



Rare-earth Information Center NEWS

Ames Laboratory
Institute for Physical Research and Technology
Iowa State University / Ames, Iowa 50011-3020 / U.S.A.

Volume XXIV

December 1, 1989

No. 4

RARE EARTHS: WORLDWIDE Markets, Applications, Technologies

Business Communications Company, Inc. (BCC) has been in the business of providing technical and economic studies since 1971. In May 1989, BCC published a 298-page marketing study entitled, *RARE EARTHS: Worldwide Markets, Applications, Technologies* (LGB-118). They came to the conclusion that important changes are taking place in the rare earth industry and that there is a shift in focus from inexpensive, mixed rare earth products to the expensive, highly purified, separated materials. This comprehensive report explains why this shift has occurred and how it is affecting the industry. This study quantifies both the U.S. and world markets for 1988 and forecasts the 1995 markets for various applications.

The scope of this report encompasses the following: (1) the properties of the rare earth elements, and a summary of special properties of many compounds; (2) government-funded research programs and primary researchers; (3) the rare earth ores and other sources, abundances, world reserves, production, beneficiation and separation techniques, and final products including a summary of methods for deriving many of the rare earth metals and compounds; (4) compounds used in specific applications and technical discussions of many of the applications; (5) the industry structure and players involved, including rare earth-bearing property owners, processors, consumers, and patent holders; (6) substitutions by rare earths and of rare earths; (7) economic information including production costs, added value of processing, raw material pricing, and product pricing; and (8) environmental concerns such as

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Yttrium Deposit

Molycorp, Incorporated, and the Mescalero Apache Tribe have agreed to develop jointly a deposit of yttrium and zirconium on the tribe's reservation in southeastern New Mexico. According to R. Gene Dewey, president of Molycorp, this could become the first commercial deposit of yttrium in the United States. Wendell Chino, tribe president, stressed his satisfaction with the agreement reached with Molycorp. The deposit, found in 1985 by Molycorp, is known to contain approximately 10 million pounds of yttrium. According to Dewey, this is enough to supply the U.S.A. for many decades.

The yttrium and zirconium are contained in the mineral eudialyte and tests indicate the elements can be extracted with conventional heap leaching technology as is done with gold and copper. The deposit is located near the surface and can be quickly developed. Test holes drilled near this deposit indicate the possibility of further reserves of similar grade.

toxicity and radioactivity associated with rare earths.

BCC put the value of the total 1988 U.S. rare earth market at \$104 million and the world market at \$343 million in U.S. dollars. They forecast the 1995 U.S. market to be \$158 million with an average annual growth rate of 6.4 percent. The 1995 world market is forecast to be \$459 million with a growth rate of 4.4 percent.

This review of the rare earth industry, written by Susan Kaplan, is one of the best we have seen.

The price for this report is U.S. \$2,650.00 and may be ordered from Business Communications Company, Incorporated, 25 Van Zant, Norwalk, CT 06855-1781, U.S.A. [Telephone (203) 853-4266; Fax (203) 853-0348]

RIC STARTS 25TH YEAR

January 1, 1990, will be the start of the twenty-fifth year for the Rare-earth Information Center (RIC). It would have been REIC, but in 1966 there already was an information center with that acronym, so the two words rare and earth became a hyphenated word in our title.

There are three goals we would like to reach next year. First, we would like to surpass 10,000 names on our mailing list for the *RIC News*. Second, we would like to surpass 150 sponsors for fiscal 1990. Third, we would like to receive enough short stories on the effect rare earths have had on your life to publish a compilation of them in a special publication.

At the present time, our readers number about 9,500 and are climbing toward our goal of 10,000. Our sponsors for the 1989 fiscal year numbered 136, 14 more than in fiscal 1988. As of this date we have received some stories as we asked for in the September issue of the *RIC News*.

The first two goals seem reachable if we continue to grow as we have in the past but your help will ensure it. Do you have a co-worker (or several) who are not receiving the *RIC News*? If so, send us their names and addresses; we will take it from there.

Is your company or organization
(Continued on page 3)



CONFERENCE CALENDAR

3rd CECRI Conference on Luminescence
Karaikudi, India
January 12-14, 1990
RIC News, XXIV, [3] 2 (1989)

International Conference on Magnetic Phase
Transitions (MPT'90)
Osaka, Japan
April 13-16, 1990
RIC News, XXIV, [2] 2 (1989)

NATO-ASI, Supermagnets, Hard Magnetic
Materials
Il Ciocco, Italy
June 10-23, 1990
RIC News, XXIV, [3] 2 (1989)

NATO-ASI, Science and Technology of
Nanostructured Magnetic Materials
Heraklion, Crete, Greece
June 25-July 7, 1990
**This Issue*

6th International Conference on Valence Fluc-
tuations (VI-ICVF)
Rio de Janeiro, Brazil
July 9-13, 1990
**This Issue*

1st International Conference on *f*-Elements
(ICFE)
Leuven, Belgium
September 3-7, 1990
RIC News, XXIII, [4] 4 (1988) and XXIV, [2] 2
(1989)

