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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High-T_c MRI Brain Scan

The first image of a human brain produced by low-field magnetic resonance imaging (MRI) using a high-temperature superconductor pickup coil instead of copper was recently published in *Nature*, 347, 317 (1990). The yttrium-barium-copper-oxide coils used were developed by ICI Advanced Materials, and fitted to the scanner at Hammersmith Hospital, London, England.

In the scanner's 0.15 T magnetic field, and at liquid-nitrogen temperature (77K), the superconductor coil has significantly greater sensitivity than copper. This results in a higher signal-to-noise ratio, which may decrease the need for repeated scans and thus reduce costs. The use of superconducting coils followed experiments by researchers to cool copper coils in liquid nitrogen in order to improve sensitivity.

The present generation of high-T_c superconducting ceramics is so far limited to applications where their low current-carrying capacity is not a problem, such as MRI coils and sensitive antennas for military communications equipment. ▲

Murray Basin Deposit

Wimmera Industrial Minerals Pty. Limited, a subsidiary of the major Australian mining group, CRA Limited, is involved with a feasibility study of five mineral sands deposits in the Murray Basin region, Victoria. Although the deposits will be mined primarily for titanium minerals and zircon, there is a significant contribution from monazite and xenotime. The measured resource of the first deposit, WIM 150 is 580,000 tonnes of contained monazite and 170,000 tonnes of contained xenotime which is equivalent in size to the current proven reserves of rare earth minerals elsewhere in Australia. The four additional deposits, although not yet drilled to "measure" status, appear to contain about six times the resources of the WIM 150 deposit. ▲

Desert Storm Strikes RIC

A few days before the breakout of hostilities in the Middle East, Joel Calhoun of the Information Center was called up for active duty in the U.S. Navy. Joel served in the Navy in the early 1980's and was in the active reserves. We wish Joel good luck and a speedy return to Iowa and RIC. The loss of Joel for an indefinite time will have an affect on RIC, and it may be a few weeks (hopefully) before we will be operating more or less normally. In the meanwhile there may be some delays in responding to your inquiries for information, so please be patient. Jennings "Cap" Capellen has come out of retirement to help us for a few hours a day, but there is a ceiling on how much he can earn without affecting his retirement benefits. In addition to "Cap", John Mason, who works in the Metallurgy and Ceramics Program at the Ames Laboratory, will be coming to the RIC for a few hours a week and Wayne Calderwood, who retired several years ago, will also fill in. Wayne, as some of you may recognize, worked for RIC evaluating over 200 binary rare earth phase diagrams in the mid-1980's. John Mason had worked with Prof. Premo Chiotti on rare earth alloys quite a few years ago before Prof. Chiotti retired from the Ames Laboratory. ▲

Thermite Reduction Process

The thermite reduction process developed at Ames Laboratory, Iowa State University, Ames, Iowa, enables one to produce an entire family of rare earth-iron alloys in a single, energy-efficient step.

The process involves adding ferric fluoride to a rare earth fluoride and calcium mixture which creates enough chemical energy to melt the metals and form alloys. Conventional methods that do not use ferric fluoride must use an external heat source to alloy metals.

The thermite reduction process, which

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Spedding Award Winner

Karl A. Gschneidner, Distinguished Professor in Liberal Arts and Sciences at Iowa State University has been named the winner of the sixth Frank H. Spedding Award. The award sponsored by Rhône-Poulenc will be presented at the 19th Rare Earth Research Conference, July 14-19, in Lexington, Kentucky. Dr. Gschneidner will address the meeting on the topic "An Odyssey Through the Rare Earths. A Quest for Knowledge". This award is especially meaningful to Gschneidner since he was a student under Spedding during his graduate school days.

Gschneidner was born in Detroit, Michigan, on November 16, 1930 and attended school there. He received his B.S. degree from the University of Detroit in 1952 and his Ph.D. from Iowa State University in 1957. He then joined the staff at the Los Alamos National Laboratory of the University of California, Los Alamos, New Mexico, where he was Staff Member (1957-1963)

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19th RERC Update

First, a few important dates to keep in mind. Manuscripts are due April 29, 1991 and registration forms are due June 4th for the Conference and June 14th for the hotel. In order to facilitate things please observe these deadlines. For more information contact Professor Lance DeLong, General Chairman of 19th RERC, Department of Physics and Astronomy, University of Kentucky, Lexington, KY 40506-0055; telephone: (606) 257-4775, Fax: (606) 258-2846.

