Rare-earth Information Center NEWS

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

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Permanent Magnets Market Survey

In October 1992, Business Communications Company (BCC) released a 215 page business opportunity report entitled *"Permanent Magnets: Types, Processing, Applications, Intermaterial Competition, and Markets"* **(GB-149A)**. The Project Analyst for the report was Dr. Thomas Abraham.

BCC predicts a 1992 United States market for permanent magnets of $455 million and a 1997 market of $763 million, reflecting a 10.9 percent annual growth.

Metallic magnets are forecast to grow at an annual rate of 10.6 percent; from $178 million in 1992 to $294.7 million in 1997. Within this segment of the market, the rare earth-cobalt magnet market will likely decline while the neodymium-iron-boron type magnets will increase their market at a 17.5 percent annual growth rate.

As listed in the Introduction, the report was prepared with the following objectives in mind: To provide an overview of the various permanent magnets, their production technologies and applications; To identify the technological and business issues related to the commercial production of permanent magnets; To understand the inter-material competition among the various permanent magnets; To analyze the domestic and foreign competition among companies within each of the permanent magnet market segments; To determine the current size and future growth of the U.S. markets for permanent magnets; To identify and profile all U.S. producers and suppliers of permanent magnets; and To identify the foreign producers of permanent magnets.

This report reviews the technology of permanent magnet materials, the U.S. companies who manufacture them, the types of permanent magnet materials, their applications, and current and anticipated demand for specific materials. For each segment of the market, the report provides an analysis of material and product types, processing

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technologies, properties, applications, new developments and patents, the U.S. markets, and foreign competition. A handy feature of the report is the appendices which include lists of manufacturers and consumers of rare earth permanent magnets and magnetic materials world-wide.

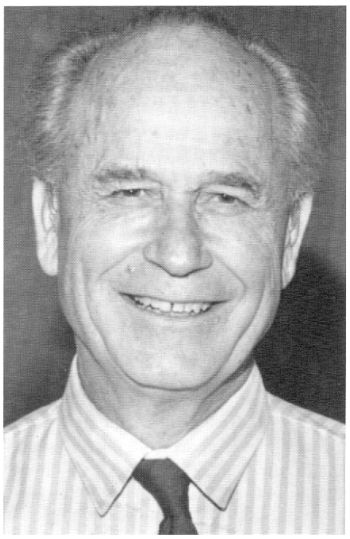
This report is well organized and appears to be one of the best we have seen in recent years. The cost of the report is $2,475.00 US. To order a copy of the report, or to obtain more information, contact Dr. Thomas Abraham, Director of Ceramics, Business Communications Company, Inc., 25 Van Zant Street, Suite 13, Norwalk, CT 06855-1781, U.S.A. Telephone (203) 853-4266. FAX (203) 853-0348. ▲

Sc_2O_3 Increases Optical Damage Resistance in $LiNbO_3$

$LiNbO_3$ is an important optical material with uses in parametric oscillators, waveguides, and optical switches. The disadvantage of this material however, is its low resistance to damage when exposed to high intensity light such as lasers. When MgO is added to $LiNbO_3$ at a concentration of 5 mol%, damage resistance increases, but growing high-quality single crystals which are free of subgrain boundaries and compositional inhomogeneities, is difficult.

J.K. Yamamoto, K. Kitamura, N. Iyi, S. Kimura, Y. Furukawa and M. Sato have discovered that the addition of 1 mol% Sc_2O_3 increases optical damage resistance as well as the 5% MgO addition {*Appl. Phys. Lett.*, **61**, 2156 (1992)}. The authors were successful in decreasing the birefringence of Sc_2O_3-doped $LiNbO_3$ by two and one-half to four times as compared to the undoped crystal. In addition, since Sc_2O_3:$LiNbO_3$ has a dopant level of 1 mol% compared to 5 mol% for MgO, the growth of high-quality single crystals may be feasible. The authors believe this is the first time a trivalent dopant (Sc^{3+}) has increased the optical damage resistance level to laser radiation in $LiNbO_3$. ▲

Spedding Award Winner



Dr. LeRoy Eyring, Regents' Professor Emeritus of the Department of Chemistry and Biochemistry of Arizona State University has been selected as the recipient of the seventh Frank H. Spedding Award. The award, sponsored by Rhône-Poulenc, will be presented at the 20th Rare Earth Research Conference being held September 12-17, 1993 in Monterey, California, USA. He was nominated for "a highly productive and effective lifetime of research on the thermodynamics and structures of rare-earth oxides and associated phases, illuminating our understanding of the defect solid state".

LeRoy Eyring was born December 26, 1919 in Pima, Arizona. He received his B.S., with "high distinction", from the University of Arizona in 1943. He served in the Navy from 1944-1946 and earned his Ph.D. from the University of California, Berkeley in 1949. He was an assistant and associate professor at the University of Iowa from

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20th Rare Earth Research Conference

The 20th Rare Earth Research Conference will be held at the Monterey Convention Center in Monterey, California, U.S.A., September 12-17, 1993 and will focus on recent developments of the *f*-elements.

