



Rare-earth Information Center NEWS

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

Volume XXVIII

September 1, 1993

No. 3

Academy of Natural Sciences of Russia

Dr. Robert Guillaumont, Professor of Chemistry at the University of Paris XI-Orsay, France, has been named an honorary member of the Academy of Natural Sciences of Russia. The award recognizes his achievement in radiochemistry and actinide chemistry.

Professor Guillaumont is well known for his pioneering research in the field of aqueous chemistry of protactinium at the tracer level and extended it to include the other actinides. He has been actively engaged in macroscopic actinide physico-chemistry, mainly in optical spectroscopy, and has contributed to the development of partitioning radiochemical methods. Prof. Guillaumont's broad research background qualifies him as both a theorist and experimentalist, whose work has contributed to the knowledge of chemical behavior of the transactinide elements.

He has also presented results on the chemical properties of the lanthanides, as well as studying solvent extraction from molten salts, thermodynamic functions of rare earth-halogen complexes, and the bone uptake of rare earths and transuranic elements. He is currently working on the problems of radioactive waste management.

Prof. Guillaumont is in charge of the French National Post Graduate course "Radiation, Radioelement, Radiochemistry" and is co-author of *Protactinium and Fundamentals of Radiochemistry*. He has taught and inspired many students and postdoctoral collaborators, and is a corresponding member of chemistry section of the French Academy of Sciences. ▲



Dr. Robert Guillaumont

Safer Red Pigments for Plastics

During the past several years, companies and producers of plastic consumer goods that use red pigments have been searching for a chemical compound to substitute for pigments currently in use. Most of the red pigments today are cadmium or heavy-metal based inorganic chemicals which may have potentially harmful effects on the environment. Although there are many different red pigments, there are very few inorganic red pigments that can be used in the plastics industry. Other available pigments are cadmium sulfoselenide, lead molybdate and ferric oxide. Cadmium sulfoselenide is the brightest red, but regulatory pressures on cadmium are increasing, so the use of cadmium in plastics is a growing concern. The lead and iron compounds are actually orange or red-brown pigments; and the former has its environmental problems too.

Many organic pigments have bright colors, but due to the optimized particle size and the chemical composition of inorganic pigments, the latter have better hiding power, dispersibility, bleeding resistance, and thermal and ultraviolet stability to resist fading. In addition, inorganics do not cause warping problems, because they are completely insoluble in the plastic medium, even at processing temperatures.

Rhône-Poulenc Chimie, France, has recently patented a new, non-toxic, environmentally-safe substitute for cadmium and other inorganic "reds" for use in the plastics industry. The new red pigment is cerium sesquisulfide (Ce_2S_3) and is the latest red inorganic pigment for use in plastics since cadmium. The new cerium sulfide compound has the cubic Th_3P_4 -type structure and was tested in polypropylene plastic. Ce_2S_3 is chemically stable up to 1500°C in inert and reducing atmospheres, and stable to 350°C in an oxidizing atmosphere. The average par-

Continued in next column ⇨

Molycorp Newsletter

Molycorp, a major rare earth producer, has initiated the publication of a new newsletter, simply called *Newsletter*. The appropriately-named *Newsletter* reports on the happenings of the company, new developments, and includes a special feature on company personnel.

The Spring 1993 issue features the article, "Molycorp and the Future" written by Gene Dewey, President of Molycorp, which reports on the current status of rare earth production at the company. Also included is information on cerium, a product from Molycorp's Mountain Pass operations.

The free *Newsletter* is edited by Dr. Barry Kilbourn and can be ordered from Sales & Marketing, Molycorp, Inc., 709 Westchester Ave., White Plains, NY 10604; Tel: 914 997 8880; Fax: 914 997 8898. ▲

⇨ *Continued from previous column*

particle size of Rhône-Poulenc's powder ranges from 1.5 to 5.0 μm and has a theoretical density of 5.0 g/cm³. Specific surface area is said to be <5 m²/g.

This new red "safe" pigment has high commercial potential because 87% of the plastics used in the U.S.A. and 80% of those in Europe are currently using cadmium. This means that over 2100 metric tons (mt) of annual pigment usage of these two markets alone could substitute Ce_2S_3 for heavy-metal pigments. With total world plastic consumption in excess of 43 million mt, this breakthrough places rare earths in an advantageous position as this new application is exploited.

For more information on this important development in plastic-coloring technology, contact: J.M. Tourre at Rhône-Poulenc Chimie, Department Terres Rares, 25, Quai Paul Doumer, 92408 Courbevoie Cedex, France; Tel: 16 1 4768 1935; Fax: 1 4768 2299. ▲

SCES '94

The International Conference on Strongly Correlated Electron Systems (SCES '94) will be held August 15-18, 1994 in Amsterdam, The Netherlands. SCES '94 aims to bring together physicists working on the various aspects of correlated electron systems. The central issue of SCES '94 is the anomalous behavior of hybridized electron systems, primarily rare earth and actinide based materials.

Other topics of the conference include: Kondo (lattice) defects; charge and spin fluctuations; heavy-electron phenomena; superconductivity in heavy-fermion systems; electron correlations and magnetic order; anomalous *f*- and *d*-electron systems and; electron correlations in high- T_c compounds.