5th International Conference on Physics of
Magnetic Materials (5ICPMM)
Szczyrk-Bila, Poland
September 3-9, 1990
**This Issue*

REE in Processes of Petrogenesis
Tashkent, USSR
September 1990
RIC News, XXIV, [2] 2 (1989)

11th International Workshop on Rare-Earth
Magnets and Their Applications and 6th
International Symposium on Magnetic
Anisotropy and Coercivity in Rare Earth-
Transition Metal Alloys
Pittsburgh, Pennsylvania, U.S.A.
October 21-25, 1990
**This Issue*

Rare Metals '90
Kokura, Kitakyushu, Japan
November 14-16, 1990
RIC News, XXIV, [3] 2 (1989)

**News Story This Issue*

Indian Rare Earths

S. K. Chandra has been appointed general manager of the products division of Indian Rare Earths Ltd. in Bombay, India. N. Rajagopal Nair has replaced Chandra as general manager of the Orissa Sands Complex.

VI-ICVF

The Sixth International Conference on Valence Fluctuations (VI-ICVF) will be held July 9-13, 1990, in Rio de Janeiro, Brazil. The conference is to be focused on mixed valency, heavy fermions, Kondo lattices and will include high- T_c superconductivity as it is related to the heavy fermions superconductivity. Topics include anomalous f - and d -electron systems, heavy fermions, electron hybridization effects, mechanisms in high- T_c and heavy fermion superconductors, Kondo and Anderson lattices, narrow gap magnetic semiconductors, and other effects of nonintegral valence systems. For information contact Professor G. E. Barbaris, Instituto de Fisica "Gleb Wataghin", UNICAMP, Cidade Universitaria, Barao Geraldo, Caixa Postal 6165, 13081 Campinas (S.P.), Brazil.

Nanostructured Magnetic Materials

A NATO Advanced Study Institute (ASI) will be held June 25th to July 7th, 1990 in Heraklion, Crete, Greece. The theme of the school is The Science and Technology of Nanostructured Magnetic Materials. The organizing committee is headed by G. C. Hadjipanayis with help from G. A. Prinz and L. Paretti. Registration is limited, so to be considered contact Professor Hadjipanayis, Department of Physics and Astronomy, University of Delaware, Newark, DE 19716, U.S.A. (FAX 302-451-1637) as soon as possible.

Fifteen invited lecturers and 33 invited speakers will be presenting material at the school. The 15 lectures will include: Crystal Field Interaction; Theories of Magnetic Hysteresis; Rare-Earth Transition Metal Multi-layers; and Magnetic Anisotropy. Among the topics discussed by the speakers will be the following: Magnetic Domain Structures of Thin Films; First Order Magnetic Processes in Rare-Earth Intermetallic Compounds; Exchange Coupled Films for Magneto-optics; Corrosion Behavior of Fe-Nd-B Magnets; Tb-Fe Thin Films; Melt-Spun Magnets; Permanent Magnet Applications; and Crystal Field Effects.

5ICPMM

The 5th International Conference on Physics of Magnetic Materials (5ICPMM) will be held, as was the fourth, in Szczyrk-Bila, Poland, on September 3-9, 1990. The conference addresses a wide range of topics in the field of physics including magnetic properties of high T_c superconductors. Other topics include the physics associated with established and new magnetic materials of various forms and states. For more information contact Dr. M. W. Gutowski, Secretary, Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warszawa, Poland.

11th RE Magnet Workshop

The Eleventh International Workshop on Rare-Earth Magnets and Their Applications will be held at the Carnegie Mellon University in Pittsburgh, Pennsylvania, on October 21-24, 1989. A satellite symposium on Anisotropy and Coercivity will be held October 25, 1990. The dates were picked to allow attendees to attend the 35th Conference on Magnetism and Magnetic Materials to be held October 29 to November 1, 1990, in San Diego, California.

A wide spectrum of topics and problems of technological and business nature will be covered. They include, but are not limited to, progress in magnetic materials and process developments; applications of rare earth magnets, such as circuit designs, concepts, and devices; manufacturing processes; economic aspects; and evaluation and standardization of test methods and instruments. The symposium will have a basic-science orientation, dealing with materials science aspects of rare earth-transition metal alloys and magnets, new material compositions, physics of magnetic anisotropy, texture, mechanism of coercivity, and corrosion resistance. There will be an exhibit of industrial products, devices, materials, and test equipment.

For further information contact: Professor S. G. Sankar, Chair, 11th International Workshop on Rare Earth Magnets, Mellon Institute, Carnegie Mellon University, 4400 Fifth Avenue, Pittsburgh, PA 15213, U.S.A.

25 Year Celebration Contest

How many world-wide postage stamps can you identify that have a direct relationship to the rare earths? The person who identifies the most will be offered a choice of one of the books the editor has available at the close of the contest or a free year's subscription to the *RIC Insight*.

