# NANONETWORK MATERIALS

## Fullerenes, Nanotubes, and Related Systems

*Kamakura, Japan 2001*

*EDITORS*

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# Preface

Fullerenes, nanotubes, and related covalent-bond network materials are now the subject of great interest owing to their topology-dependent novel physical and chemical properties and to their potential for a variety of applications. In this growing field of science and engineering, both theorists and experimentalists have made many significant contributions. Some of them were of essential scientific importance, others were technologically important enough to stimulate further intensive research in the field, and others were both.

In 1970, the first scientific paper on the $C_{60}$ cage was written by E. Osawa, who theoretically discussed physical and chemical properties of this unusual all-carbon cluster having the truncated icosahedron geometry. It took as long as fifteen years for this $C_{60}$ to be first experimentally detected in the cluster beam by H. W. Kroto, R. E. Smalley and coworkers in 1985. Thereafter, some theorists discussed one of the most important aspects of the $C_{60}$ fullerene and its endohedral derivatives, i.e. the possibility to use them as atomlike building blocks of materials: La@$C_{60}$ by A. Rosén and K@$C_{60}$ by S. Saito. This dream of theorists was realized in 1990 by W. Krätschmer and coworkers, who produced the crystalline solid $C_{60}$ where $C_{60}$ fullerenes form a close-packed lattice. Once the existence of fullerenes became definite and they became available in macroscopic amounts, they have been studied extensively during the last decade and have proved to be actually the novel atomlike building blocks of a new class of hierachical materials: They can form van der Waals solid, molecular magnet, insulating ionic compounds, ionic but metallic compounds, covalent-bond crystalline materials (polymerized $C_{60}$), and even the high-transition temperature ($T_c$) superconductors. A recent hole doping into solid $C_{60}$ achieved via field-effect transistor configuration by B. Batlogg and coworkers is found to give rise to the $T_c$ of as high as 52K.

From the viewpoint of the dimensionality of materials, $C_{60}$ and other fullerene families can be classified as zero-dimensional (0-D) network of $sp^2$ C atoms, being different from the two-dimensional (2-D) network graphite. Another new-dimensionality $sp^2$ C material, i.e. the one-dimensional carbon nanotube which fills the gap between 0-D fullerenes and 2-D graphite, was discovered by S. Iijima in 1991 without preceding work by theorists. On the other hand, immediately after the discovery, its unusual electronic transport property, i.e., the topology-dependent semiconducting or metallic electronic structure, was theoretically predicted by three groups [N. Hamada, S. Sawada, and A. Oshiyama; K. Tanaka, K. Okahara, M. Okada, and T. Yamabe; R. Saito, M. Fujita, G. Dresselhaus, and M. S. Dresselhaus]. This fascinating prediction, confirmed later experimentally, triggered further intensive research of nanotubes and they are now studied as key materials of nanoelectronics. Also their mechanical and chemical properties are of high importance in connection with various applications.

Now it is a world-wide trend to support the research on nanoscience and nanotechnology and fullerenes and nanotubes are the most important materials in the field. The Japanese Government (Ministry of Education, Culture, Sports, Science and Technology) has supported this fruitful field via a program called Grant-in-Aid for Scientific Research on Priority Area during the period of as early as 1993 to 1995, and from 1998 to present. As a part of the present project "Fullerenes and Nanotubes", the International Symposium on Nanonetwork

Materials, Fullerenes, Nanotubes, and Related Systems was held in Kamakura, Japan from January 15 to 18, 2001. This proceedings book contains most of the invited and contributed papers presented during the Symposium and consists of the following seven chapters:

I. Nanotubes: Synthesis

II. Nanotubes: Electronic and Mechanical Properties

III. Fullerenes and Fullerides

IV. Fullerene Polymers

V. Endohedrals

VI. Clathrates

VII. Other Molecular Materials

The Symposium could provide an international forum for the discussion of the current status and future prospects of the nanonetwork materials. We, the organizers, would like to express our gratitude for the support from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Susumu Saito
Tsuneya Ando
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Koichi Kikuchi
Mototada Kobayashi
Yahachi Saito