To receive a copy of the First Announcement or any other additional information, contact the Conference Secretariat: A. de Visser, Van der Waals-Zeeman Laboratorium, Universiteit van Amsterdam, Valckenierstraat 65, 1018 XE Amsterdam, The Netherlands; Tel:31 20 525 5732/5716; Fax:31205255788; E-mail:SCES94@phys.uva.nl. ▲

1994 China Conference and Plant Tours

Interested in learning more about the permanent magnet industry in China? Did you know that China is now the third largest economy in the world, ranking just behind the U.S.A. and Japan, and is growing rapidly? The 164 permanent magnet producers in China have developed new manufacturing processes and applications, and are currently seeking partners for joint venture operations.

The People's Republic of China is fast developing its resources and the plans that will affect the producers of permanent magnets world-wide. To help de-mystify the Chinese magnetic materials industry and to identify the best opportunities for outside investors, Intertech Conferences is planning a two-day international conference in Beijing in the spring of 1994. Highlights of this conference will include a tour of four nearby manufacturing plants and an opportunity to hold private meetings with Chinese buyers and suppliers.

For more information on the 1994 China Conference and Plant Tours, and to receive a pre-program questionnaire, contact: Intertech Conferences, 411 US Route One, Portland, ME 04105 USA; Tel:2077819800; Fax:2077812150. ▲

Conference Calendar*** A NEWS STORY THIS ISSUE****September '93**

20th Rare Earth Research Conference
Monterey, California, USA

September 12-17, 1993
RIC News, XXVII, [1] 2 (1992)
RIC News, XXVII, [3] 2 (1992)
RIC News, XXVIII, [1] 2 (1993)
RIC News, XXVIII, [2] 2 (1993)

Actinides '93

Santa Fe, New Mexico, USA
September 19-24, 1993
RIC News, XXVI, [3] 2 (1991)

November '93

XVIII Symposium of the Academy of Sciences of the State of São Paulo
São Paulo, Brasil
November 16-19, 1993
* This issue

June '94

International Conference on Nitromagnetics
Honolulu, Hawaii, USA
June 15-17, 1994
RIC News, XXVIII, [2] 2 (1993)

July '94

Eleventh International Conference on Solid Compounds of Transition Elements (SCTE-11)
Wrocław, Poland
July 5-8, 1994
RIC News, XXVIII, [2] 2 (1993)

ICM '94

The International Conference on Magnetism 1994 (ICM'94) will be held August 22-26, 1994 in Warsaw, Poland. ICM'94 is sponsored by the International Union of Pure and Applied Physics and the National Committee for Scientific Research. Proceedings of ICM'94 will be published in *Journal of Magnetism and Magnetic Materials* with abstracts due March 1, 1994.

For a copy of the first circular, contact: The Secretariat, ICM'94, Institute of Molecular Physics, Polish Academy of Sciences, ul. Smoluchowskiego 17, 60-179 Poznań, Poland; Tel:61 674 071; Fax:61 674 751.

The three satellite meetings of ICM'94 are: *Strongly Correlated Electron Systems 1994*, 15-18 August, 1994, in Amsterdam, The Netherlands. For more information con-

August '94

3rd International Conference of f-Elements (ICFE)
Helsinki, Finland
August 1-5, 1994
*This issue

Strongly Correlated Electron Systems
Amsterdam, The Netherlands
August 15-18, 1994
*This issue

International Conference on Magnetism
Warsaw, Poland
August 22-26, 1994
*This issue

4th International Symposium on Research in High Magnetic Fields
Nijmegen, The Netherlands
August 29-31, 1994
*This issue

14th International Colloquium on Magnetic Films and Surfaces
Düsseldorf, Germany
August 29-September 2, 1994
*This issue

tact: A. de Visser, Van der Waals-Zeeman Laboratorium, Universiteit van Amsterdam, Valckenierstraat 65-67, 1018 XE Amsterdam; *4th International Symposium on Research in High Magnetic Fields*, August 29-31, 1994, Nijmegen, The Netherlands. Contact: J.A.A.J. Perenboom, Katholieke Universiteit Nijmegen, Postbus 9010, 6500 GL Nijmegen; *14th International Colloquium on Magnetic Films and Surfaces*, August 29-September 2, 1994, Düsseldorf, Germany. Contact: E. Kisker, Heinrich-Heine-Universität Düsseldorf Universitätsstrasse 1, W-4000 Düsseldorf 1, Germany. ▲

Nd_2O_3 is used as a decolorizer in high boric oxide glasses, and as a dopant in laser glasses and garnets. ▲

3rd ICFE

The third International Conference of f-Elements (3rd ICFE) will be held August 1-5, 1994 in Helsinki, Finland. This meeting will be a broad scope conference featuring the chemistry and physics of f-elements as well as their applications.

To receive the first circular or more information about the 3rd ICFE, contact: Prof. L. Niinistö, Helsinki University of Technology, Laboratory of Inorganic and Analytical Chemistry, SF-02150 Espoo, Finland; Tel: 358 0 4511; Fax: 358 0 462 373. ▲

XVIII Symposium

XVIII Symposium of the Academy of Sciences of the State of São Paulo will be held November 16-19, 1993. The conference will address topics in lanthanide and actinide chemistry. The deadline for the submission of abstracts is September 30, 1993. For more information, contact Professor G. Vincentini, Instituto de Química, University de São Paulo, C.P. 20.780, CEP 01498-970, São Paulo, Brasil; Tel: 55 11 210 2122 ext. 372; Fax: 55 11 815 5579. ▲

Vapor Deposited Fluoride Glass

The most promising application for fluoride glass today is for ultra-low loss optical fibers which operate in the mid-infrared region. However, optical fibers made of these materials exhibit high extrinsic scattering from microcrystals, caused by oxygen contamination during conventional fabrication techniques, and impurity absorption by transition metal lanthanide, and hydroxide ions.