The subject of the stamp may be a person who did some work on rare earth materials, a rare earth containing mineral, the chemical symbol of a rare earth, a building in which research on or manufacturing of rare earths occurred, etc. The relationship to the rare earths must be clearly definable—a TV screen, a cracking catalyst unit, an automobile, etc. are not acceptable, although rare earths are used in these items. The contest is open immediately upon publication of this issue of the *RIC News* and closes on September 17, 1990, (all entries must be postmarked on or before September 17 and received by October 1, 1990). The winner will be announced in the December 1, 1990, issue of the *RIC News*.

The stamps must be identified by the country, date of issue, value, and subject (and if available, the Scott catalog number). In case of ties, the earliest postmark wins. Employees of RIC are not eligible. RIC will be the sole judge whether submitted entries are valid and meet the above criteria.

RIC Starts 25th Year

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involved in rare earths, but is not a benefactor of RIC? Perhaps it should be. We do need additional financial aid to continue to put out this newsletter and to serve the scientific and technological community. Just write us and we will be happy to send you more information about becoming a sponsor.

The third goal will depend entirely on you, our readers. So please take pen in hand and write us a story. It can be on any rare earth related incident that has affected you or your company. Some subjects that come to mind include: the influence some person in the rare earth field had on you; how you decided to become involved in rare earths; humorous inci-

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Report on 2nd RES

by

J.-C. G. Bünzli

The Second International Symposium on Rare Earth Spectroscopy (RES-89) was held September 9-14, 1989 in Changchun, Jilin, People's Republic of China. The chair of the organizing committee was Professor Su Qiang. The symposium was organized by the Academia Sinica in Changchun (Changchun Institute of Applied Chemistry, Laboratory of Rare Earth Chemistry and Physics). It was sponsored by the National Natural Science Foundation of China, the Chinese Society of Luminescence, the Chinese Society of Rare Earth, the Chinese Chemical Society, the Third World Academy of Sciences, and six other institutions or commercial companies.

Due to the June events in Beijing, most of the western scientists did not (or were not allowed to) attend the symposium, which somewhat reduced its scientific meaning. RES-89 was attended by about 110 scientists and industrial representatives: 45 from the Changchun institutes, 54 from other regions of China, 4 from the USSR, 3 from India, 2 from Japan, 1 from Switzerland, and 1 from Iran.

Two plenary sessions were held on Sunday, September 10 (Chairs, J.-C. G. Bünzli and S. Tanaka) with lectures by Professors A. A. Kaminskii, S. Tanaka, J.-C. G. Bünzli, and Sia Shangda. Oral sessions on Monday and Tuesday, with 12 invited and 120 contributed papers, completed the scientific part of the meeting.

Participants were offered a substantial social package with a reception on September 9, a visit to the Palace of the Last Emperor and a film studio, as well as a concert by the Jilin Provincial Orchestra on the 11th, a visit to the Institute of the Academia Sinica and a banquet on Tuesday the 12th, and a sight-seeing tour of the Song-Hua Lake and Jilin City on September 13.

The atmosphere of the meeting was friendly. The invited and contributed papers were essentially focused on solid state spectroscopy, luminescent centers, phosphors, and coordination chemistry, and represented an interesting contribution to these fields.

The abstract booklet of the sym-

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ERES

An organization known as the European Rare Earth Society (ERES) has been formed. ERES is a permanent association set up under provisions of the Swiss law, with headquarters in Lausanne.

ERES was formed to encourage the development of scientific and technological activities in the field of *f*-elements, with special reference to European and neighboring countries. The aims to be pursued by the ERES are: promotion of European international and interdisciplinary research projects; exchange of professional, technical, industrial, and economic information by suitable means, e.g. newsletters or journals; promotion of educational activities (workshops, summer schools); organization of international conferences on *f*-elements (ICFE), in coordination with other similar conferences; and maintenance of close contacts with similar societies and organizations around the world including national and international bodies interested in subject areas involving *f*-elements.

There will be two forms of membership, corporate or individual. Individual members will have 1 vote while corporate members will have 5 or 10 votes depending on their level of support. Membership dues are to be set by the General Council, with suggested dues submitted by the Executive Committee.

The General Council (GC), of ERES consists of all of the members and is the supreme organ. It should meet at least triennially, possibly in connection with an ICFE meeting.

The call is out for corporate members and for sponsors for the ICFE. Individual memberships will be available in February 1990 with the first GC meeting to be held in September 1990 at the 1st ICFE.

At this time, no decision has been made on membership for people outside of Europe. For more information and further developments contact the secretary-treasurer, Professor J.-C. G. Bünzli, Institut de Chimie Mineral et Analytique, Place du Chateau 3, CH-1005 Lausanne, Switzerland or the chair, Professor L. Niinistö, Department of Chemistry, Helsinki University of Technology, SF-02150 Espoo, Finland.

High T_c Reviews Theories

Theories of High Temperature Superconductivity is a collection of papers that assemble ideas and calculations of many of the leading scientists working on the theoretical understanding of ceramic superconductors. Most of the leading viewpoints are presented for analysis and comparison. Some papers were written or rewritten for the book while others are papers that were or are to be published in journals and proceedings. The four sections are: Background, BCS-like Theories, Resonating Valence Bond Models, and Hubbard-like Models Explicitly Including Oxygen.