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## CONTENTS

**Preface** .......... xv
**Symposium Organization** .......... xvii
**Conference Photograph** .......... xix

### I. NANOTUBES: SYNTHESIS

**SWNTs Synthesized in External Magnetic Field** .......... 3
B. Jeyadevan, Y. Sato, K. Tohji, A. Kasuya, R. Hatakeyama, H. Ishida, N. Sato, K. Ueno, and T. Takagi
**Production of Thick Single-Walled Carbon Nanotubes by Arc Discharge in Hydrogen Ambience** .......... 7
Y. Ando, X. Zhao, K. Hirahara, and S. Iijima
**Production and Measurements of Isolated Single-Wall Carbon Nanotubes** .......... 11
S. Arepalli, P. Nikolaev, W. Holmes, V. Hadjiev, and B. Files
**In-Situ Spectroelectrochemical Study of Single-Wall Carbon Nanotubes** .......... 15
S. Kazaoui, N. Minami, N. Matsuda, H. Kataura, and Y. Achiba
**Synthesis of Carbon Nanocoils Using Electroplated Iron Catalyst** .......... 19
L. Pan, M. Zhang, A. Harada, Y. Takano, and Y. Nakayama
**Preparation of Carbon Nanotubes by Using Mesoporous Silica** .......... 23
S. Kawasaki, S. Komiyama, S. Ohmori, A. Yao, F. Okino, and H. Touhara
**Gas Dynamic and Time Resolved Imaging Studies of Single-Wall Carbon Nanotubes Growth in the Laser Ablation Process** .......... 27
R. Sen, S. Suzuki, H. Kataura, and Y. Achiba
**New Simple Method of Carbon Nanotube Fabrication Using Welding Torch** .......... 31
H. Takikawa, Y. Tao, Y. Hibi, R. Miyano, T. Sakakibara, Y. Ando, S. Ito, K. Hirahara, and S. Iijima
**Temperature and Time Dependence of the Growth of Carbon Nanotubes by Thermal Chemical Vapor Deposition** .......... 35
H. J. Jeong, Y. M. Shin, K. S. Kim, S. Y. Jeong, Y. S. Park, Y. C. Choi, and Y. H. Lee
**Effect of Ni-Surface Morphology on the Growth of Carbon Nanotubes by Microwave Plasma-Enhanced Chemical Vapor Deposition** .......... 39
Y. C. Choi, Y. M. Shin, H. J. Jeong, D. J. Bae, S. C. Lim, K. H. An, and Y. H. Lee
**Growth Mechanism of Carbon Nanotubes Grown by Microwave Plasma-Assisted Chemical Vapor Deposition** .......... 43
T. Muneyoshi, M. Okai, T. Yaguchi, and S. Sasaki
**Automation of Purification for Single-Walled Nanotubes** .......... 47
T. Ogawa, Y. Sato, K. Shinoda, B. Jeyadevan, K. Tohji, A. Kasuya, and Y. Nishina

**Time and Space Evolution of Carbon Species Generated with a Laser Furnace Technique** .......... **51**
S. Suzuki, H. Yamaguchi, R. Sen, H. Kataura, W. Krätschmer, and Y. Achiba

**Synthesis of Vertically Aligned Carbon Nanotubes on a Large Area Using Thermal Chemical Vapor Deposition** .......... **55**
C. J. Lee, K. H. Son, T. J. Lee, S. C. Lyu, and J. E. Yoo

**Synthesis of Aligned Carbon Nanotubes by $C_2H_2$ Decomposition on $Fe(CO)_5$ as a Catalyst Precursor** .......... **59**
J. H. Han, J. E. Yoo, S. C. Yoo, C. J. Lee, and K.-H. Lee