Y. Nishida et al. report a successful chemical vapor deposition (CVD) technique to overcome these problems in *Jpn. J. Appl. Phys.* Vol 31, Part 2, L1692-4 (1992). Their CVD process uses the thermal reaction between metal β -diketonates and hydrogen fluoride to synthesize ternary, and five-component (ZBLAN) glass particles, with the composition ZrF_4-BaF_2-NaF and $ZrF_4-BaF_2-LaF_3-AlF_3-NaF$, respectively. The metal β -diketonates selected in this study were; the Zr chelate of 1,1,1,5,5,5-hexafluoro-2,4-pentanedione ($Zr(hfa)_4$), the Ba, La, and Na chelates of 1,1,1,2,2,2-pentafluoro-3,5-heptanedione, $(Ba(ppm)_2)$, $(La(ppm)_3)$, and $(Na(ppm))$, and the Al chelate of 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyl-4,6-octanedione ($Al(fod)_3$). Ar-based 20 vol.% fluorine gas was used as the carbon getter gas.

Continued on page 5 ⇨

A Decade of High- T_c

The last ten years have been witness to tremendous advances in the understanding of the cause and effects of superconductivity. *Ten Years of Superconductivity: 1980-1990* is the seventh in the series of *Perspectives in Condensed Matter Physics*. This compendium presents some of the major and important research papers that have been published in periodicals and books from 1977 to 1991 that deal with the discoveries in superconductivity.

The discovery by J.G. Bednorz and K.A. Müller of the existence of the superconductive state above 30K in rare earth-copper oxide materials made headlines around the world. Their discovery was directly responsible for the increased research on superconductivity, and the re-introduction of this field into the forefront of science. Any unexpected occurrence of superconductivity is a challenge to scientists interested either in the physics of this phenomenon or in its materials science aspects. In this respect, the eighties have been revolutionary in the sense that, on various occasions, superconductivity was discovered in materials whose physical properties did not lend evidence to the existence of this ground state.

The book includes papers dealing with superconductivity of rare earth borides, cuprates, oxides, other rare earth compounds, as well as non-rare earth materials. The editor has also included a collection of reprints in this review that deal with other subjects, such as the coexistence of magnetic order and superconductivity, heavy electron and organic superconductors. This maintains the theme of the book because many aspects of superconductivity in high T_c oxide compounds may be connected with these features in other compounds.

This is an excellent book for the student wanting to become well-versed in the most significant period of time of superconductivity research, as well as those who work in the field who want a complete collection of the most important papers written on the subject. For non-specialists who might be interested in this collection of reprints, the editor briefly reviews the possibilities for identifying superconductivity and discusses some special features of the superconductive state.

The 321-page *Ten Years of Superconductivity: 1980-1990* was published in 1993 by Kluwer Academic Publishers Group and

Continued in next column ⇨

Permanent Magnet Short Course

Described by the publisher as "the best reference source on permanent magnet materials available today", *A Short Course in Permanent Magnet Materials*, written by William A. Cassady, is indeed just the book to gain an understanding and appreciation of permanent magnets. The book is geared to provide a general understanding of the basics of permanent magnets. The first six sections of the book describe the history, technical descriptions, material specifications and design factors of magnetic materials, primarily rare earth permanent magnets. The book also lists the primary users and applications of permanent magnets in industry, automotive, transportation, aerospace, electronics, medical, and home uses. The author does an excellent job of explaining how the scientific properties of permanent magnets are measured, described, and used.

Section seven provides a list of commercial sources of rare earth permanent magnets which include 59 commercial manufacturers, distributors, and processors of permanent magnets. There are also six manufacturers of magnetic instrumentation for use with permanent magnets. The final section of the book will be of special interest to "free thinkers" as current research of space powered generators (SPG's) is reviewed.

The book is recommended to those desiring a general and basic background on the subject or who wish to know more about permanent magnets without all the usual detailed descriptions of these materials. This would be an excellent source for the student rare earther wishing to know more about these substances.

The 192-page *A Short Course in Permanent Magnet Materials* was published in 1993 and is available for \$63.50 by ordering directly from: SJL Publishing Company, P.O. Box 152, Hanna, IN 46340-0152 USA; Tel: 219 324 9678; Fax: 219 324 3606. However, *RIC News* readers can receive the book for only \$49.99, just mention that you read about this offer in the September 1, 1993 issue of the *RIC News*. ▲

⇨ Continued from previous column was edited by H.R. Ott. The hardcover book is available for Dfl 210.00 (\$127.00 US, £85.00) by ordering from the publisher: P.O. Box 322, 3300 AH Dordrecht, The Netherlands; Tel: 31 78 524400; Fax: 31 78 183273; Telex: 20083 kadc nl. ▲

New Gmelin Handbook

Optical Spectra of Ce and Pr, Rare Earth Elements, Volume E1 Gmelin Handbook of Inorganic and Organometallic Chemistry, 8th Edition, is the latest compilation of research on rare earths from the excellent Gmelin series. This volume reports on the spectra of these Ce and Pr ions in solid rare earth compounds, host crystals, and glasses. The main topics covered in the book are the phenomenological descriptions of 4f-4f level transitions. The electronic spectra in this region are an important tool for the investigation of solid state properties. For example, optical technologies such as lasers and cathode ray tube phosphors.