The scientific program consists of eight symposia, poster sessions, and the Spedding Award Lecture. The Symposia topics and the organizers are: "Comparative Aspects of Lanthanide and Actinide Behavior", J.R. Peterson; "Synthesis and Properties of Light Metal Glasses Utilizing the Rare Earths", J. Poon; "New Developments in Industrial Applications of Rare Earths", B.T. Kilbourn; "Lanthanides in Biochemistry and Medical Diagnostics", W. DeW. Horrocks; "Characterization of Rare Earth Energy Level Structures in Optically Opaque Materials", L. Soderholm; "Molecular Lanthanide Chemistry in the Development of New Materials and Reaction Catalysts", W.J. Evans; "Recent Developments in the Magnetic Properties in Rare-Earth-Based Materials", L.E. DeLong; and "Optical Spectroscopic Probes of Electronic Excited-State Structure and Dynamics in Lanthanide Systems", M.F. Reid.

To receive additional information, contact: Dr. Herbert B. Silber, 20th Rare Earth Research Conference, Chemistry Department, San Jose State University, San Jose, CA 95192 USA; Tel:(408)924-4954 or (510)486-4640; Fax:(408)924-4945. ▲

International Conference

The Eleventh International Conference on Solid Compounds of Transition Elements (SCTE-11) is scheduled to be held at the W. Trzebiatowski Institute of Low Temperature and Structure Research in Wroclaw, Poland, July 5-8, 1994.

The Conference will provide a forum for solid state physicists and materials scientists to present and discuss new work on binary and ternary transition *d*- and *f*-electron element compounds. The emphasis will be on hydrides, borides, carbides, silicides, pnictides, chalcogenides and intermetallic phases. The preparation of these solids, their structure and physical properties, as well as theoretical aspects such as chemical bonding and crystal field effects will also be covered.

For a copy of the first circular for SCTE-

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Conference Calendar

*** A NEWS STORY THIS ISSUE**

July '93
MAG'93 International Conference and Exhibition, Alexandria, Virginia, USA
July 29-30, 1993
RIC News, XXVIII, [1] 2 (1993)

August '93
International Conference on Luminescence and Optical Spectroscopy of Condensed Matter (ICL'93)
Storrs, Connecticut, USA
August 9-13, 1993
RIC News, XXVIII, [1] 2 (1993)

International Conference on Strongly Correlated Electron Systems (SCES'93)
San Diego, California, USA
August 16-19, 1993
RIC News, XXVIII, [1] 2 (1993)

European Magnetic Materials & Applications Conference (EMMA'93)
Kocise, Czecho-Slovakia
August 24-7, 1993
RIC News, XXVII, [3] 2 (1992)

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)
*This issue

Actinides '93
Santa Fe, New Mexico, USA
September 19-24, 1993
RIC News, XXVI, [3] 2 (1991)

June '94
International Conference on Nitromagnetics
Honolulu, Hawaii, USA
June 15-17, 1994
*This issue

July '94
Eleventh International Conference on Solid Compounds of Transition Elements (SCTE-11)
Wroclaw, Poland
July 5-8, 1994
*This issue

New Address

The offices of Advanced Material Resources, Inc., formerly Sino Asia Rare Earth Inc., have moved from San Francisco, California, to Milford, New Hampshire. The company offers a full line of rare earth metals, oxides, fluorides, concentrates, other rare earth compounds, and mischmetal. They can be reached at P.O. Box 301, Milford, NH 03055 USA; Tel:800 265 3302; Fax:603 673 7271. They maintain a field office on the west coast at 4204 Wakebridge Drive, Riverside, CA 92505 USA. ▲

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11, or for more information on the Conference, contact: Professor Wojciech Suski, Eleventh International Conference on Solid Compounds of Transition Elements, Polish Academy of Sciences, W. Trzebiatowski Institute of Low Temperature and Structure Research, P.O. Box 937, 50-950 Wroclaw 2, Poland; Tel:48 71 35021; Fax:48 71 441029; Telex:0712777 int pl. ▲

ICN '94

The International Conference on Nitromagnetics (ICN '94), will be held June 15-17, 1994 at the Tokai University Pacific Center (TUPC), Honolulu, Hawaii, USA. The conference will provide an international forum for researchers who are involved in research and development of hard and soft magnetic materials interstitially modified by nitrogen.

The topics will cover any and all aspects of nitromagnetics; materials preparation, characterization, processing and fabrication technologies, analysis and modelling of nitrogen-modified rare earth intermetallics: $R_2Fe_{17}N_x$, $R(Fe\text{-}T)_{12}N_x$ etc., and nitrogen modified iron or cobalt thin films $Fe_{16}N_2$, Fe-T-N, Co-T-N, etc. (T=transition metal).

To receive the first and future circulars, or more information, contact: the Secretariat of ICN'94, Mr. Tsunehisa Kurino, The Society of Non-Traditional Technology, 1-2-8, Minato-ku, Tokyo 105, Japan, Tel:81 3 3503 4681; Fax:81 3 3597 0535. ▲

Handbook Index

Since the first volume of the *Handbook on the Physics and Chemistry of Rare Earths* was published in 1978, 15 other volumes have been published. The first 15 volumes contain 104 chapters on various aspects of rare earths, their alloys and compounds. Some of the topics of technological importance include the excellent permanent magnet properties of the Nd-Fe-B alloys, the magneto-optical behavior of Co(or Fe)-Gd(or Tb) amorphous thin films, and the existence of superconductivity at temperatures well above liquid nitrogen (77 K) in $YBa_2Cu_3O_{7-x}$.