**Formation of Radioactive Fullerenes by Using Nuclear Recoil** .......... **63**
T. Ohtsuki, K. Ohno, K. Shiga, Y. Kawazoe, Y. Maruyama, K. Shikano, and K. Masumoto

**Open Nanotubes of Insulating Boron Nitride** .......... **67**
D. Golberg, Y. Bando, K. Kurashima, and T. Sato

**Inter-Process Measurement of MWNT Rigidity and Fabrication of MWNT Junctions Through Nanorobotic Manipulations** .......... **71**
L. Dong, F. Arai, and T. Fukuda

**Selective Lateral Nano-Bridging of Carbon Nanowire between Catalytic Contact Electrodes** .......... **75**
Y. H. Lee, Y. T. Jang, C. H. Choi, E. K. Kim, B. K. Ju, D. H. Kim, C. W. Lee, J. K. Shin, and S. T. Kim

## II. NANOTUBES: ELECTRONIC AND MECHANICAL PROPERTIES

**Quantum Oscillations for the Spectral Moments of Raman Spectra from SWCNT** .......... **81**
H. Kuzmany, M. Hulman, W. Plank, A. Grueneis, C. Kramberger, H. Peterlik, T. Pichler, H. Kataura, and Y. Achiba

**Electronic Structure Studies of Carbon Nanotubes: Aligned, Doped, and Filled** .......... **87**
J. Fink, X. Liu, H. Peisert, T. Pichler, M. Knupfer, M. S. Golden, D. M. Walters, and H. Kataura

**Lithium Storage in Single Wall Carbon Nanotubes** .......... **95**
B. Gao, H. Shimoda, X. P. Tang, A. Kleinhammes, L. Fleming, Y. Wu, and O. Zhou

**Electronic Structure and Quantum Conductance of Nanotube Structures: Defects, Crossed-Tube Junctions, and Nanopeapods** .......... **101**
S. G. Louie

**Electromechanical Properties of Multiwall Carbon Nanotubes** .......... **107**
A. Zettl and J. Cumings

**Field Emission from Carbon Nanotubes with Clean Surface and Adsorbed Molecules** .......... **113**
K. Hata, A. Takakura, and Y. Saito

**Hydrogen Insertion and Extraction Mechanism in Single-Walled Carbon Nanotubes** .......... **117**
S. M. Lee, Y. H. Lee, G. Seifert, and T. Frauenheim