J. Woods Halley edited this 264 page book that contains 26 papers. It was published in 1988, costs U.S.\$54.95, and may be obtained from its publisher, Addison-Wesley Publishing Company, Order Department, South Street, Reading, MA 01867, U.S.A. Ask for ISBN 0-201-12008-9.

New Technology

J. L. Mayo wrote *Superconductivity, The Threshold of a New Technology* with the intention of providing a practical introduction to superconductivity for the general interest science and technology reader. No specific technical knowledge is required to comprehend the information in this book. Compiled is information on the full spectrum of superconductivity, from the scientific background to the applications to the business and financial aspects. It will be a welcome introduction to superconductivity for junior high and senior high students, science writers, and the public in general.

The soft cover book was published in 1988 by Tab Books Inc., Blue Ridge Summit, PA 17294-0850, U.S.A. The 144-page book costs U.S.\$12.60.

Studies Series

The RIC has received volumes 1 and 2 of a new series of in-depth research studies of importance to the superconductivity field. The series is being published by Nova Science Publishers and the first two volumes, published in 1989, are edited by A. Narlikar. The title of the books are

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Studies of High Temperature Superconductors, Advances in Research and Applications.

Each chapter is meant to give a detailed review or an extended paper on one or more of the many aspects of research on or application of high T_c superconductors. They will include theories, structural chemistry, superconducting and normal state properties, experimental techniques, fabrication of various forms and shapes, and applications.

Volumes 1 and 2 contain 381 and 367 pages, respectively. They both contain 15 chapters and cost U.S.\$72.00 each. They may be ordered from Nova Science Publishers, 283 Commack Rd., Suite 300, Commack, NY, 11725, U.S.A.

Electronic Structure

"Electronic structure of the high-temperature oxide superconductors" is the title of a review by W. E. Pickett that appeared in *Rev. Mod. Phys.*, **61**, 433-512 (1989). A copy of reprint number 347 may be obtained for U.S.\$10.50 from American Institute of Physics, Reprint Department, 335 East 45th Street, New York, NY 10017, U.S.A.

Since the discovery of high temperature superconductivity, a large number of electronic structure calculations have been carried out as a first step in understanding the electronic properties of these materials. In this paper these calculations (mostly of the density-functional type) are gathered and reviewed, and their results are compared with experimental data. The results show the important electronic states are dominated by the copper d and oxygen p orbitals, with strong hybridization between them. Photon, electron, and positron spectroscopies provide important information about the electronic states, and comparison with electronic structure calculations indicates that, while many features can be interpreted in terms of existing calculations, self-energy corrections or "correlations" are important for a more detailed understanding. According to the author, the antiferromagnetism that occurs in some regions of the phase diagram poses a particularly challenging problem for any detailed theory. This study also discusses structural stability, lattice dynamics, and electron-

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phonon coupling. Finally, a brief review is given of the attempts so far to identify interaction constants appropriate for a model Hamiltonian treatment of many-body interactions in these oxide superconductors.

Copper Oxide Superconductors

John Wiley & Sons, Inc. has in one volume reported on the worldwide efforts in superconductivity research that took place in the period from April 1986 to early 1988. The book, copyrighted in 1988, has the simple but complete title, *Copper Oxide Superconductors*.

Superconductor researchers, solid state physicists, and others will find that with a list of 1,214 references, the 289-page book gives a comprehensive survey of experimental results on copper oxide superconductors with transition temperatures from 30 K to above 120 K. The authors, C. P. Poole, Jr., T. Daffa, and H. A. Farach, address the BCS theory, the electron-phonon interaction mechanism, and new theoretical models. They also discuss sample preparation and compare the copper oxide superconductors with transition metal and other superconductors.

The book costs U.S.\$35.00 and may be ordered from John Wiley & Sons, Inc., Department 9-6778, P.O. Box 6792, Somerset, NJ 08875-9976, U.S.A. This is undoubtedly one of the better books for getting a handle on the early days of this scientific discovery.

Advances in Superconductivity

Advances in Superconductivity contain the referred proceedings of the First International Symposium on Superconductivity held August 28-31, 1988, in Nagoya, Japan, under the sponsorship of the International Superconductivity Technology Center. It contains 920 pages, was edited by K. Kitazawa and T. Ishiguro, and published in 1989 by Springer-Verlag in Tokyo. The cost of this book is U.S.\$130.00 and may be ordered from Springer-Verlag New York Inc., P.O. Box 2485, Secaucus, NJ 07096-2491, U.S.A. or Springer-Verlag, 4123/Rezensionswesen, Tiergartenstrasse 17, D-6900 Heidelberg 1, West Germany.