This volume is primarily concerned with the spectra and energy levels of trivalent cerium and praseodymium. Since pure spectra of the divalent ions are unknown, only limited data for mixtures of trivalent and divalent (5 to 10%) ions in CaF₂ host crystals are reported. Because of the empty 4f shell of tetravalent cerium, no intra-ionic transitions appear in this region. However, some examples of Ce⁴⁺ spectra are given, which deal mainly with phonon modes, charge transfer bands, and interband transitions. Interestingly, even though Pr⁴⁺ has the same electron configuration as Ce³⁺, no corresponding spectra were reported.

The book is divided into two sections: Section 1 deals with cerium spectra in fluorite, garnet, and glass hosts. The praseodymium spectra, in Section 2, are studied more intensively than the cerium spectra because of the work conducted on praseodymium halides, or Pr³⁺-doped rare earth halides such as LaF₃ and LaCl₃, because of interesting laser and laser-related properties. One of these properties is upconversion, which occurs when a short-wavelength emission can be induced by pumping with radiation having a longer wavelength. Using this effect, the feasibility of the LaF₃:Pr³⁺ and LaCl₃:Pr³⁺ systems as infrared quantum counter materials is discussed. Other than the hosts listed for cerium, important host materials for Pr³⁺ ions are borates, phosphates, double nitrates and ethyl sulfates.

The 275-page *Rare Earth Elements E1 Optical Spectra of Ce and Pr* was published in 1993 and contains 198 figures. The cost to receive the hardcover book is DM 1,598.00 (\$-1020.00 US) and can be ordered from Springer-Verlag GmbH & Co. KG, Postfach 10 52 80, Tiergartenstrasse 17, D-6900 Heidelberg 1, Germany; Tel:0 62 21 487-0; Fax:0 62 21 41 39 82. ▲

Handbook Volume 16

Volume 16 of the *Handbook on the Physics and Chemistry of Rare Earths* contains five chapters. The first chapter (chapter 105) deals with one of the most stimulating topics in lanthanide science: the dual-valence state elements Ce, Pr, and Tb (valences of 3 and 4) and Sm, Eu, Tm and Yb (valences of 2 and 3). The authors write about information gathered from neutron scattering experiments. The major topics include cerium-based valence fluctuation systems, cerium-based heavy-fermion materials and ytterbium-based materials. About one-fourth of the chapter deals with Sm-, Eu-, and Tm-based systems.

The second chapter is concerned with the thermal conductivity of rare earth-containing materials and is the first major review on this topic. The varied response of thermal conductivity to long-range magnetic order, spin-glass behavior, heavy fermions and Kondo lattices, crystalline electric fields, and superconductivity in metallic systems is explored. The thermal conductivity of insulators and semiconductors is also covered.

The third and fourth chapters deal with special classes of materials. The third chapter explains the chemistry, structure, electrical, magnetic and thermal behaviors; spectroscopic properties; and luminescence of pyrochlores. Pyrochlores are a group of ternary oxides that include insulators, semiconductors, and metallic materials. The fourth chapter, nearly half the volume, deals with the crystal structures of about 100 of the approximately 225 known rare earth minerals. The crystal chemistry of these compounds is discussed with emphasis on the differences between the yttrium group and the cerium group, and the isomorphous substitution of rare earth ions by non-rare earth ions. The chapter is well illustrated with drawings of the crystal structures of these minerals.

The final chapter (chapter 109) discusses appearance potential spectroscopy (APS), which measures the probability for electronic excitation of a core level electron as a function of the incident electron energy. APS is a complementary technique to the more common Auger electron spectroscopy and x-ray photoelectron spectroscopy, and yields information on unoccupied states, chemical bonding, near-neighbor configuration in the surface layer, and chemical analysis.

A new feature of volume 16 that has been

Continued in next column ◊

Nd Predicts Volcanic Eruption

An international group of scientists have discovered a link between volcanic eruptions and a Nd isotope. Mt. Unzen, a volcano on Kyushu, Japan, has erupted several times since awakening from dormancy in November, 1990. The eruptions have killed 43 persons and have left nearly 2,300 homeless [*New York Times International*, Thursday, April 29, A9 (1993)].

Mt. Unzen lies about 25 miles east of Nagasaki and is being studied by a group of scientists from Japan, Taiwan, and the United States. After studying lava samples from Mt. Unzen and neighboring volcanoes dating from 275,000 years to the present, they found the presence of two neodymium isotopes, Nd-144 and Nd-143. The samples were taken from both small and large eruptions. These two isotopes were found in all the lava samples, but the rocks that originated in the earth's crust have a higher concentration of Nd-144 while the rocks that originate at deeper depths have a higher concentration of Nd-143. Geologists associate violent volcanic eruptions as originating deeper in the earth's mantle, which underlies the continental and oceanic crusts.

Similar findings have been reported from lava in the United States, but the flows were too old to be used in predicting eruptions. This new evidence may be an important predictive tool for determining future eruptions, potentially saving lives and property. ▲

added to the *Handbook* series is an author index which includes an alphabetical listing of authors that have been referenced throughout the book. Author names are cross-referenced with other authors of the same reference for easy and quick location and identification.

The 589-page volume 16 of the *Handbook on the Physics and Chemistry of Rare Earths* was published in 1993 and can be ordered from Elsevier Science Publishers, P.O. Box 103, 1003 AC Amsterdam, The Netherlands. In the U.S.A. and Canada contact Elsevier Science Publishing Co. Inc., P.O. Box 882, Madison Square Station, New York, NY 10159 USA. The cost of volume 16 is Dfl 495.00 (\$309.00 US), but the Cumulative Index for volumes 1-15 of the *Handbook* series and volume 16 are available for Dfl 500.00 (\$312.50 US). This is a 30% discount of the cost of both books. The cost to receive the *Cumulative Index* alone is Dfl 235.00 (\$147.00 US). ▲

Permanent Magnets - 1993 Update

Did you know that...