**Optical Anisotropy of Aligned Single-Walled Carbon Nanotubes in Polymer** .... 121
M. Ichida, S. Mizuno, H. Kataura, Y. Achiba, and A. Nakamura
**Polarized Absorption Spectra of 0.4nm-Sized Single-Wall Carbon Nanotube Arrays Formed in Channels of $AlPO_4$-5 Single Crystals** .... 125
Z. K. Tang, Z. M. Li, G. D. Li, N. Wang, H. J. Liu, and C. T. Chan
**Structural (*n*, *m*) Determination of Isolated Single Wall Carbon Nanotubes by Resonant Raman Scattering** .... 129
A. Jorio, R. Saito, J. H. Hafner, C. M. Lieber, M. Hunter, T. McClure, G. Dresselhaus, and M. S. Dresselhaus
**High Energy-Resolution EELS Study of the Electronic Structure of Boron Nitride Cones** .... 133
M. Terauchi, M. Kawana, M. Tanaka, K. Suzuki, A. Ogino, and K. Kimura
**Electrical Contact with Titanium Carbide to an Individual Single-Walled Carbon Nanotube** .... 137
F. Nihey, T. Ichihashi, M. Yudasaka, and S. Iijima
**Multiwalled Carbon Nanotubes as Single Electron Transistors** .... 141
M. Ahlskog, R. Tarkiainen, L. Roschier, M. Paalanen, and P. Hakonen
**Conduction Mechanism in Multiwall Carbon Nanotubes** .... 145
S. Roche, F. Triozon, D. Mayou, and A. Rubio
**Electrical Transport through Crossed Carbon Nanotube Junctions** .... 149
T. Nakanishi and T. Ando
**Energy Barriers in Carbon Nanotube Junctions** .... 153
R. Tamura and M. Tsukada
**Scanning Tunneling Spectroscopic Characterization of Single Walled Carbon Nanotubes in Bundles** .... 157
K. Suzuki, Y. Maruyama, M. Nagayama, T. Kumagai, F. Kosha, K. Tohji, H. Takahashi, A. Kasuya, and Y. Nishina
**Estimation of the Mechanical Strength of Nanotube Bundle** .... 161
Y. Nishina, T. Maeda, A. Kasuya, K. Tohji, and Y. Sato
**Optical Properties of Fullerene-Peapods** .... 165
H. Kataura, T. Kodama, K. Kikuchi, K. Hirahara, S. Iijima, S. Suzuki, W. Krätschmer, and Y. Achiba
**Electron Transport in Carbon Nanotubes Encapsulating Fullerenes** .... 169
D-H. Kim, H-S. Sim, and K. J. Chang
**Electronic Structure and Energetics of Carbon Nanotubes Encapsulating $C_{60}$** .... 173
S. Okada, S. Saito, A. Oshiyama, and Y. Miyamoto
**Intercalation of SWNTs as Investigated by Raman and X-ray Photoemission Spectroscopy** .... 177
T. Ito, Y. Yatsu, H. Fudo, Y. Iwasa, T. Mitani, H. Kataura, and Y. Achiba
**Adsorption and Desorption of Weakly Bonded Adsorbates from Single-Wall Carbon Nanotube Bundles** .... 181
T. Hertel, J. Kriebel, G. Moos, and R. Fasel
**Chirality Dependent G-Band Raman Intensity of an Individual Single Wall Carbon Nanotube** .... 185
R. Saito, A. Jorio, J. H. Hafner, C. M. Lieber, M. Hunter, T. McClure, G. Dresselhaus, and M. S. Dresselhaus

**Photoconductivity of Single-Walled Carbon Nanotubes** .................... **189**
A. Fujiwara, Y. Matsuoka, H. Suematsu, N. Ogawa, K. Miyano, H. Kataura, Y. Maniwa, S. Suzuki, and Y. Achiba

**Electronic Structure of Multi-Walled Carbon Nanotubes Studied by Photoemission Spectroscopy** .................... **193**
S. Suzuki, C. Bower, Y. Watanabe, S. Heun, T. Kiyokura, K. G. Nath, T. Ogino, W. Zhu, and O. Zhou

**STM/STS on Carbon Nanotubes at Low Temperature** .................... **197**
K. Nomura, M. Osawa, K. Ichimura, H. Kataura, Y. Maniwa, S. Suzuki, and Y. Achiba

**Dielectric Function of $C_{60}$-Encapsulating Nanotube** .................... **201**
N. Hamada, M. Yamaji, S. Okada, and S. Saito

**Structural and Electronic Property Changes of Single-Walled Carbon Nanotubes under Pressure** .................... **205**
L. C. Qin, J. Tang, T. Sasaki, M. Yudasaka, A. Matsushita, and S. Iijima

**Preparation of Mechanically Aligned Carbon Nanotube Films and Their Anisotropic Transport Phenomena** .................... **209**
D. J. Bae, K. S. Kim, Y. S. Park, K. H. An, J. M. Moon, S. C. Lim, and Y. H. Lee

**Polarization Characteristics of Zeolite Single Crystals Containing Carbon Nanotubes** .................... **213**
N. Nagasawa, I. Kudryashov, S. Tsuda, and Z. K. Tang

**Electrochemical Hydrogen Storage in Single-Walled Carbon Nanotubes** .................... **217**
W. S. Kim, K. H. An, Y. S. Park, and Y. H. Lee