Over 150 papers are included in this large impressive volume. In-

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Superconductivity

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tense recent activity in the field of high-temperature superconductivity, both in Japan and elsewhere is discussed. Current research and developments by major Japanese companies are discussed by leading company scientists. New materials and recent theoretical work is reported on by both Japanese and international researchers. Future applications including magnetic levitation vehicles, electronics based on Josephson junctions, power delivery, energy storage, ship propulsion, and magnetic resonance imaging are particularly stressed.

Contributions are organized by topics: crystal chemistry and electronic structure, processing and microstructure, processing and properties, tapes and thick films, thin films, and wires and coils. This appears to be one of the most comprehensive volumes we have reviewed.

TMS at Las Vegas

Fifty-seven papers on superconductivity presented at a symposium that was part of the 118th Annual Meeting of The Minerals-Metals-Materials Society (TMS) are in the book, *High Temperature Superconducting Compounds: Processing & Related Properties*. The symposium was held February 27-28, 1989 in Las Vegas, Nevada.

The symposium announcement asked for novel approaches to solving the problem associated with the critical currents, mechanical properties, and chemical properties of high T_c ceramic superconductors. Many of the papers presented are in this spirit. Almost half the papers are on production of bulk materials, a third on fabrication of specific forms and shapes, and the rest are reviews or on the thermodynamic, physical or chemical properties of these fascinating materials.

The editors for the proceedings were S. H. Whang and A. Das Gupta. The 693-page book may be ordered from TMS, 420 Commonwealth Drive, Warrendale, PA 15086, U.S.A. The list price is U.S.\$150.00 but TMS members pay \$85.00 and TMS student members pay \$65.00.

Adriatico Research Conference

Progress in High Temperature Superconductivity, Volume 14, contains the Proceedings of the Adriatico Re-

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search and Workshop on *Towards the Theoretical Understanding of High T_c Superconductors* held in Trieste, Italy, on July 25-29, 1988. It was part of the longer workshop on mechanisms for high temperature superconductivity held from June 20th to July 29th.

The papers in this volume summarize some of the most meaningful contributions presented during these two events. The 81 papers were divided into eight sections covering: one-band Hubbard model for high T_c superconductors; other models based on magnetic interactions including multi-band models; nonmagnetic models; numerical studies; one-dimensional Heisenberg and Hubbard models; phenomenological theories and related papers; experimental-spectroscopies, transport, etc.; and experimental superconducting properties.

The proceedings contain 787 pages; were edited by S. Lundqvist, E. Tosatti, M. P. Tosi, and Yu Lu; and was published in hardcover in 1988. The proceedings are also designated as Volume 1, No. 5, pages 539-1319 of *International Journal of Modern Physics B*. They are available for U.S.\$86.00 from World Scientific Publishing Company, 687 Hartwell Street, Teaneck, NJ 07666, U.S.A.

Superconductivity

Superconductivity is but one of 14 volumes of the Proceedings of the First Materials Research Society International Meeting on Advanced Materials (IMAM), which was held at Sunshine City, Tokyo, Japan, from May 30 to June 3, 1988.

IMAM Volume 6, *Superconductivity*, published in 1989, was edited by K. Kitazawa and K. Tachikawa. It has 1,027 pages and includes 149 papers. In this proceedings volume, recent research activities on advanced superconducting materials have been collected worldwide but especially from Japan and other Asian countries. While papers on metallic superconductors, such as Nb_3Sn and Nb_3Al , and papers on $PbMo_6S_8$ are included, the present volume contains mainly papers on high- T_c oxide superconductors. Some of the areas covered include oxide wires, films, and tapes; synthesis and fabrication; composition effects; physical properties; and applications. The editors of

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LAURENCE QUILL

Laurence L. Quill died February 13, 1989, in Benson, Arizona, 11 days short of his 88th birthday. He was born in Carson City, Nevada, and received a B.S. in 1924 and M.S. in 1925 in chemistry from the University of Nevada. He received his Ph.D. from the University of Illinois in 1928. He taught at Illinois, Ohio State University, and the University of Kentucky. While at Kentucky, Quill served as a chemist and consultant to the Manhattan Project that developed the United States atomic bomb. He worked as a rare earth expert with the Metallurgical Section at the University of Chicago. He joined the faculty at Michigan State University in 1946 and remained there until he retired in 1966. He was known for his study of rare earth chemistry. Among his areas of expertise were compounds of scandium and the lanthanides, solubility and thermal analysis of their salts, artificial radioactivity of the rare earths, and chelate compounds.

WILLIAM SAVAGE

William R. Savage, a professor of physics and astronomy at the University of Iowa, died on May 28, 1988, after a brief illness at the age of 61.

Born in Cedar Rapids, Iowa, U.S.A., on September 12, 1926, he received his B.S. and Ph.D., both in physics, from Iowa State University. His thesis, done under D. Hudson and F. H. Spedding, was a study of the heat of sublimation of rare earth metals.

After two years at the Honeywell Research Center in Hopkins, Minnesota, and five years at the Central Research Laboratories of Texas Instruments in Dallas, Texas, he became part of the physics department at the University of Iowa in Iowa City, Iowa. His research involved specific heats, resistivity and magnetic susceptibilities of dilute magnetic alloys, and intermediate valence compounds.

this volume hope that these proceedings will be a helpful guide in future research activities.