Global permanent magnet sales are projected to triple by 2002 to \$7.0 billion US when 85% of the market will be equally shared by two permanent magnet materials, ferrite and rare earth magnets, principally neodymium-iron-boron (NdBF₂)?

Active noise cancellation technology for use at home, in the work place and the automotive industry will be just some of the new markets for rare earth permanent magnets?

China, a major factor within the magnet industry, is rapidly emerging as a significant producer and user of Nd-B-Fe magnets under license from patent holders?

Nd-B-Fe and other rare earth permanent magnets will have a 20% yearly average growth over the next ten years, while the price is expected to decrease by 35% or more by the late 1990's?

The global consolidation trend among producers will accelerate during the next ten years?

Anisotropic bonded rare earth magnets will accelerate the market expansion as major new applications emerge in the appliance and automotive fields?

These facts and many others are presented in the rare earth permanent magnet market study *Permanent Magnets - 1993 Update* by the Permanent Magnet Consultants, Wheeler Associates. Since 1988, the world has changed considerably as increasing economic interdependence and falling barriers created a free flow of information. The countries of eastern Europe are establishing their own free-market systems. These countries need to sell raw materials and finished products as well, while others need to buy end products which use magnets. Japan, China and the Pacific Rim are making new investments and strategic alliances. The Economic Community is eliminating border tariffs and realigning their state-supported industries. Less-developed countries are working hard to gain entry into permanent magnet markets and the U.S.A. is determined to remain a strong force in the permanent magnet market place.

Permanent Magnets - 1993 Update draws its authority from internationally-renowned experts in the permanent magnet field. These experts report on the following topics: Permanent Magnet Industry Structure, leaders, mergers and joint ventures; Producers of Permanent Magnets; Technologies, patent positions, R&D efforts and processes; Raw Materials, sources, availability

Continued in next column ◊

Fluoride Glass/Continued from page 3 ◊

The authors prepared the fluoride glass by heating the component gas sources in stainless steel cylinders with temperatures ranging from 60°C to 180°C, depending on the metal source gas. Argon was used as the carrier gas and supplied to the reactor vessel which was pressurized at 10 Torr and heated to 240°C. The products of the vapor phase reaction were then deposited on the substrate. Condensation of the metal source gases was avoided by heating the paths at a higher temperature than the oven. The resulting amorphous glass particles ranged between 700Å and 1000Å in diameter.

Composition of the glass particles were controlled by changing the carrier gas flow rate of each starting material and the vaporization temperature. The successfully CVD-synthesized ZBLAN glass exhibited good thermal stability and the thermal properties of the glass particles were essentially the same as those of conventional melt-cast glass. This new procedure in preparing fluoride glass could solve the problem of providing long, ultra-low loss optical fibers. ▲

◊ Continued from previous column

and cost trends; Products for Today and Tomorrow; Ten-year status of Nd-B-Fe magnets; Markets/Applications and a look into the future; China and the Asian Rim; C.I.S. and Eastern Europe including an on-site evaluation of raw materials and markets; Design Factors; Magnetizing and Testing; Statistics, projections to 2003, production value by producer and geographic area, by magnet type and market, and; Executive Summary by Mr. Port Wheeler.

This report is one of the most comprehensive reports on rare earth permanent magnets that we have ever seen. It provides the reader with an excellent background on these materials, explains the history, present development, markets, and production of permanent magnets. The report also makes predictions on future developments and the global position of permanent magnets for the next ten years.

Permanent Magnets - 1993 Update was published in 1993, contains over 400 pages and uses tables and graphs where appropriate to show the reader trends and past performance of technical and market information. The book can be ordered from Wheeler Associates, Permanent Magnet Consultants, P.O. Box 825, Elizabethtown, KY, 42701 USA; Tel:502 765 6773; Fax:502 765 2137. Each subscriber receives two copies of the report, sold as a set, for \$4500.00 US. Additional copies are available for \$200.00 US each. ▲

Rare Earths '92 in Kyoto Proceedings

The international conference Rare Earths '92 in Kyoto was held June 1-5, 1992 in Kyoto, Japan to commemorate the 10th anniversary of the founding of the Rare Earth Society of Japan. The conference was represented by more than 530 delegates from 28 countries world-wide. The conference was comprised of plenary and keynote lectures, invited talks, and poster sessions. One hundred seventy five papers out of the more than 350 presented at the conference have been published and appear as a two-volume hardbound set in a special issue of *J. Alloys and Compounds*, 192-3 (1993).

A wide range of topics were covered in the 17 symposia which include: rare earth luminescent materials in the nineties; crystal growth and physical properties; problems of the rare earth industries; separation technology; hydrogen storage materials; catalysts and catalysis; superconductors; new materials and their phenomena; heavy fermions in rare earth compounds; organometallics; magnetism and magnetic materials; and spectroscopy.

Of interest to those in the rare earth industry will be the section entitled: "Problems of the Rare Earth Industries". Three papers take account of the current rare earth industry. "Rare Earth Industry of China", by Z. Chuandian provides general information on the establishment, growth, and maturity of the Chinese RE industry. Many of these same topics are covered in "Rare Earths Industry of Today in the Commonwealth of Independent States" by V.D. Kosynkin et al. "The Rare Earth Industry: A World of Rapid Change" by P. Falconnet, provides an excellent review of rare earth production and consumption figures by region, reserves, and provides projected world-wide demand of total rare earths by geographical area to the year 2000. He states that the volume of non-separated RE's will decline while separated RE's will increase in both volume and profitability. According to the author, separated RE tonnage will double from around 8000 tons in 1990 to 16000 tons in 2000. The largest gains will be in for permanent magnet materials at 16% per year, while gains for phosphors are forecast at 5.8%.

