, personal news of members, and news of international

developments in the field of carbon materials. The present editor of the Carbon Newsletter is Dr D E Clarke, University of Loughborough, whose address is at the end of this paper. Dr Clarke will be pleased to send a copy of the Carbon Newsletter to the Chairman or Secretary of Carbon Groups from other countries and he welcomes information about activities and meetings in carbon materials held in other countries for publication in the Newsletter.

4. INTERNATIONAL RELATIONS

The annual cycle of international carbon conferences ensures that the officers of the British Carbon Groups keep in contact with their opposite numbers in other countries on an informal basis. More formally, the British Carbon Groups are represented on the IUPAC Nomenclature Committee for Carbon and, recently, a working group, "Eurocarbon", was set up to co-ordinate activities between Carbon Groups in Europe. The initiative taken by the Carbon Society of Japan in convening a meeting of Carbon Group representatives during Carbon 90 in Tsukuba, and to which this paper is addressed, is a welcome development in which the British Carbon Groups are anxious to play their full part.

5. Addresses

Hon. Secretary Joint Carbon Group

Dr A J Wickham, Nuclear Electric plc, Berkeley Nuclear Laboratories, Berkeley, GL 13 9PB, UK.
Tel: 0 453 812 400; Fax: 0 453 812 529.

Hon. Secretary ICGG

Dr K M Thomas, Northern Carbon Research Laboratories, Chemistry Department, The University, Newcastle upon Tyne, NE1 7PU, UK.
Tel: 0 91 222 7085/7084; Fax: 0 91 222 6999.

Hon. Editor, Carbon Newsletter

Dr D E Clarke, Carbon Research Group, Department of Chemical Engineering, University of Technology, Loughborough, LE11 3TU, UK.
Tel: 0 509 222 526; : 0 509 231983.

CARBON RESEARCH IN THE USA

P. A. Thrower
Department of Materials Science & Engineering
The Pennsylvania State University
University Park, PA 16802

Basic research on carbon materials in the USA has a current emphasis on fibers and composites. Of the nearly 350 papers presented at the 19th Biennial Conference on Carbon (1989) shows that nearly 45% of the papers were from the USA. Of these the majority related to carbon fibers and composites in some way or other. The 'Fibers and Composites' section had by far the largest number of papers, but contributions on this subject were also to be found in sections on mesophase, carbonization, reactivity, pyrocarbon, and intercalation. There were also a number of papers presented on carbon filaments.

We shall return to the subject of fibers and composites, because it is here that we perhaps face the greatest challenges and most need international collaboration. However there are other areas where important research is being done and these must not be overlooked. There continues to be interest in carbons as catalyst supports (Penn State Univ.) and in the formation of soot (General Motors, UC Davis, Brown Univ., Penn State Univ., Exxon). Activated carbons always are in the news and debate about pore size distributions continues to draw attention (Kent State Univ., Univ. of Kentucky, Air Force Astro. Lab., Naval Res. Lab., Penn State Univ.)

We must also not overlook the great importance of current research into the production of diamond thin films, which are often considered outside the mainstream of carbon research. A recent workshop on this subject held in Ohio (May 20-24, 1990) attracted around 160 scientists of whom all but 20 came from the USA. There are many universities and industrial laboratories involved in this effort. The proceedings of this meeting will be published in *Carbon* 28 6.

Intercalation is still of some interest (MIT, SUNY Buffalo) although the research effort on this phenomenon has declined and some of the remaining effort is directed to modifying the properties of carbon fibers.

The reactivity of different carbonaceous solids is of continued interest and work is in progress at many locations (Auburn Univ., SUNY Buffalo, Penn State Univ., US Dept. of Energy, Brown Univ., General Motors). Much of this work is also applicable to fibers and composites where the major effort is in preventing reactivity.

Funding for carbon research in the USA, particularly with reference to carbon-carbon composites, is well below what is needed to solve some of the most pressing problems. Support for

research by the traditional graphite manufacturers appears to be minimal and there are nowadays very few publications on graphites for electrodes and anodes. Whether significant improvements can be made in the performance of bulk materials can be made is still perhaps an open question. Improved strength and oxidation resistance can certainly be achieved in smaller artefacts, but there are difficulties involved with scaling production to larger pieces and it appears that some effort is called for in this area. Proprietary considerations are undoubtedly a hindrance to cooperation.