Superconductivity, ISBN:1-55899-035-6, is available from Materials Research Society, 9800 McKnight Road, Pittsburgh, PA 15237, U.S.A. The cost to MRS members is U.S.\$58.00 (nonmembers \$62.00 in the U.S., others U.S.\$74.00).

WILLIAM STEYERT

Dr. William A. Steyert died May 2, 1988, at the age of 55 in Allentown, Pennsylvania, after a lengthy illness. He was well known in physics for his work at low temperatures and on cryogenic refrigeration. He obtained his B.S. in 1954 from the Massachusetts Institute of Technology, and his M.S. (1956) and Ph.D. (1960) from the California Institute of Technology. He was a postdoctor at the University of Illinois, then spent 21 years at the Los Alamos National Laboratory before joining APD Cryogenics in 1982.

He not only did experiments at ultralow temperatures (e.g. Mössbauer effect, the Kondo state) but also developed methods of reaching these temperatures. He was one of the pioneers in exploring magnetic refrigeration and also worked on metal hydride compressors and the Joule-Thompson compressor for cooling materials. Much of his refrigeration work was with rare earth compounds, especially those containing gadolinium.

Proceedings 4ICPMM

The Proceedings of the 4th International Conferences on Physics of Magnetic Materials was published in 1989 by World Scientific Publishing Company of Singapore. The conference was held September 4-10, 1988 in Szczyrk, Poland.

The conference addressed a wide range of topics in the field of physics of magnetic materials including high T_c superconductors. Thirty-one of the 36 invited talks are included in this hardcover book of the 206 contributed papers presented, ~75 were published in *Acta Phys. Polon.* A76, [1/2], 1-414 (1989).

In addition to theory, topics such as magnetic films, metallic glasses, NdFeB magnets, $\text{Ho}_2\text{Co}_{17}$ and $\text{Ho}_2\text{Fe}_{14}\text{B}$ magnets, and spin glasses are covered.

The proceedings contain 645 pages; were edited by W. Gorzkowski, H. K. Lachowicz, and H. Szymczak; and are available for U.S.\$78.00 from World Scientific Publishing Company at any of the following addresses: P.O. Box 128, Farrer Road, Singapore 9128; 687 Hartwell Street, Teaneck, NJ 07666, U.S.A. or 73 Lynton Mead, Totteridge, London N20 8DH, England.

10th Magnet Workshop

The Proceedings of the Tenth International Workshop on Rare-Earth Magnets and Their Applications, a two-volume soft cover set plus two supplements, are now available. The workshop was held May 16-19, 1989, in Kyoto, Japan. In the U.S.A. copies may be ordered for \$100.00, plus postage, from Dr. Karl Strnat, KJS Associates, 1712 Springfield Street, Dayton, OH 45403, U.S.A. Elsewhere they can be obtained for Yen 15,000 (postage extra except for Japan) from Mr. Tsunehisa Kurino, The Society of Non-Traditional Technology, Toranomon-Kotohira Kaikan Building, 1-2-8 Toranomon, Minato-ku, Tokyo 105, Japan. Since the first workshop in 1974 the conferences have evolved into a truly international endeavor that promotes a worldwide exchange of information and encourages cooperation between people from the business and scientific world.

From looking over the table of contents it is obvious that interests in Nd-Fe-B based magnets, their derivatives, and their present and future applications continues unabated. Papers report on improved magnet compositions with better temperature stability, corrosion resistance, lower costs, and better producibility. Other papers report on alternative processing or treatment methods such as bonding, injection moulding, extrusion, calendaring, die-forming, and hot deforming.

Also apparent in the papers is the shift of attention back to applications and devices utilizing Nd-Fe-B magnets now that they and their derivatives have reached commercial status. As usual when held in an Asian country, the proceedings contain an increased number of papers on medical and dental applications of magnets. Also included are papers on raw materials availability and the market emphasis found in different countries.

This workshop includes papers on the coercivity mechanisms and their relationships to the metallurgical microstructures and on the quest for new and novel intermetallic compounds that might have still higher energy products or other desirable characteristics. Among these compounds are $\text{R}(\text{Fe},\text{M})_{12}$, RFe_{23} , and various substituted $\text{R}_2(\text{Fe},\text{M})_{14}\text{B}$ and R_2M_{17} alloys.

Titanium Alloys

Three papers on titanium appeared in a recent issue of *Scripta Metallurgica*. Two of these papers by S. Naka et al. [23, 477-82 and 501-5, (1989)] deal with Ti-Y while the third [23, 461-6 (1989)] deals with Ti-Er.

The first paper, by C. Perrier, S. Naka, and L. P. Kublin, dealt with the deformation of rapidly solidified Ti-Y alloys (0.74 and 1.84 wt% Y) below 700°C. The various properties (including 0.2 percent proof stress at different temperatures, steady-state creep rate for various stresses, and strain-stress relationships) are compared to T40 grade titanium.