We have received a tentative program from Professor Herbert Silber, Program Chairman, and the following are some of the highlights. As of late January the session titles and the confirmed speakers are as follows. (I) "Applied Science and Technology": Bruce Hinton, S. J. Poon, J. Lucas, and Tetsuo Sakai; (II) "Spectroscopy": Rufus Cone, Brian Judd, David Metcalf, and Michael Reid; (III) "Rare Earth and Actinide Magnetism": B. R. Cooper, J. J. M. Franse, H. Fujii, and A. Szytula; (IV) Coordination and Bioinorganic Chemistry": Robert Byrne, Emil Rizkalla, David Clark, and William Evans; (V) "Low-Dimensional Materials": D. Sellmyer, J. Lynn, and O. Fischer; (VI) "Magnetic Superconductors": M. B. Maple, N. Koon, A. Buzdin, and J. B. Ketterson; (VII) "High Temperature Superconductors": R. Bhatt, H. Mook, and Helmut Brandt; (VIII) "Coordination Chemistry, Part 2": Michael Tweedle, L. A. Carreira, and J-C Bunzli; (IX) "Metal-Insulator Transitions": Zachary Fisk and Satish Malik; and (X) "Actinide Physics and Chemistry": U. Benedict, Lynda Soderholm, and John Gibson. It seems that a distinguished list of speakers and chairs have been lined up by the program committee. ▲

2nd RE Workshop

The second announcement we received gives the meeting dates as May 9-10, 1991 and not May 10-11 as mentioned in an earlier issue of the *RIC News*. Deadline for registration is March 31 and Abstracts are due March 15. For more information contact Dr. Paolo Guerriero, ICTR-CNR, c.so Stati Uniti 4, 35020 Padova, Italy: Telephone 049-845362-8295962; Fax 049-845449-8295699. The symposium is supported by the European Rare Earths and Actinides Society. ▲

Conference Calendar

A NEWS STORY THIS ISSUE

March '91

The Magnetic Bearings and Dry Gas Seals Conference and Exhibition (ROMAG'91)
Washington, D.C., U.S.A.
March 13-15, 1991
RIC News, XXV, [2] 2 (1990)

7th International Symposium on Halide Glasses
Lorne, Victoria, Australia
March 17-21, 1991
* This Issue

April '91

Journees des Actinides
Lagos, Algarve, Portugal
April 28-May 1, 1991
RIC News, XXV, [2] 2 (1990)

May '91

2nd Workshop on the Basic and Applied Aspects of the Rare Earths
Venezia, (Venice) Italy
May 9-10, 1991
RIC News, XXV, [3] 4 (1990) and
* This Issue

International Workshop on Magnetism, Magnetic Materials and Their Applications
La Habana, Cuba
May 21-29, 1991
* This issue

Second International Conference on Rare Earth Development and Applications (2nd ICRE)
Beijing, China
May 27-31, 1991
RIC News, XXV, [2] 2 (1990)

July '91

19th Rare Earth Research Conference (19th RERC)
Lexington, Kentucky, U.S.A.
July 14-19, 1991
RIC News, XXV, [1] 2 (1990) and
* This Issue

June '92

Rare Earths '92 (International Conference)
Kyoto, Japan
June 1-5, 1992
RIC News, XXV, [3] 2 (1990)

International Workshop Magnetic Materials

An international workshop on Magnetism, Magnetic Materials, and Their Applications will be held May 21-29, 1991 in La Habana, Cuba. No agenda giving the scope of the conference was included with the announcement. For more information contact Fabrizio Leccabue, MASPEC/CNR Institute, Via Chiavari 18/A, 43100 Parma, Italy: FAX 0521-96315. ▲

The 7th International Symposium on Halide Glasses

The 7[th] International Symposium on Halide Glasses will take place on 17-21 March, 1991 at Lorne, Victoria, Australia. The symposium is sponsored by the Centre for Advanced Materials Technology in association with Montech Pty. Ltd., and Monash University, Clayton, Victoria. Featured in the program will be a session on rare earth doped glasses and fibers. For more information contact: Clare MacAdam or Leanne Carnell,

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Montech Pty. Ltd., Monash Science Park, Ground Floor, Building 2, Blackburn Road & Martin Street, Clayton, Victoria 3168, Australia Tel:61-3-558-6222 Fax:61-3-558-6589. ▲