**Saturation of Emission Current from Carbon Nanotube Field Emission Array** .................... **221**
S. C. Lim, H. J. Jeong, Y. M. Shin, K. S. Kim, W. S. Kim, Y. S. Park, Y. C. Choi, K. H. An, D. J. Bae, and Y. H. Lee

**Characteristic Interactions of Gases in Solid Carbon Nanotubes** .................... **225**
C. W. Jin, K. Ichimura, K. Imaeda, and H. Inokuchi

**Chemical Interaction of Rare Gases in Solid Carbon Nanotubes** .................... **229**
K. Ichimura, K. Imaeda, and H. Inokuchi

**The Effect of Solvent on Electrical Transport Properties in Single-Wall Carbon Nanotubes** .................... **233**
S. Masubuchi, H. Masubuchi, S. Kazama, H. Kataura, Y. Maniwa, S. Suzuki, and Y. Achiba

**Analysis of $C_{60}$ Insertion into Single Wall Carbon Nanotube by Molecular Dynamics Simulation** .................... **237**
T. Ishii, K. Esfarjani, Y. Hashi, Y. Kawazoe, and S. Iijima

**Supercapacitors Using Singlewalled Carbon Nanotube Electrodes** .................... **241**
K. H. An, W. S. Kim, Y. S. Park, H. J. Jeong, Y. C. Choi, J. M. Moon, D. J. Bae, S. C. Lim, and Y. H. Lee

**Resonances in Deformed Carbon Nanotubes** .................... **245**
H. S. Sim, C. J. Park, and K. J. Chang



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**Electrochemical Lithium Insertion of Heat Treated and Chemically Modified Multi-Wall Carbon Nanotubes** . . . . . 249
H. Touhara, I. Mukhopadhyay, F. Okino, S. Kawasaki, T. Kyotani, A. Tomita, and W. K. Hsu
**Spin Valve Effect in Magnetically Doped Nanotube-Based Transistors** . . . . . 253
K. Esfarjani, Z. Chen, A. A. Farajian, and Y. Kawazoe
**Charge Oscillation at Doped Nanotube Junctions** . . . . . 257
A. A. Farajian, K. Esfarjani, and M. Mikami
**Effective-Mass Theory of Capped Carbon Nanotubes** . . . . . 261
T. Yaguchi and T. Ando
**Observation of Coulomb Blockade in a Ti /Multi-Wall Carbon Nanotube /Ti Structure** . . . . . 265
A. Kanda, K. Tsukagoshi, Y. Ootuka, and Y. Aoyagi
**Energy Gap Induced by Lattice Deformation in Carbon Nanotubes** . . . . . 269
H. Suzuura and T. Ando
**Low Temperature Magneto-Transport in Multi-Wall Carbon Nanotubes** . . . . . 273
R. Enomoto, N. Aoki, K. Ishibashi, and Y. Ochiai
**Structural Transformations in Single Wall Carbon Nanotube Bundles** . . . . . 277
V. Kumar, M. Sluiter, and Y. Kawazoe
**In-situ Atomistic Observation of Carbon Nanotube during Field Emission** . . . . . 281
T. Kuzumaki, Y. Horiike, and T. Kizuka
**Processing of Individual Carbon Nanotubes – Cutting and Joining** . . . . . 285
T. Kizuka and T. Kuzumaki