The second paper, by S. Naka, H. Octor, E. Bouchand, and T. Khan, is concerned with the reprecipitation of Y_2O_3 dispersed in titanium. The authors investigated the interaction between dispersed particles and grain boundaries during heat treatment after cold rolling. A mechanism based on the dissolution and the reprecipitation of the small Y_2O_3 particles induced by migrating grain boundaries was postulated to explain the excellent size stability of these particles in Ti during heat treatment in the alpha-phase field after cold rolling.

The third paper, by J. P. A. Löfvander, S. A. Court, and H. L. Fraser, dealt with composition of some particles found in a Ti-25Al-0.7 Er (at.%) alloy. The powders were formed by centrifugal atomization and the alloy formed by hot isostatic pressing. The matrix was found to be the intermetallic phase Ti_3Al , which contained spherical particles of Er_2O_3 and some other irregular shaped particles a few hundred nm across that were thought to be TiErO_{2-x} .

Globe Metallurgical

Globe Metallurgical, Incorporated, said to be the largest U.S. producer of ferroalloys and silicon metal, will move its executive offices from Beverly, Ohio, to Cleveland, Ohio, by late fall 1989. Globe said the move is being made for better access to transportation to serve growing international markets and better service to major customers. A customer service department will be maintained in Beverly and manufacturing operations will continue there and in Selma, Alabama.

Electron Challenge

Number 394 in the ACS Symposium Series is entitled, "The Challenge of *d* and *f* Electrons; Theory and Computation," was edited by D. R. Salahub and M. C. Zerner, and published in 1989. It was developed from a symposium sponsored by the Inorganic and Physical Chemistry division of the American Chemical Society (ACS) and the Physical and Theoretical Chemistry division of the Canadian Society for Chemistry at the Third Chemical Congress of North American (195th National Meeting of the ACS) held June 5-11, 1988 in Toronto, Canada.

The symposium presents recent advances in the theory and computation of systems containing *d* and *f* electrons and the application of these advances to a number of complex systems. The latest developments in molecular orbital theories, in correlation calculations, and in local and nonlocal spin density theories are discussed. Most of the 27 papers do not use rare earth compounds to illustrate the theoretical points but most of the theories are applicable to rare earth compounds.

The 405-page book costs U.S. \$89.95 in the U.S. and Canada and has an export price of U.S.\$107.95. It may be ordered from the American Chemical Society, 1155 Sixteenth Street, N.W., Washington, D.C. 20036, U.S.A.

RIC News
(USPS 464-960)

Vol. XXIV, No. 4 December 1, 1989

Published
quarterly in March, June,
September, and December
by

Rare-earth Information Center,
Ames Laboratory,
Institute for Physical
Research and Technology,
Iowa State University,
Ames, Iowa 50011-3020

Second-class postage
paid at Ames, Iowa

Postmaster: Send address changes to:
RIC News, Rare-earth Information Center,
Ames Laboratory,

Institute for Physical
Research and Technology,
Iowa State University,
Ames, IA 50011-3020
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H icc6 Proceedings P

The proceedings of the 6th International Conference on Crystal-Field Effects and Heavy Fermion Physics have been published in Volumes 76 and 77 of *Journal of Magnetism and Magnetic Materials*. Published in 1988 by North-Holland Publishing of Amsterdam, the proceedings were edited by W. Assmus, P. Fulde, B. Lüthi, and F. Steglich. The conference was held July 18-21, 1988, in Frankfurt, West Germany. The hard cover book containing the two volumes may be obtained from Elsevier Science Publishers B.V., P.O. Box 103, 1000 AC Amsterdam, The Netherlands for Dfl. 828.00 (~U.S.\$400.00).

The 6th conference concentrated on the exciting physics that is associated with heavy fermion systems. Classical crystal field effects played a relatively small role. On the other hand, developments in high-temperature superconductivity have shown the presence of strong electron correlations. To elucidate the similarities and differences between these superconductors and heavy-fermion systems an evening session was held on this subject.

The proceedings are divided into 11 sections, as follows, with the number of papers per section listed in parentheses: Fermi surface and band structure (9); ground state (15); thermodynamic properties (38); transport properties (37); magnetoacoustic (7); low and high energy excitation (16); neutron scattering (23); resonance (12); heavy fermion superconductivity (19); high temperature superconductivity (27); and material aspects (10). The proceedings end with two conference summaries. Theory is summarized by T. V. Ramakrishnan and the experimental presentations are summarized by J. Flouquet.

RIC Starts 25th Year (Continued from page 3)

dents in your or someone else's life involving rare earths; what led up to your important discoveries; or how rare earths have enriched your life. Remember, it is a chance for you to get your story in a booklet and possibly in the *RIC News*.

Rare-Earth Permanent Magnets

Volume 80, Number 1, of *Journal of Magnetism and Magnetic Materials* contains a significant proportion of the papers presented at a symposium on the properties, processing and applications of rare earth, iron-rich, high performance permanent magnets. The symposium was part of the 1988 European Materials Research Society (E-MRS) fall conference held November 8-10, 1988, in Strasbourg, France.