In order to increase the usefulness of the fifteen volumes, publication of comprehensive subject and author indexes were considered to be a valuable addition to this popular series. After four years in the making, the Cumulative Index of Volumes 1-15 of the *Handbook on the Physics and Chemistry of Rare Earths* was published in 1993 and is now available.

A unique aspect of this index volume are 11 tables of most of the physical properties of the rare earth metals. The index also includes an errata listing all corrections of mistakes discovered while compiling this index, and those errors are pointed out by authors, editors and users of the *Handbook*.

The 521-page Cumulative Index to the *Handbook on the Physics and Chemistry of Rare Earths* can be ordered for Dfl.235.00 ($147.00 US)[but see below] from K. van der Harst, Elsevier Science Publishers, P.O. Box 103, 1000 AC Amsterdam, The Netherlands. In the U.S.A. and Canada contact Judy Weislogel, Elsevier Science Publishing Co. Inc., P.O. Box 882, Madison Square Station, New York, NY 10159 USA.

The publishers are offering a 30% discount if the *Cumulative Index* volume is purchased together with volume 16 of the *Handbook on the Physics and Chemistry of Rare Earths* which is expected to be published within the next month, and is scheduled to be reviewed in the September 1, 1993 issue of the *RIC News*. Volume 16 by itself costs for Dfl 495.00 ($309.50 US), but the publishers are offering both the *Cumulative Index* and Volume 16 for Dfl 500.00 ($312.50 US). ▲

Th. Goldschmidt AG

As of January 1, 1993, the metallurgical operations of Th. Goldschmidt AG were merged with those of Elektro-Thermit GmbH, a subsidiary of Goldschmidt. All rare earth permanent magnet alloy produc-

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Yttrium Structural Alloys

Researchers at Ames Laboratory have produced a new family of yttrium-based and high yttrium content structural alloys which contain up to 90% Y. These materials use deformation processing technology to produce a metal matrix composite material. Precursor alloy billets are deformation processed to produce long metal reinforcing fibers within a continuous metal matrix of yttrium. During processing, the matrix phase and the reinforcing are co-deformed, forming the composite in-situ.

Development is currently being carried out on yttrium-titanium and yttrium-refractory metal alloys, such as niobium, tantalum, molybdenum, chromium, vanadium and tungsten. These alloys may have applications in aerospace and other markets where the low density and relatively high melting point are of great interest. Future work will extend into other rare earth metal systems including scandium to produce analogous structural alloys based on those materials. Preliminary results of this work are presented by A.M. Russell et.al. in the yet-to-be-published *Proceedings of the Seventh World Conference on Titanium* which was held July 7, 1992 in San Diego, California. The process has been granted United States Patent #5,200,004 (1993).

For additional information concerning this and other research with rare earth alloys, contact: Timothy W. Ellis, Materials Preparation Center, 242 Spedding, Iowa State University, Ames, IA 50011-3020; Tel:515 294 1366; Fax:515 294 3709. ▲

Such a Deal

A supplier of rare earth metals and compounds has decided to discontinue their rare earth business and is offering their remaining inventory for quick liquidation:

- 50 kg of Y_2O_3, may be 99.99%, $500 US.
- 30 kg of fluorescent grade Eu_2O_3, 99.99%, $20,000 US.
- 1000 kg of lanthanum metal, 99%, $15,000 US.

The best offer made will be considered.

All materials are in original packing and are of Chinese origin. Producer specification sheets are available for all above materials except for the Y_2O_3. Special price structures exist for the purchase of all above listed items sold together. Since the company offering these materials wishes to remain anonymous, interested persons may contact RIC directly at Tel:515 294 2272; Fax:515 294 3709, or by writing to us at the return address given on page 8. ▲

Spedding Award/*Continued from page 1* ➪

1949-1961. He spent 1958 in Europe as a National Science Foundation (NSF) postdoctoral fellow and 1959-1961 in Australia on a Guggenheim Fellowship and a Fulbright-Hays award. After these two "Lehr-und Wanderjahre", he returned to his native state in 1961 as Professor and Chairman of the Chemistry Department of Arizona State University at Tempe. He served as Head until 1969 and Professor until 1990. LeRoy was named Regents' Professor of Chemistry in 1988 and Regents' Professor Emeritus in 1990. He served as the main force of the NSF supported effort to develop an area Solid State Science Center from 1969-1972 and Director of the established Center from 1974-1976.

Volume 156 of the *Journal of the Less-Common Metals*, published in December of 1989, was dedicated to him on the occasion of his 70th birthday. The Eyring Lectures in Chemistry were established in his honor at Tempe in 1988. LeRoy was active as an invited and/or plenary lecturer at many conferences and educational institutions, including the Frank H. Spedding Lecture at Iowa State University in May of 1993.