To order both of these hardbound volumes in the U.S. and Canada: Elsevier Science Publishing Co., Journal Information Center, 655 Ave. of the Americas, New York, NY 10010, Tel:212 633 3750; elsewhere: Elsevier Sequoia, P.O. Box 564, CH-1001, Lusanne 1, Switzerland. Cost for both volumes is \$497.00 US. ▲

Minteq International

Minteq International Inc. and Specialty Minerals Inc. were recently formed as wholly-owned subsidiaries of Mineral Technologies Inc. (MTI). Pfizer Inc., an international health care company, sold the assets of its Minerals Division and its Quigley Company subsidiary to MTI November 1, 1992. MTI is a research and technology-based company which provides a wide range of mineral, mineral-based and synthetic mineral products used primarily in the manufacture of paper and steel. The company also offers building materials, ceramics, paints, glass, metal alloys, and rare earths.

Both Minteq International Inc. and Specialty Minerals Inc. maintain their R&D facilities in Easton, Pennsylvania and Minteq International has 15 production facilities world-wide. For more information about the companies, contact: Minteq International Inc., 30 Daisy Hill Road, Canaan, CT 06018; Tel:203 824 5435; Fax:203 824 1079. ▲

Tom Wilson Retires

After 26 years with Molycorp, Senior Vice President Tom Wilson retired at the end of 1992. Tom has been closely involved with the growth of the rare earth business during these years and has seen rare earths become a vital part of our daily lives.

Henry Aldorf has assumed some of Tom's duties as general manager of lanthanide sales and marketing. Mr. Aldorf was previously managing director of Molycorp's Paris office.

Tom will be missed by those who have dealt with him and we wish him well in his retirement. ▲

New Chief Technology Officer

Isaac R. Barpal has been named as the senior vice president for technology at Allied-Signal Inc. As the company's chief technology officer, he will be responsible for Allied-Signal's corporate research and technology organizations in Morristown, NJ; Buffalo, NY; and Des Plaines, IL, and for research and technology efforts throughout the company.

Mr. Barpal assumed his new office with Allied Signal August 1, when Mary L. Good announced her retirement from the company to become the undersecretary of technology in the Commerce Department. Rare Earthers know Ms. Good for her research on the spectroscopy of europium compounds. ▲

RIC recently received a copy of *Cerium: A Guide to its Role in Chemical Technology* written by Barry T. Kilbourn of Molycorp, Inc. The booklet is described in issue number 1 of the company's *Newsletter* (see page 1) in this issue of *RIC News*.

The 51-page booklet includes sections on Resources and Recovery, Chemistry, and Applications of cerium and has a bibliography of ~120 references. The resource and recovery section deals with cerium minerals and their processing in cerium recovery. Also covered are the production of cerium derivatives and the yearly amount of cerium oxide produced. The chemistry section discusses various cerium compounds, electronic structure and valences, steel making and metallic alloys. It also provides information on analysis, environmental behavior, biochemistry, and toxicology of cerium. The use of cerium in metallurgy, glasses, ceramics, lighting devices, and catalysts are covered in the applications section. Also discussed are the chemical reactions of cerium and some of its compounds.

The booklet may be obtained from Molycorp, Incorporated, Sales and Marketing Division, 709 Westchester Avenue, White Plains, NY 10604, U.S.A. ▲

Atomet Inc.

Atomet Inc. has started production for scandium oxide with purities of 99.95% and higher, as well as distilled scandium metal up to 99.999% purity. Other scandium compounds are also available. For more information contact: Atomet Inc., 222 Sherwood Avenue, Farmingdale, NY 11735-1718 USA; Tel:516 694 9000; Fax:516 694 9177; Telex:685 2289. ▲

Russell B. Scott Memorial Award

The Cryogenic Engineering Conference Board established the Russell B. Scott Memorial Award to recognize the best papers published in *Advances in Cryogenic Engineering*. Separate awards are presented for Outstanding Paper in Cryogenic Engineering Research and Outstanding Paper in Application of Cryogenic Engineering.

The Russell B. Scott Memorial Award for the best research paper given at the 1991 Cryogenic Engineering Conference, and published in *Adv. Cryogen. Engin.* 37, 883-90 (1992) was presented to C.B. Zimm, E.M. Ludeman, M.C. Severson, and T.A. Henning of Astronautics Corporation of America for "Materials for Regenerative Magnetic Cooling Spanning 20K to 80K." The award was presented at the Cryogenic Engineering Conference and International Cryogenic Materials Conference held July 12-16, 1993 in Albuquerque, New Mexico.

The paper covers medium to high power cryocoolers based on the active magnetic regenerative concept (AMR), which is under development for hydrogen liquefaction. Refrigeration performance is dependent on the temperature dependence of the adiabatic temperature change upon application of a magnetic field (ΔT_s). The authors report on measurements of ΔT_s and the field dependent heat capacity, of the ferromagnetic materials GdPd, GdNi, GdNi₂, and (Er_{0.86}Gd_{0.14})Al₂. These three binary compounds have sharp ordering transitions encompassing all of the available magnetic entropy, whereas the ternary phase with two magnetic rare earths shows a broadened transition. GdNi₂ and GdPd have properties well suited for use in AMR stages operating from 80K to 40K and 40K to 20K, respectively. ▲

The RIC NEWS

is sent to over 12,000 persons
world-wide. This is made possible
through the financial assistance
of our 138 Supporters.