An interesting mixture of papers on fundamental magnetic behavior, microstructural studies, processing methods, and applications are included. In addition to the $R_2Fe_{14}B$ -type phases, work is reported on $R_2Fe_{14}B_{1-x}$, $R_2Fe_{14}C_x$, $R_2Fe_{14}Mn_xC_x$, RFe_{12-3} , $Fe_3B(Nd_2Fe_{14}B)$, R_2Fe_{17} , and $R_2Fe_{17}C_x$ phases, where R is a single rare earth or a mixture of rare earths. Papers on the effects of various additions, notably aluminum, and of various ageing treatments on the magnetic properties of Nd-Fe-B magnets are included. There are papers that describe the production of magnets by the die-upset-forging of melt-spun ribbon, by cold-compaction of melt-spun ribbon with soft metals, by mechanical alloying, and by hot working of cast material. Also included are papers on the production of new permanent magnets from melt-spun material based on the alloys $Nd_2Fe_{17}B_{18}$ and $SmFe_{11.75}Ti_{1.04}$. These two alloys are said to look promising and the former is said to be close to commercial utilization. The proceedings end with a review of the various applications of Nd-Fe-B magnets in electromagnetic machines and a description of a novel disc-type motor.

The proceedings were edited by I. R. Harris and published in 1989 by North-Holland Publishing of Amsterdam, The Netherlands. This issue of the journal may be purchased from Elsevier Science Publishers B. V., Journals Department, P.O. Box 211, 1000 AE Amsterdam. The cost is Dfl. 156.00 (~U.S.\$75.00).

Report - 2nd RES

(Continued from page 3)

posium is available for U.S.\$5.00 from Professor Su Qiang, Changchun Institute of Applied Chemistry, Academia Sinica, Changchun, Jilin, People's Republic of China.

Ames Specialty Metals

Edge Technologies Inc., an Iowa-based company, announced the formation of its second business division based on research conducted at Iowa State University (ISU). The division, Ames Specialty Metals, has been licensed by ISU to produce permanent magnet alloy materials, using a new technology developed by the Ames Laboratory of the Institute for Physical Research and Technology (IPRT). Ames Specialty Metals will use the "thermite reduction" process patented by three ISU scientists, J. Wheelock, D. Peterson, and R. Schmidt. The present emphasis will be on production of neodymium-iron-boron alloys. M. Induni, president of Edge Technologies reports that the thermite process gives us potential advantages in areas of cost, corrosion-resistance, and simplicity of manufacturing.

Work on adapting the thermite reduction to produce permanent magnet alloys began in 1983 and led to the 1986 patent. In 1987, ISU's Center for Advanced Technology Development (CATD) began further development of the process to bring it closer to commercial scale and started looking for a licensee.

ARKADII ELISEEV

Arkadii A. Eliseev died in his home in Moscow on December 5, 1988, at the age of 57. He was born in 1931 in the city of Kyem, which is located in the Karelskaya Autonomous Republic. Eliseev was educated at the Leningrad University, where he received his M.S. in physics in 1954. From 1954 to 1967 he was a research scientist in the X-ray Division of the General and Inorganic Chemistry Institute of the Academy of Science of the USSR. From 1967 until his death he was a professor of Crystal Chemistry and Crystallography in the Moscow Institute of Fine Chemical Technology.

He was a world renowned expert on rare earth chalcogenides. He worked early with the tellurides and later with selenides and sulfides. As his colleague, Dr. G. M. Kuzmichyeva wrote, "His warm human qualities and his genuine professional abilities will be terribly missed by all of us who took pleasure in his company." Many people who knew him echo these sentiments.

SPONSORS

The second quarter of fiscal 1990 has been encouraging as 9 of the 27 sponsors this quarter are new members in our family of benefactors. This brings our overall total to 78 for the first half of the year leaving 72 needed during the second half to hit our goal of 150 for the year. Last year at this time we had 64.

The second quarter sponsors wishing to be listed with the number of years they have been sponsors in parentheses, are listed below.

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 NUCLEMON-Nuclebrás de Monazita e Associados, Limited, Brazil (16)

(Continued in next column)

VIKTOR SPITSYN

The RIC recently learned of the death on January 30, 1988, of Viktor Ivanovich Spitsyn. He was born on April 25, 1902, in Moscow. He was educated at Moscow University, completing a degree in physical chemistry in 1922. His thesis was on tungstic acid and his first independent research was devoted to chemistry and technology of W, Mo, Be, and Ta, elements in which he maintained a lifetime interest. He directed research on scandium compounds and a series of complex lanthanide compounds including volatile β -diketonates. He studied ways of stabilizing tetravalent lanthanides and their use as anti-corrosion agents. He and his colleagues studied and compared the lanthanides with the actinides. From 1942 until the end of his life he was head of the Inorganic Chemistry Department of the Lomonosov Moscow University. He won numerous awards and his work has received international recognition.

(Continued from previous column)

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