Dr. Eyring played a major role in development of the concept that, what had been considered non-stoichiometric oxide phase of continuously varying composition is really closely spaced sequences of ordered stoichiometric phases. He was especially active in studying the oxide phases of praesodymium and terbium, but he also studied the other rare earths, the actinides, and other elements. In addition to his oxide investigations, he also worked with chlorides, oxynitrides, carbonates, sulfides, borides, and fluoride bronzes. Since 1970, he has become one of the most knowledgeable and proficient users of high resolution electron spectroscopy for direct visualization of the atom arrangements in solids.

His first paper was published in 1949 and 44 years later his name is still appearing as an author on scientific papers (175 papers and book chapters as of early this year). He is also editor or co-editor of 10 books and has served as co-editor, along with Karl Gschneidner, Jr., of the 18 volumes of the *Handbook on the Physics and Chemistry of Rare Earths*, either published or in press.

As one supporting letter stated, "I was pleased to hear that LeRoy Eyring is being nominated for the award, for he is surely 'Mr. Rare Earth Oxides', and has been for about 45 years". The staff at the Rare-earth Information Center readily agrees and extends our congratulations. ▲

IEEE Awards

The IEEE Morris N. Leibmann Memorial Award was presented to three IBM researchers; Dr. Praveen Chaudhari, Dr. Jerome J. Cuomo and Richard J. Gambino. The three scientists were cited "For the discovery of amorphous magnetic films used in magneto-optic storage systems."

Dr. Chaudhari joined IBM in 1966, and has since carried out research while holding various management responsibilities in science and such related technologies as; optical storage, magnetic bubbles, and the Josephson program. He was appointed director in 1981 and Vice President of the Science Department in 1982. In 1989, he became a member of the Corporate Technical Committee and in 1990, returned to the Research Division as a research staff member. Dr. Chaudhari has worked on the structure and properties of amorphous solids, quantum transport in disordered systems, mechanical properties of thin films, defects in solids, superconductivity, and on magnetic monopole and neutrino mass experiments. He has published over 100 papers, edited two books and holds over a dozen patents.

Dr. Cuomo worked as a research staff member for IBM from 1963 to 1983, where he developed a Materials Processing Service Laboratory. He has made important contributions to the development of lanthanum-boron electron emitters and silicon nitride dielectric layers. Dr. Cuomo has pioneered work in selective chemical vapor deposition, dendritic solar thermal absorbers, sputtered amorphous silicon, amorphous magnetic materials with uniaxial anisotropy for bubble domain and magneto-optic applications, and ion beam modification and synthesis of materials. He also invented and produced single crystal Josephson tunneling junctions out of Nb and NbN. Since 1983, he has managed the Materials Laboratories Advanced Materials Processing area with research projects in enhanced plasma processes, laser deposition and cathodic arc processes. He is co-editor of three books, and author or co-author of 8 other chapters, 165 refereed journal articles, and 70 patents.

Richard J. Gambino joined IBM in 1961 and has conducted research on the magnetic properties of rare earth alloys and intermetallic compounds, as well as on thin film materials for magnetic bubble devices and magneto-optic storage applications. He is one of the discoverers of perpendicular magnetic anisotropy in rare earth-transition

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Molecular Switch

Researchers at the University of Texas, Austin, report the discovery that the electrical current carried by a thin-film superconductor with zero resistance can be controlled by altering the oxidation state of an organic polymer film that is in contact with the superconductor. This effect forms the basis of a new type of molecular switch for controlling superconductivity. When normal metals are placed in contact with a superconductor, the metal's electrons spill onto the superconductor, diluting the paired electrons (Cooper pairs) that carry the supercurrent, resulting in power loss.

J.T. McDevitt, S.G. Haupt, D.R. Riley, C.T. Jones and J. Zhou have acheived this same effect with a synthetic polymer known as polypyrrole {*J. Amer. Chem. Soc.*, **115**, 1196 (1993)}. This polymer, a synthetic metal, can be switched between insulating and conducting states, allowing the superconductor to be turned on or off when the two are bonded.

The simple device is described as consisting of a narrow, thin-film strip of $YBA_2Cu_3O_{7-x}$ which is part of a superconducting circuit. The strip, or microbridge, is coated with polypyrrole and does not effect the superconductor when it is in the neutral, or insulating state. Since the film's T_c is 82 K, the film is superconducting at the operating temperature of 77 K, and the switch is "on". When the polypyrrole is oxidized to its conductive "metallic" form, this lowers the superconductive film's T_c to 67 K. Since this temperature is below the ambient temperature of 77 K, the microbridge cannot superconduct, and the switch is "off". The oxidation state of the polymer is altered by electrochemical doping.