## III. FULLERENES AND FULLERIDES

**$C_{60}$ as Building Block for New Interesting Carbon Structures and Species** . . . . . 291
W. Krätschmer
**Superconductivity in Fullerene Systems** . . . . . 297
M. L. Cohen
**Electronic Structure of $Ba_4C_{60}$ and $Cs_4C_{60}$** . . . . . 305
K. Umemoto and S. Saito
**EPR in $RbC_{60}$ Under Pressure** . . . . . 309
S. Kobayashi, H. Sakamoto, K. Mizoguchi, M. Kosaka, and K. Tanigaki
**Behaviors of Metals in Production of Nanonetwork Materials Investigated by Radiochemical Technique** . . . . . 313
K. Sueki, K. Akiyama, C. Kurata, K. Oogama, Y. L. Zhao, M. Katada, S. Enomoto, S. Ambe, F. Ambe, H. Nakahara, and K. Kikuchi
**Ferromagnetic Transition in Europium Fullerides $Eu_xSr_{6-x}C_{60}$** . . . . . 317
K. Ishii, A. Fujiwara, H. Suematsu, and Y. Kubozono
**$C_{60}$ Molecular Configurations Leading to Ferromagnetic Exchange Interactions in TDAE-$C_{60}$** . . . . . 321
B. Narymbetov, A. Omerzu, V. V. Kabanov, M. Tokumoto, H. Kobayashi, and D. Mihailovic

**Metallic Phases in Sodium Fulleride $Na_xC_{70}$** ................................ 325
T. Hara, M. Kobayashi, Y. Akahama, and H. Kawamura
**Production of $C_{59}N$: $C_{60}$ Solid Solution** ................................ 329
F. Fülöp, A. Rockenbauer, F. Simon, S. Pekker, L. Korecq, S. Garaj, and A. Jánossy
**Dynamic Jahn-Teller Mechanism of Superconductivity in Alkali-Metal-Doped $C_{60}$** ................................ 333
S. Suzuki, S. Okada, and K. Nakao
**Theoretical Study on the Photoemission Spectra of $A_3C_{60}$ (A=K and Rb)** ................................ 337
T. Chida, S. Suzuki, and K. Nakao
**Phase Diagrams of Alkali-Metal-Doped $C_{60}$: Spin- and Orbital-Polarized States** ................................ 341
J. Hirosawa, S. Suzuki, and K. Nakao
**Study on the Physical Properties of $Na_4C_{60}$** ................................ 345
Y. Takabayashi, Y. Kubozono, S. Fujiki, S. Kashino, K. Ishii, H. Suematsu, and H. Ogata
**Fabrication of $C_{60}$/Amorphous Carbon Superlattice Structures** ................................ 349
N. Kojima, Y. Ohshita, and M. Yamaguchi
**AC Conductivity of Alkali Doped $C_{60}$Compounds Across the Superconductor-Insulator Transition** ................................ 353
A. Maeda, H. Kitano, R. Matsuo, K. Miwa, T. Takenobu, Y. Iwasa, and T. Mitani
**Study on the Origin of Pressure-Induced Superconductivity of $Cs_3C_{60}$** ................................ 357
S. Fujiki, Y. Kubozono, Y. Takabayashi, S. Kashino, M. Kobayashi, K. Ishii, and H. Suematsu
**Structure and Properties of $RE_{2.75}C_{60}$** ................................ 361
J. Takeuchi, K. Tanigaki, and B. Gogia
**Unusual Magnetic Properties of High-Temperature Reaction Products of Cerium Metal and $C_{60}$ Solid** ................................ 365
S. Motohashi, Y. Maruyama, K. Watanabe, K. Suzuki, S. Takagi, and H. Ogata
**NMR Studies of Ammoniated Alkali Fullerides** ................................ 369
H. Tou, N. Muroga, Y. Maniwa, T. Takenobu, H. Shimoda, Y. Iwasa, and T. Mitani
**Orientational and Magnetic Transitions in Ammoniated Alkali Metal Fullerides** ................................ 373
T. Takenobu, M. Miyake, T. Muro, Y. Iwasa, and T. Mitani
**NMR Studies of Alkali-Doped $C_{60}$ Superconductors with Small Lattice Constants** ................................ 377
K. Kitazume, H. Tou, Y. Maniwa, M. Kosaka, and K. Tanigaki
**Magnetic Properties of TDAE-$C_{60}$ under Pressure** ................................ 381
K. Mizoguchi, M. Machino, H. Sakamoto, T. Kawamoto, M. Tokumoto, A. Omerzu, and D. Mihailovic
**Synthesis and Structure of Alkaline Earth and Rare Earth Metal Doped $C_{70}$** ................................ 385
T. Takenobu, Y. Iwasa, T. Ito, and T. Mitani