There is little doubt that the area which cries out for cooperation is that of carbon-carbon composites. Good work is being done not only in the USA (too many locations to list), Japan and Europe, but also in India (NPL - New Delhi), Israel (Technion - Israel Inst. of Tech.), China (Beijing Res. Inst. of Materials) and Korea (KAIST). Much of this foreign interest in the subject has evolved in the last five to seven years, and research has tended to be basic rather than oriented towards engineering applications. Dr. R. A. Meyer (UC Santa Barbara) has surveyed publications on this subject for the last twelve years and claims that while there has been a decline of 75% in research papers from US authors at international conferences, foreign papers have increased by 367%. It appears that government research funding for this topic will further decrease in the next two to three years.

Carbon-carbon composites are materials which have properties, especially at high temperatures, which are unmatched by other materials. There is currently a wide range of fiber materials available from various precursors and manufacturers, and it is probably true to say that little development of new fibers is called for. In fact, we could accomplish most of our goals using currently available fibers, provided we were able to understand the relationships between the various processing variables involved in the manufacture of the composites and their resulting properties. We have very limited knowledge of this area and small advances require large amounts of experimentation. Other research areas requiring urgent attention are an understanding of fracture phenomena, prediction of mechanical behavior, interactions between fibers and the matrix and their respective roles in property determination, and protection of the composites against oxidation.

The use of carbon-carbon composites for such items as exit cones and rocket nozzles for space vehicles is well known, and has been quite successful. In most cases these units are for one-time use, and existing materials are adequate. Materials to be used for more structural applications, demanding repeated use in hostile environments are still to be achieved. The cost of such development is large, and the expertise, equipment and financial support required are probably more than any one organization or country can reasonably afford. International cooperation with free exchange of technical information between participants is therefore important. Such an effort is already taking place to some extent in Europe. The USA has been somewhat restricted in cooperative possibilities by security controls. There is some evidence that this attitude is gradually changing.

There is no doubt that tough, strong, oxidation-resistant carbon-carbon composites are needed for future developments of aircraft engines and structures, the US national aerospace plane, etc.

International cooperation in these endeavors must result in benefits to all participants. It is time for the USA to recognize that a large amount of experimental duplication in different countries is currently taking place. Such efforts are not productive, and result in a waste of man and money power. Perhaps the world political climate is now ready for this situation to change.

In conclusion, the author's personal feelings are that there is more work needed in the areas of filamentous carbon use, not necessarily for the fiber constituent, and of pyrocarbon for the matrix constituent of the composite. Perhaps there are advantages to be gained by using a combination of pitch and filamentous carbon as the matrix? We also need to explore radically different methods for tackling the oxidation problem. These tasks are obvious candidates for cooperation.

I am grateful to my friend and colleague Bob Meyer for discussions regarding this presentation.

CARBON RESEARCH ACTIVITIES IN JAPAN

YUZO SANADA

Metals Research Institute, Faculty of Engineering
Hokkaido University, Sapporo, 060, Japan

1. The 117th (Carbon Materials) Committee, JSPS

As one of technical committees belonging to Japan Society for Promotion of Science (JSPS), "Carbon Materials, the 117th Committee" has established and started his activity since 1948. The committee consists with members derived from about 25 academic and research institutions and 65 private sectors at present. The technical committee is aimed to exchange informations on carbon material science. The meeting is held periodically every two months. The next, for instance, will be scheduled on 28 and 29, September 1990 in Tokyo as the 211th meeting. Agenda being presented here are wide areas of carbon science and technology covering carbon precursor, carbonization, graphitization, characterization/analytical method, application and electrical brush.

Carbon materials have also been dealt in the 124 Committee "High Temperature Resisting Ceramics".

2. The Carbon Society of Japan

In close connection to the activities in the 117 Committee, we have an academic society, namely, "The Carbon Society of Japan (CSJ)" since 1949. The first issue of the Journal, TAPSO(carbon) was published from the society in 1949. The latest issue of No.113 has been published in July, 1990.

The membership of Carbon Society of Japan has increased to more than 1000 at present, about 800 in 1982 and 500 in 1972 due to the fact that the interests in carbon materials and technology are continuing in the last 20 years in Japan.