Professor McDevitt points out that this discovery is important because it is the first time that normal electrons from a molecular material have been shown to interact strongly with superconducting (paired) electrons. He believes that the ability of YBa_2CuO_{7-x} to carry a supercurrent is weakened by the leakage of the polymer's electrons into the superconductor's paired electrons. This "proximity effect" works both ways: The superconductor's electron pairs can also be transferred onto the doped polymer. This opens up the possibility that perhaps this reverse flow of electrons could induce superconductivity in the polymer, though no definite results have been confirmed. ▲

New Rare Earth Separation Process

United States Patent 5,045,289 was granted in September, 1991, to Research Corporation Technologies for a process that uses supercritical CO_2 in rare earth separation. The new process is claimed to be safe, economical, and more efficient than conventional techniques such as leaching. A description of the process also appeared as "Synthesis of Lanthanide Carbonates" in *J. Less Comm. Metals*, **167**, 223-32 (1991). The work was conducted and reported by Q. Fernando, N. Yanagihara, J.T. Dyke and K. Vemulapalli.

The process starts with an aqueous suspension of material containing rare earth oxides, which is then mixed with supercritical CO_2. Lanthanides in the +III oxidation state then react with the carbon dioxide, whereas +IV lanthanides do not. The process achieves yields of 95% of the normal carbonates, rather than the hydroxy carbonates, after one hour at 40°C and 100 atmospheres. The rare earth carbonates are then separated in dilute acid. Thorium dioxide, zirconium dioxide and cerium dioxide either did not react, or gave low yields under these conditions. This is an advantage because the thorium disposal problem would virtually be eliminated.

Supercritical CO_2 processing could also eliminate the costly and hazardous steps of acid leaching, caustic leaching and/or solvent extraction. There is no need for corrosive processing materials such as concentrated hydrochloric acid and sodium hydroxide.

The authors claim that operating costs would decrease because of the system's simplicity. The energy requirements are primarily for pressurizing CO_2 and preheating it to slightly above room temperature. Equipment costs are decreased and yields increased by using the reactor vessel for multiple passes with each batch of raw material because the reactor is simply recharged with CO_2 and pressurized.

Supercritical fluid processing is not widely used for the separation of metals, but it is a well established technology in food processing applications such as decaffeination of coffee and the extraction of hops.

For more information contact: Jeffrey Jacobs at Research Corporation Technologies, 6840 East Broadway Blvd., Tucson, AZ 85710-2815; Tel:602 296 6400; Fax:602 296 8157. ▲

Layered Superconductors

Volume 275 of Symposium Proceedings of the Materials Research Society (MRS) is entitled *"Layered Superconductors: Fabrication, Properties, and Applications"*. Included are 141 papers presented at a MRS symposium held in San Francisco, California from April 27 to May 1, 1992.

Part one of the book addresses the fundamentals of superconductors and superconductivity including thermoelectric, thermomagnetic effects and oxygen deficiencies in YBCO (Y-Ba-Cu-O) high temperature superconductors. Parts two and three describes the procedure for preparing superconductors layer-by-layer, including characterization of these films. Parts 4 and 5 include vortex dynamics and flux pinning, microstructures, growth kinetics and critical currents. There are 74 papers which contain information on fabrication and properties of superconductors, and their applications. Some of these applications include superconducting switches and electronic capacitors. A separate chapter deals with bulk processing and properties. Most of the papers in this volume deal with the properties and applications of YBCO superconductors and multilayers. The effects of atomic-scale and bulk layering on superconducting and normal states are emphasized. One hundred and six of the papers deal with superconductors and/or substrates that contain rare earths. Many of the papers include micrographs and photographs of the fabricated materials in their final form.

The proceedings, published in 1992, contain 929 pages and were edited by D.T. Shaw, C.C. Tsuei, T.R. Schneider, and Y. Shiohara. They are available in hardcover or as microfiche for $57.00 US (MRS members), $66.00 US (U.S. nonmembers), and $74.00 US (Foreign nonmembers) from Materials Research Society, Publications Department, 9800 McKnight Road, Pittsburgh, PA 15237, U.S.A. Tel:412 367 3012: FAX:412 367 4373. ▲

IEEE Awards/*Continued from page 4* ⇨

metal amorphous alloy films. In 1976, he showed that amorphous alloys of gadolinium have spin glass properties because of their disordered structure. In the 1980's, Gambino showed that the light rare earths have much larger magneto-optic effects than the heavy rare earths at shorter wavelengths, an advantage for high density storage.

We congratulate all three of these rare earth scientists on their awards and outstanding accomplishments. ▲

Hydrogen in Intermetallic Compounds II

Hydrogen in Intermetallic Compounds II. Surface and Dynamic Properties, Applications, Volume 67 of Topics in Applied Physics, was published by Springer-Verlag in 1992. The 328-page book contains 7 chapters on the properties and applications of metal hydride intermetallic compounds.

The introductory chapter will enable non-specialists to gain an overall picture of the field and to appreciate the relevant scientific issues of rare earths, and other metal hydrides. Other chapters cover: Surface Properties and Activation; Dynamics of Hydrogen in Intermetallic Hydrides; Hydride Formation and Decomposition Kinetics; Applications; The Perturbed Angular Correlation Method and Its Application to Hydrogen in Metals; and, Experimental Techniques II: Application of New Techniques to Study Surface and Bulk Properties of H-Metal Systems.