Is your company or organization one of these Supporters?

If not, perhaps your company or
organization should be.

To help publish and distribute the *RIC News*, contact the Director of RIC, Tel:515 294 2272, Fax:515 294 3709, Telex:283359, E-mail:RIC@ALISUVAX, or write us at our address which appears in the masthead.

Crystal Orientation in High- T_c Superconductors

Researchers at the Superconductivity Industrial Research Laboratory of the International Superconductivity Industrial Technology Research Center, Tokyo, Japan, have announced a first-ever breakthrough in high-temperature superconductors. The new development proves that controlling the crystal orientation of yttrium barium copper oxide (YBCO) high temperature superconductors is feasible (*Japan New Materials Report*, 8, [2], 4-5 (1993)).

Certain superconductor properties in the past have been limited because the crystal orientation of YBCO has been random. Crystal orientation is accomplished by an improved version of the melt-powder-melt-growth (MPMG) technique developed by the laboratory in 1989. It involved processing a YBCO sample at a high temperature, followed by cooling, powdering, forming, heat processing, and crystal growth. To control crystal orientation, different temperature gradients are used from two different directions.

Crystals grown in this way allows electric current and magnetic flux to travel in one direction only. Test results show that these YBCO superconductors have three times the magnetic repulsion of conventionally-produced crystals.

These new crystal-oriented superconductors could improve the performance of superconductive bearings, flywheels, temperature controlled clamps for aircraft production, magnetic shielding, and high power electrical switches. ▲

Workshop and Symposium on Permanent Magnets

The Rare-earth Information Center (RIC) is proud to announce the availability of the proceedings of both the *Twelfth International Workshop on Rare Earth Magnets and their Applications*, and the *Seventh International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth Transition Metal Alloys*, which were held in Canberra, ACT, Australia, in July 1992. Because of a limited first printing of these two proceedings, RIC obtained permission from the Workshop/Symposium (Conference) Organizers to reprint a limited number of copies of each for distribution to persons (organizations) who were unable to attend the Workshop and/or Symposium. The reprinted edition is identical to the original edition, except that a slightly heavier grade of paper was used in the second printing. The proceedings are beautifully bound in two volumes with a full color reproduction of a Kerr domain pattern of a highly aligned $\text{Pr}_{15}\text{Fe}_{77}\text{B}_8$ sample for the cover of both volumes.

The Conference, which was supported by the Australian Department of Industry, Technology and Commerce, was dedicated to the memory of Karl Strat. The memorial address was delivered by Marlin Walmer. The Organizing Committee recommended that future Workshops include an Invited Memorial Lecture. The Conference was attended by 135 persons from 22 countries. Over 120 papers were delivered and are presented in the Workshop (74) and Symposium (50) proceedings. Most interest centered on: mechanical alloying and processing; hydride-decryption (HD) and hydrogenation-disproportionation-desorption-recombination (HDDR) processing for both magnet production and powder production for polymer bonded magnets; the 2-17 nitride magnet materials; the $\text{Nd}(\text{Fe}_{1-x}\text{M}_x)_{12}$ materials with the ThMn_{12} structure doped with nitrogen or carbon. The cost of the two-volume set is \$150.00 US, or \$75.00 US for either volume alone. These costs include mailing in the USA at the "Library Materials" rate (delivery time: one to two weeks), or surface book rate elsewhere (delivery time: four weeks to four months). If faster delivery times are desired, use the following rates (the number in parenthesis is the cost for one volume):

Canada (first class)	\$15.00 (9.00)
Europe (airmail)	40.00 (25.00)
Australia and Japan (airmail)	55.00 (35.00)
South America (airmail)	25.00 (15.00)

Continued in next column ⇨

#3 Diesel Fuel?

The results of a two-year study conducted by the East China Technical Institute show that a new rare earth dopant in diesel fuel increases fuel economy and decreases emissions (*China Rare Earth Information*, [28] 3-4, February, 1993).

The RE dopant is prepared by adding certain rare earth organic compounds to the base fuel in amounts depending on combustion stoichiometry. The addition of the dopant reportedly increases fuel economy 4-5% while reducing particulate emissions by 20%. ▲

Plasma Sprayed Ytria Coatings

Because of their thermal and mechanical properties, ceramics are excellent choices for providing protection to engine and structural components from high temperatures and severe stresses. These materials are also used to prevent structural components from corrosion under various operating and environmental conditions.

A paper that appeared in *Mat. Res. Bull.*, 28, 415-25 (1993) discusses the metastable phases in yttrium oxide plasma spray deposits and their effect on coating properties. V. Gourlaouen et al. describe how plasma sprayed yttria sometimes yields structural types other than those found in the equilibrium diagrams. For example, the demanding conditions of this technique produces a minor B phase in the neighborhood of the major C form. ▲

⇨ Continued from previous column

To order send a check (payable to the RIC Newsletter Fund) or purchase order for the appropriate amount, including the extra shipping costs if rapid delivery is desired. The check should be made payable through a US bank in dollars; otherwise add an additional \$25.00 (our bank processing cost). Please state whether you are ordering the complete two-volume set, or which one of the two individual volumes: the *Workshop* or the *Symposium*. The check or purchase order should be sent to the Rare-earth Information Center, Institute for Physical Research and Technology, Iowa State University, Ames, IA 50011-3020, USA (Phone: 515-294-2272; Fax: 515-294-3709).