The activities of the society are (1) to publish journal with quarterly issues and one special issue, (2) to hold annual meeting in December and advanced seminar in February, respectively. We organize also fundamental courses of carbon science and

682

technology in each year. Every meeting and seminar organized by CSJ have received participants as many as 100-250 in average. We support the summer seminar organized by a special group for young and fresh researchers and engineers.

3. Principal Activities and International Relations

In July, 1984, the First International Symposium on Carbon in Japan was held in Tokyo. The symposium had a significant influence upon the carbon research and promotion of the technology in Japan. In consequence, the carbon research has been forced to come into further extension of its application field, such as petroleum refining, coal, steel, chemical, nuclear power and electronics industries.

What the activities of research and development on carbon materials are currently going in Japan is able to extract from programs prepared by the organizing committee of the Symposiums. The Second International Symposium on Carbon, New Processing and New Applications was held in Toyohashi in 1982. The technical program of the symposium were divided into 3 fields with 11 sessions as follows.

(1) Raw Materials Preparation

Mesophase Control

Manufacturing Methods

Characterization and Design

(2) Nuclear Carbon

Carbon Fiber

Intercalation Compounds

Bisocarbons and Potential Uses

(3) Physics

Chemistry

Technology

In the present symposium, the main theme, just the same as that of the 2nd symposium, is still believed to be a timely topic working of further extensive discussion. That is, new processing includes novel raw materials and their preparation, mesophase control, new forming and/or manufacturing methods, design and characterization of microscopic structure and/or texture, and so

683

forth. New applications are those, for example, connected with various composite materials, energy science and engineering, bio-science, electrical and electrochemical engineering, and preparative chemistry. It is anticipated the distinguished presentations of the investigation on not only composite materials as a classic type of filler-binder system but also fiber reinforced composites, monolithic carbon derived from high molecular aromatic hydrocarbons, and carbon related materials such as diamond, BN, SiC etc. by CVD, PVD and so forth from our community.

4. New Carbon Forum

As a current activity on R and D of carbon materials in Japan, emphasis should put on the establishment of "New Carbon Forum" in 1986 under the support of MITI. More than 40 private sectors relevant to manufacturing, testing and application of carbons were involved in the forum. Target of the forum lies on innovative products and manufacturing. Survey of seeds and needs relating to carbon materials has been performed in the forum. Items surveyed in 1986-1989 were nuclear fusion, aerospace, transportation vehicles, machinery, electronics, opto-electronics, fuel cell, chemical and biomechanical fields. Advanced technology for carbonization and graphitization, near net shape forming and novel characterization/testing methods were also included in the survey. In 1990, the activity of the forum has been rearranged in 6 subcommittees, that is,

- (1) carbon composite material,
- (2) activated carbon,
- (3) resin carbonization,
- (4) functional aromatic polymer,
- (5) CVD film and
- (6) evaluation technology.

5. CPC Club

CPC (coal, petroleum and carbon) club has been established in 1987 by Prof. H. Honda (former chairman of the 117th Committee and CSJ). CPC organizes technical meetings periodically and has issued a series of monograph and review paper on carbon science

and technology in every year. Informations on current advances of carbon materials in Japan are mostly included here.

Appendix (Addressees)

Carbon Materials, the 117th Committee, JSPS (Chairman, Prof. T. Tsuzuku)

Subcommittee A	(Dr. M. Nakamizo)	Chemistry
"	B (Prof. M. Inagaki)	Physics
"	C (Prof. S. Kimura)	Testing Method
"	D (Prof. K. Okubo)	Carbon Brush

Yamato Bldg., 5-3-1, Kojimachi, Chiyoda-ku, Tokyo, 102

Tel: 03-263-1721, Fax: 03-222-1986

Carbon Society of Japan (President, Prof. S. Otani)

Saito Bldg., 2-16-13, Yushima, Bunkyo-ku, Tokyo, 113

Tel: 03-815-8514, Fax: 03-815-8529

New Carbon Forum, c/o Carbon Association of Japan (Chairman of Executive Committee, Dr. T. Ishikawa, Chairman of Organizing Committee, Mr. I. Natsume)

Tokyo Kaijo Shin-Bldg., 1-2-1, Marunouchi, Chiyoda-ku, Tokyo, 100

Tel: 03-212-3188, Fax: 03-212-4490

- END -

DATE FILMED

01 / 29 / 91