Chapter six is of special interest. Entitled "Applications", by G. Sandrock, S. Suda, and L. Schlapbach, it provides a comprehensive review of actual and potential applications of intermetallic hydrides included $LaNi_5H_6$. Not only are the history and basics of hydrogen storage presented, but also how the transportation, and other industries are looking into these materials as alternate-energy sources. It is also interesting to see how these materials can be used for environmentally clean power generation, heat storage and refrigeration for domestic use.

This excellent review of these important materials is complete with 126 figures, 25 tables, and 1,464 references. *Hydrogen in Intermetallic Compounds II* is edited by L. Schlapbach and is available for DM 148.00 (~$95.00 US) from Springer-Verlag, Heidelberger Platz 3, W-1000 Berlin 33, Germany. ▲

Custom Re Salts and Solutions

GFS Chemicals, Inc., is expanding its line of products to include "made to order" rare earth salts and solutions. The company can offer almost any rare earth element in a single or mixed salt, or solution form. Custom products can be produced in large volumes using their state-of-the-art facility.

To place an order, or for more information contact: Mr. McBride, GFS Chemicals, Inc., P.O. Box 245, Powell, OH 43065 USA; Tel:800 858 9682 (outside the USA:614 881 5501); Fax:614 881 5989; Telex:981282 GFS CHEM UD. ▲

Mineral Commodities by Fax

The United States Bureau of Mines (U.S.B.M.) has initiated a new service that enables users of their annual *Mineral Commodity Summary* to receive this information by fax. Current information on mineral and mineral-related publications, including metals prices, is available 24 hours a day, 7 days a week through the MINES FaxBack system. This new system allows callers to retrieve information and order publications for delivery to their fax machines in minutes. This way, U.S.B.M.'s monthly and quarterly *Mineral Industry Survey* publications on mineral commodities are made available to the public as soon as they are released and sent to the printer, two to three weeks earlier than usual.

MINES FaxBack works from any Group III-compatible fax machine equipped with a touch-tone telephone. To use the system, the caller simply calls MINES FaxBack and follows a series of voice messages that assist the caller in ordering the desired documents. A catalog is available from MINES FaxBack which lists all available publications.

For information on how to use the system, contact: David Barma, U.S. Bureau of Mines, Office of Public Information, 810 7th Street, NW., Washington, DC 20241-0002 USA; Tel:202 501 9649. ▲

Pacific Industrial Development Corp.

A worldwide producer and manufacturer of rare earth products with roots in the People's Republic of China is now offering services in North America. Pacific Industrial Development Corporation (P.I.D.C) offers high purity rare earth oxides, metals and phosphor-grade material.

For further information on the company, or to receive a free sample of their high-purity rare earth oxides, contact: Mr. Wei Wu, V.P. North American Operations, P.I.D.C., P.O. Box 448, Ypsilanti, MI 48197, USA, Tel:313 434 6456; Fax:313 434 4763. ▲

Rare and Earthly Goof

On page 8 of the March 1, 1993 issue of the *RIC News*, we reviewed an article entitled "Quasi-particles in Heavy Fermion Systems" by G. Zwicknagl, and in the story referred to the author as "he". Our apologies go out to Dr. Gertrud Zwicknagl for this error, and also for any inconvenience this may have caused her, or our readers. ▲

Specific Heat of high-Tc Superconductors

"The Specific Heat of High-T_c Superconductors" by N.E. Phillips, R.A. Fisher and J.E. Gordon [*Prog. Low Temp. Phys.*, **13**, 267-~350 (1991)]. The review provides a comprehensive bibliography, as well as tables, graphs and figures, on the specific heat of conventional, and high-T_c YBCO superconductors. Included in the review is information on the compounds $YBa_2Cu_3O_7$ (YBCO), $TmBa_2Cu_3O_7$, $La_{2-x}Sr_xCuO_4$, $DyBa_2Cu_3O_7$, and other rare earth-substituted YBCO compounds, as well as non-rare earth superconductors.

The review discusses component contributions to the specific heat of high temperature superconductivity (HTSC), which take into account temperature and magnetic field dependences. The authors also present the separation of the lattice and electronic components of the specific heat by analyzing specific heat at intermediate and high temperatures. This includes the analysis of qualitative features of the lattice specific heat and the separation of lattice and electronic specific heats by differential and conventional calorimetry on superconducting and non-superconducting samples. The authors also review the specific heat "anomaly" at T_c including sample dependence, magnetic field dependence, and the effect of Gaussian fluctuations.

The relationship between specific heat of superconductors and electron density of states, not only from band-structure calculations, but also experimental data, is reviewed. Of interest is the fact that all rare earths except Ce and Tb can replace Y in the orthorhombic YBCO structure, although special synthetic procedures are necessary in some cases. Pm, with its half-life of 19 hours, however, has not yet been investigated.

This excellent review contains 286 references, 4 tables and 62 figures. ▲

New Fellows

The American Physical Society announced its newly elected fellows in the *APS News*, **2**, [3] 29-30, March, 1993. The Division of Condensed Matter Physics initiated ten rare earthers: Alexei A. Abrikosov, Ernst Bucher, Jack E. Crow, Peter M. Levy, Jeffrey W. Lynn, Stuart S.P. Parkin, John M. Rowe, Edward A. Stern, Joe D. Thompson, and Conrad M. Williams.