RIC gratefully acknowledges Dr. John Cook, Division of Applied Physics, CSIRO, Lindfield, NSW, Australia, for supplying some of the information used in the above news item. ▲

RIC News	
Vol. XXVIII, No. 3	September 1, 1993
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	
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 Telephone: (515)294-2272 Telex: 283359 Facsimile: (515)294-3709 BITNET: RIC@ALISUVAX	
K. A. Gschneidner, Jr.	Editor
Joel Calhoun	Staff Writer
Jennings Capellen	Staff Writer

Fourth Quarter 1993 Supporters

The Following companies provided financial support to the Center in the fourth quarter, 1993. We wish to acknowledge these companies for supporting us in 1993. They are grouped according to their appropriate category with the number of years they have supported us in parentheses.

Patron (\$1000 to \$1999)

Mitsubishi Materials Corp., Japan (9)
United Technologies Research Center, U.S.A. (8)

Sustaining (\$400 to \$999)

Aldrich Chemical Co., Inc., U.S.A. (13)
Eastman Kodak Co., U.S.A. (16)

Subscriber (less than \$400)

CRE Products Inc., U.S.A. (2)

Single-Crystal Lanthanum Encapsulated by Carbon

R. Ruoff et al. of the Molecular Physics Laboratory of SRI International, Menlo Park, California, report that they have prepared a new class of materials [*Science*, 259, [1], 346-8 (1993)]. The authors used a carbon arc to synthesize single-domain microcrystals of lanthanum dicarbide encapsulated within nanoscale polyhedral carbon particles. The particle sizes of the material range from 20 to 40 nanometers (nm).

Subsequent analysis of the new substance by high-resolution transmission electron microscopy and energy dispersive spectroscopy (EDS), revealed that La and carbon were the only two elements present in the compound. EDS analysis showed regular sets of lattice fringes, which indicates that a single crystal of LaC₂ is present, while no evidence of amorphous compounds were found.

The crystal boundaries of the La are shown to conform to the carbon shell walls, which suggests that the crystal is completely encapsulated by polyhedral carbon. Characteristic interatomic distances of 3.39 and 2.78 angstroms identify the compound inside the nanoparticle cavities as α -LaC₂, which is stable at room temperature. Bulk α -LaC₂ is metallic, and decomposes to form acetylene and other hydrocarbons plus La₂O₃ when exposed to H₂O.

After preparation of pure encapsulated particles, the samples were exposed to air for several days which showed no evidence of degradation. This suggests that their stability is due to the presence of carbon polyhedral shells. ▲

Supporters 1994

Since the June issue of the RIC News went to press, RIC has received support from four new family members, and renewed support from 26 other organizations. The supporters from the first quarter of fiscal year 1994 who wish to be listed, grouped according to their appropriate category, and with the number of years that they have contributed to the Center in parentheses, are listed below.

Benefactor (\$10,000 or more)

Rhône-Poulenc Chimie Minerale Fine, France (24)

Donor (\$4000 to \$9999)

Sponsor (\$2000 to \$3999)

CERAC, Inc., U.S.A. (18)
Mitsubishi Kasei Corp., Japan (20)
Shin-Etsu Chemical Co., Ltd., Japan (24)

Patron (\$1000 to \$1999)

Davison Chemical Division of W. R. Grace & Co., U.S.A. (26)
Rhône-Poulenc Basic Chemicals Co., U.S.A. (14)

The Society of Non-Traditional Technology, Japan (5)

Sustaining (\$400 to \$999)

Ashton Rare Earths Ltd., Western Australia (4)
Astronautics Corp. of America, U.S.A. (8)

Eastport International

Eastport International, of Annapolis, Maryland, has signed an agreement in Moscow to represent Redmetservis Co., Ltd., in the U.S.A. Redmetservis is a private company that includes 22 enterprises and 3 scientific research institutes in Russia, Ukraine, Kazakhstan, Kyrgystan and

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

A/T Products Corp., U.S.A. (14)
Atlantic Metals and Alloys Inc., U.S.A. (5)
Dexter Magnetic Materials Division, U.S.A. (8)
Edge Technologies, Inc., U.S.A. (5)
Ferro Corp., U.S.A. (18)
GFS Chemicals, Inc., U.S.A. (1)
Institute for Integrated Energy Systems, University of Victoria, Canada (2)
Johnson Matthey-ALFA/AESAR, U.S.A. (6)
Kilborn, Inc., Canada (4)
Korea Institute of Geology, Mining & Materials, South Korea (6)
Martin Marietta Energy Systems Inc., U.S.A. (6)
Materials Research Corp., U.S.A. (5)
Meldform Metals Ltd., England (4)
Nippon Yttrium Co., Ltd., Japan (15)
North-Holland Physics Publishing (a Department of Elsevier Science Publishers), The Netherlands (6)
NUCLEMON-Nuclebrás de Monazite Associados, Ltd., Brazil (20)
USR Optonix Inc., U.S.A. (23)
Subscriber (less than \$400)
Duracell Inc., U.S.A. (1)
Eastport International, Inc., U.S.A. (1)
SG Magnets Ltd., England (4)
Sumikin Molycorp, Inc., Japan (1)
Level of Support Not Disclosed
Department of Industry, Technology and Regional Development, Australia (6)

Tadjikistan. The company offers rare earth oxides, fluorides and chlorides for export to countries outside the former U.S.S.R.

To receive a complete information package of the company's products and services, contact: Mr. Paul Stiles, Eastport International, 612 Third Street, Annapolis, MD 21403 USA; Tel/Fax: 410 268 7678/7680. ▲