**Structural and Physical Properties of Lithium Fullerides $Li_xC_{70}$** .............389
H. Kumada, M. Kobayashi, Y. Akahama, and H. Kawamura
**The Structural and Magnetic Properties in TDAE-Fullerene System**..........393
K. Oshima, Y. Nogami, T. Kambe, N. Nagao, and M. Fujiwara
**Synthesis and Structure of All-Carbon Bisfullerene $C_{121}$** ..................397
H. Shimotani, J. Wang, N. Dragoe, and K. Kitazawa
**Photoinduced Polymerization in Crystalline $C_{60}$ via Multi-Photoexcitation: Lattice-Relaxation and Energy-Transfer of Excitons**........................................401
M. Suzuki
**The Morphology of Vapor Grown $C_{60}$ Crystals as an Ideal Example of the Gibbs-Wulff's Law** ..........................................405
E. Schönherr, K. Matsumoto, and K. Murakami
**Synthesis and Crystal Structure of Cocrystallite with Silver Octaethylporphyrin and $C_{70}$** ..................................409
T. Ishii, R. Kanehama, N. Aizawa, M. Yamashita, H. Matsuzaka, H. Miyasaka, T. Kodama, K. Kikuchi, I. Ikemoto, Y. Iwasa, and M. Shiro
**Photosensitized Oxygenation of Alkenes in the Presence of Bisazafullerene $(C_{59}N)_2$ and Hydroazafullerene $C_{59}HN$** .....................413
N. Tagmatarchis and H. Shinohara
**Transition of the Heterofullerene $(C_{59}N)X$ to the Monomeric Phase of $C_{59}N$**.................................................417
W. Plank, T. Pichler, S. Baes-Fischlmair, M. Krause, H. Kuzmany, N. Tagmatarchis, and H. Shinohara
**Survey of Natural Fullerenes in Southwestern China**......................421
E. Osawa, M. Ozawa, K. Chijiwa, K. Hoyanagi, K. Tanaka, and M. Kusunoki
**Effect of Chemical Treatment on the Structure of Ultradisperse Diamond and Onion-Like Carbon** ...............................425
A. E. Alexenskii, M. V. Baidakova, A. T. Dideikin, V. Y. Osipov, E. Osawa, M. Ozawa, A. I. Shames, V. I. Siklitsky, and A. Y. Vul'
**Studies of Porphyrin-Fullerene Dyads with Oligoethylene Glycols Spacers in Solution**...........................................429
R. Ogura, T. Toida, K. Tsunoda, H. Yajima, and T. Ishii
**Magnetic-Field Induced Ferromagnetism in Bissilylated $C_{60}$ by Pyrolysis**...................................................433
Y. Kajihara, K. Tanigaki, and T. Akasaka
**Characterization of Actinide Metallofullerenes** ............................437
K. Akiyama, K. Sueki, Y. L. Zhao, H. Haba, K. Tsukada, T. Kodama, K. Kikuchi, T. Ohtsuki, Y. Nagame, H. Nakahara, and M. Katada

## IV. FULLERENE POLYMERS

**NMR Studies of Alkali-Doped $C_{60}$ Polymers** .............................443
Y. Maniwa, H. Ikejiri, H. Tou, S. Masubuchi, S. Kazama, M. Yasukawa, and S. Yamanaka

**Dimer Structure of $Sm_3C_{70}$** .......... 447
H. C. Dam, X. H. Chen, T. Takenobu, T. Itou, Y. Iwasa, T. Mitani, E. Nishibori, M. Takata, and M. Sakata