RIC congratulates these, and all newly elected Fellows to the American Physical Society. ▲

Metal Prices Through 1991

Recently, RIC has been inundated by requests for information on prices for rare earth oxides, alloys, compounds, and metals. Up until now, the only place to locate prices for rare earths were through the suppliers themselves. However due to the competitive nature of the rare earth business, it has become increasingly difficult to extract this information by casual methods. *Metal Prices in the United States Through 1991*, a book that provides prices of rare earth metals from 1950 to 1991 may be of some help.

The historical perspective of the publication is interesting, because pricing information is contained in graphs and tables, which illustrate trends in metal prices. In some cases, the prices are tracked as far back as 1813, with some discussion of the events that influenced those prices. Economists and other analysts that are looking at commodity issues often need historic price data. However, as a word of warning, prices can vary widely depending on the amount purchased, the purity and the form of the product.

Information for commonly traded commodities such as copper, zinc, gold, and silver is presented as well as specialty metals such as rhenium, scandium, and the rare earths. The report also includes information on iron ore, iron and steel, and iron and steel scrap.

A copy of *Metal Prices in the United States Through 1991* can be obtained from the Publication Distribution Office, U.S. Bureau of Mines, Cochrans Mill Road, P.O. Box 18070, Pittsburgh, PA 15236, USA; Tel:412 892 4338. ▲

High-T_c Wires

A joint government/industry based research project between the U.S. Department of Energy's Argonne National Laboratory and the BASF Corporation will work on ways to produce superconducting wire for the transmission of electrical current. The project involves working with two different methods of making high-T_c wires carry electrical current more efficiently. Both methods deal with the alignment of tiny grains of Y-Ba-Cu oxide (YBCO) superconducting wire that will be imbedded in a polymeric matrix fiber. The grains will be aligned either by mechanical or magnetic means.

BASF will embed superconductors in a polymeric carrier and then spin the fiber to make the superconducting wire more flexible (providing the superconductor is compatible with the dispersants and polymers used to make the fibers). The Argonne team will then grow long, thin crystals of the YBCO material, which will then be mixed with fiber raw materials, with the aid of dispersants, by the BASF scientists in the unsintered or "green" state. These fibers will then be sent to Argonne for heat treatment and testing to measure their current-carrying ability.

In the second approach, Argonne will expose the superconductor-loaded polymer matrix to a high magnetic field of between 6 to 8 Tesla in order to align the crystals. Aligning the crystals in the fiber is important for making superconducting wires, since the crystals carry current better in certain directions.

The $325,000 project will take about seven months and will be funded by both BASF and the U.S. Department of Energy. ▲

Brightest Green Lasers

Laser scientists at the General Electric Research and Development Center, Schenectady, New York, have developed a high quality green laser beam with an average power of 52 W [*R&D Magazine*, **34**, No.6, 21 (1992)]. This beam is more than twice as bright as any published brightness for green light produced by a solid-state yttrium-aluminum-garnet (YAG) laser.

M.E. McLaughlin, manager of the GE Center's laser technology program, and scientists J. Unternahrer and M. Kukla use a commercial Q-switched YAG laser and amplify it in a continuous wave-pumped, face-pumped amplifier to produce a 92 W beam. The beam then passes through a nonlinear doubler crystal, which halves the wavelength to 532 nm, producing the 52 W green beam plus residual infrared. This method produces high average power while maintaining low distortion, according to McLaughlin.

Applications for this rare earth laser include: cutting, drilling, or machining of some polymeric composites. The device can be used as either a pulsed or continuous wave laser, or as an amplifier.

The scientists are working on a frequency conversion technique that would enable a laser to radiate high average power light in the ultraviolet and deep ultraviolet regions for use in laser surgery and other medical uses. "This would promise much greater user flexibility compared with gas lasers, while offering a more compact system with modularity, high reliability, greater safety, and other advantages," McLaughlin says. ▲

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Dr. Kamal Girgis (1936-1992)

Dr. Kamal Girgis died unexpectedly on August 2, 1992, while on vacation in the United States. He was born May 11, 1936 in Fayum, Egypt, and later studied chemistry and physics in Cairo. In 1963, he joined Prof. Fritz Laves' group in Zürich as an assistant, and was inspired to devote his doctoral thesis to Prof. Laves' interest in the structure and properties of intermetallic compounds. Fascinated by this new and almost unknown field of science, he then continued to work independently once his dissertation was completed in 1969. When Dr. Laves retired in 1976, Dr. K. Girgis formed his own research group, which is still active today. He has published nearly 20 papers in prominent scientific journals on the crystal and magnetic structures of rare earth intermetallic compounds. These papers and the theses of his younger co-workers demonstrate his untiring effort and significant contributions towards the development of a unified theory for the structures of intermetallic compounds.

Dr. Girgis received the first teaching award of the Department of Materials Science from his students in recognition for his close personal attention to their academic needs. ▲

Yukon RE Deposit

A new major source of rare earths, with an estimated value of over $500,000,000 US, has been discovered in southern Yukon. The Whitehorse-based company, Dodgex Ltd., reports that a wide fluorite-bearing vein may contain over 1,500,000 mt of ore. A representative rock outcrop shows a composition of 0.15% yttrium oxide, 0.62% niobium oxide, 1.10% zircon, 0.03% hafnium oxide, and 1.37% lanthanides, consisting of mostly cerium, lanthanum and neodymium oxide.

Production of material from this deposit is scheduled to begin in late 1994. Mineral assemblage of the vein indicates the potential for efficient ore beneficiation, using an acid leach process to produce several intermediate mixed concentrates. The deposit is also located in an area with well established roads which should provide easy access.

Developers of the site are seeking venture capital to participate in the commercialization of this deposit. For more information contact: James S. Dodge, President, Dodgex Ltd., 14 McDonald Road, Whitehorse, Yukon Y1A 4L2, Canada. ▲

Professor Bohdan Stalinski (1924-1993)

Professor Bohdan Stalinski, a member of the Polish Academy of Sciences and Director of the International Laboratory of High Magnetic Fields and Low Temperatures in Wroclaw, passed away from a prolonged illness on February 26, 1993.

He was born February 29, 1924 in Ozmiana. After receiving his Chemistry degree from the Technical University of Wroclaw, he earned his Ph.D studying the structure, magnetic and electric properties of the transition metal hydrides. In 1952, Stalinski published his results on the discovery of ferromagnetism in uranium trihydride and tridueteride at temperatures below 180 K.

Professor Stalinski expanded his research program to include the low temperature specific heat, Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR) measurements on rare earth hydrides. One of the important outgrowths of these studies was his contributions to our knowledge of the metal-semiconductor transitions in these materials. His expertise in this area made him an internationally-renowned expert in this field.

He received the J. Sniadecki Medal of the Polish Chemical Society and the Maria Sklodowska-Curie prize of the Polish Academy of Sciences for his achievements. ▲

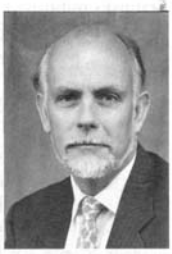
More Lemaire

The December 1, 1992 issue of the *RIC News* contained the story of the untimely deaths of Dr. and Mrs. Remy Lemaire, and their son, Pierre, as a result of an automobile accident in Namibia on September 1, 1992. It is important to point out that Dr. Henri Lemaire, who is currently the Scientific Director at UGIMAG, Grenoble, France, worked with Dr. Remy Lemaire on the development of RCo_5 permanent magnets. Both received the Blondel Medal in 1977 for "the industrial process for the elaboration of rare earth-cobalt permanent magnets". The Blondel Medal is named after the inventor, André Blondel, who worked on increasing the efficiency of electrical generators in the early days of this century. Some people have confused the identities of both Drs. Remy Lemaire and Henri Lemaire because they not only worked on permanent magnets, but also lived in the same area in France for a time. ▲

Energy Department Awards

Last September, the 1991 E.O. Lawrence Award was presented by the U.S. Department of Energy to Zachary Fisk of Los Alamos National Laboratory, and Richard E. Smalley of Rice University, in recognition of recent contributions to the development, use or control of atomic energy.

Zachary Fisk



Richard E. Smalley

Zachary Fisk was cited for his "discovery and synthesis of new and novel magnetic and superconducting materials as well as pioneering research on their properties." His work led to the demonstration of reentrant superconductivity, in which a material is superconducting below a temperature T_{c1} and normally conducting below a lower temperature ($T_{c2} < T_{c1}$), in magnetically ordered rare earth compounds. He is best known among rare earthers for his leading role in the discovery of a series of cerium compounds that are superconducting heavy-fermion systems.

Richard E. Smalley was cited for his "bold and innovative research and consistent leadership in the generation and characterization of atomic clusters, and in particular, for the discovery of C_{60} (Buckminsterfullerene) and its related compounds." In 1985, Professor Smalley and his colleagues identified the composition and structure of C_{60}, {*RIC News*, **XXI**[1], 2 (March, 1986)} a soccer ball-shaped molecule, by analyzing carbon clusters synthesized from the condensation of carbon vapor. One of the first "buckyballs" to be discovered contained a lanthanum atom encapsulated in a C_{60} cage. ▲

Goldschmidt */Continued from page 3* ➪

tion is now being carried out at Elektro-Thermit, under the direction of Dr. Martin Wehrmann. Dr. Wehrmann replaced Mr. Oberste-Ufer, formerly in charge of magnet activities for Th. Goldschmidt, who was promoted to General Manager of one of Goldschmidt's affiliated companies.

For more information, contact Elektro-Thermit GmbH directly at: Postfach 101043, D 4300 Essen 1, Germany; Tel:49 201 173 03; Fax:49 201 1732836. ▲

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★★★★★★★★★★★★★★★★★★★★★★★★

Since the March issue of the RIC News went to press, RIC has received support from five new family members, and renewed support from 34 other organizations. The supporters from the fourth quarter of fiscal year 1993 who wish to be listed, grouped according to their appropriate catagory, and with the number of years that they have contributed to the Center in parentheses, are listed below.

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