**Photopolymerization of $C_{60}$ Crystal under High Pressure** .......... 451
M. Sakai, M. Ichida, and A. Nakamura

**Out-of-Plane and In-Plane Structures of the Cast Films of Long Alkyl Chain-Linked $C_{60}$ via Phenyl Ring** .......... 455
M. Chikamatsu, K. Kikuchi, T. Kodama, H. Nishikawa, I. Ikemoto, N. Yoshimoto, T. Hanada, Y. Yoshida, N. Tanigaki, and K. Yase

## V. ENDOHEDRALS

**Structure of IPR-Violated Fullerene, $Sc_2@C_{66}$** .......... 461
E. Nishibori, M. Takata, M. Sakata, C. R. Wang, M. Inakuma, and H. Shinohara

**Chemistry of Endohedral Metallofullerene Ions** .......... 465
T. Akasaka, T. Wakahara, S. Nagase, K. Kobayashi, M. Waelchli, K. Yamamoto, M. Kondo, S. Shirakura, Y. Maeda, T. Kato, M. Kako, Y. Nakadaira, X. Gao, E. Van Caemelbecke, and K. M. Kadish

**Spin Dynamics of Lanthanum Metallofullerenes** .......... 469
S. Okubo and T. Kato

**Valence Change of Tm Atom in Metallofullenes** .......... 473
K. Kikuchi, K. Sakaguchi, N. Ozawa, T. Kodama, H. Nishikawa, I. Ikemoto, K. Kohdate, D. Matsumura, T. Yokoyama, and T. Ohta

**Electronic Structure of $Eu@C_{60}$** .......... 477
S. Suzuki, M. Kushida, S. Amamiya, S. Okada, and K. Nakao

**Electronic Structures of the $La@C_{82}$ Crystals by the Relativistic LCAO Method** .......... 481
S. Amamiya, S. Okada, S. Suzuki, and K. Nakao

**Low-Energy Electron Energy Loss Spectroscopy of Monolayer and Thick $La@C_{82}$ Films Grown on $MoS_2$ Substrates** .......... 485
K. Ueno, Y. Uchino, K. Iizumi, A. Koma, K. Saiki, Y. Inada, K. Nagai, Y. Iwasa, and T. Mitani

**Photophysical and Photochemical Properties of Higher Fullerenes and Endohedral Metallofullerenes** .......... 489
O. Ito, M. Fujitsuka, T. Akasaka, and K. Yamamoto

## VI. CLATHRATES

**Silicon and Germanium Clathrates with Magnetic Elements** .......... 495
K. Tanigaki, T. Kawaguchi, A. Nagai, and M. Yasukawa

**A New Silicon Clathrate Compound: $I_8Si_{46-x}I_x$** .......... 499
E. Reny, S. Yamanaka, C. Cros, and M. Pouchard

**NMR Studies of Silicon Clathrate Compounds** .......... 503
H. Sakamoto, H. Tou, Y. Maniwa, H. Ishii, E. Reny, and S. Yamanaka

**A Sign of Superconductivity in Li-Doped $\alpha$-Rhombohedral Boron............507**
A. Oguri, K. Kimura, A. Fujiwara, M. Terauchi, and M. Tanaka

## VII. OTHER MOLECULAR MATERIALS

**Laser Induced Dissociation of Linear $C_6$ and Reorientation of Trapping Sites in Solid Neon............513**
T. Wakabayashi, A. L. Ong, and W. Krätschmer
**Spiral Carbon Nanoparticles............517**
M. Ozawa, E. Osawa, and H. Goto
**Electronic Structures of Carbyne Model Compounds............521**
S. Hino, Y. Okada, K. Iwasaki, M. Kijima, and H. Shirakawa
**Magnetic Properties of K-Absorbing Zeolite LTA............525**
H. Kira, H. Tou, Y. Maniwa, and Y. Murakami
**Mechanism of Magnetism in Stacked Nanographite: Theoretical Study............529**
K. Harigaya, N. Kawatsu, and T. Enoki

**List of Participants............533**
**Author Index............551**

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