Gordon A. Barlow

With deep regret Molycorp Inc. announced that Gordon A. Barlow had died on October 29, 1990. Memorial services were held in Rancho Palos Verdes, California, and in Batavia, New York, where he was buried. Gordon, a graduate of Alfred University, had been Sales and Marketing Manager for Lanthanide Products for many years. ▲

Rare Earth Operation

Ganjian Rare Earth Ltd., a joint venture with Canada Rare Earth Metal Company, has started operation in Ganzhou, Jiangxi, China, after a two-year construction period. The $3.28-million project will process 200 mt/yr mixed rare earths to produce products worth nearly $14 million per year. ▲

Spedding Award Winner*/Continued from page 1* ⇨

and Section Leader (1961-1963). He was a Visiting Assistant Professor of Physics at University of Illinois, Urbana in 1962-63.

After returning to Iowa State University as Associate Professor in 1963, he organized the Rare-earth Information Center in 1966 and was named Director of the Center. He was promoted to Professor and Senior Metallurgist in 1967, and named a Distinguished Professor in Liberal Arts and Sciences in 1979. He was Program Director of the Metallurgy and Ceramics program at the Ames Laboratory from 1974 to 1979.

Dr. Gschneidner is primarily interested in the physical metallurgy of rare earth metals and alloys, theory of alloy phase formation, electronic transformation of cerium, spin fluctuations in exchange enhanced solids, heavy fermions, and superconductivity. He has published 216 articles in refereed journals, written 99 chapters in books, published 28 reports and bulletins, 204 phase diagram evaluations, and written or edited 18 books on these subjects. He holds four patents and one statutory invention registration for metallurgical or ceramic processes.

Dr. Gschneidner has served on several government advisory committees and panels and on several editorial boards of scientific journals. He is senior editor for a series of volumes entitled *Handbook on the Physics and Chemistry of Rare Earths* (13 volumes have been published and one is in press). He has served as an invited speaker at many national (30) and international (25) conferences and seminars (63) on rare earth materials and on the theory of alloy formation. He has received several other awards including the 1978 William Hume-Rothery Award of The Minerals, Metals and Materials Society; the Department of Energy's 1982 Material Science Research Competition in Metallurgy and Ceramics; and the Burlington Northern Award for Excellence in Research from Iowa State University (in 1989). In 1990, he was named a Fellow of both The Minerals, Metals and Materials Society and ASM International. In 1984, one of his papers was named a CITATION CLASSIC by Institute for Scientific Information, Philadelphia. He is a member of the Board of Directors of the Rare Earth Research Conference, Inc. and a member of the Steering Committee of the International Conference on f-elements.

To quote from one of the letters seconding his nomination for this award: "Professor Gschneidner is the world's premier scien-

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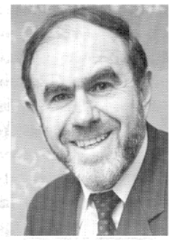
tist in the field of rare earth intermetallic compounds. He has made in-depth, focused contributions to the fundamental science of rare earth elements and their compounds. In addition, he has advanced the practical applications of important rare earth based materials. The breadth of Dr. Gschneidner's contributions is documented by the fact that his research is cited by theoretical physicist and engineers alike." ▲

MRS Medal



The Materials Research Society (MRS) has established a new award, the MRS Medal. It recognizes specific outstanding research achievements having major impact in any of the various fields which together comprise materials research. The first two recipients were Drs. A. J. Freeman and D. F. Shriver, both of Northwestern University in Evanston, Illinois. The first two awards were bestowed at the 1990 MRS fall meeting held last November in Boston, Massachusetts.

Prof. Arthur Freeman, pictured above, was recognized for his pioneering achievements in laying the foundations of the newly developing field of monolayer magnetism and artificially layered magnetic materials. This new field, intensely pursued, holds fascinating possibilities for future applications as well as fundamental studies of surfaces. Many of the materials to which these computational predictions apply are rare earths or contain rare earths. ▲

Thulium Laser

This upconversion solid state laser is the first solid state laser that operates in the blue region of the visible spectrum [*R&D Magazine*, 32, No.10, 65 (1990)]. It is excited using multiphoton infrared excitation.

The thulium laser converts infrared light from semiconductor laser diodes into blue light by multiphoton excitation. This laser could be the basis for high data-rate undersea communications systems. Applications could include improved undersea imaging, laser radar and ranging, and target illumination and designation. The laser could also be used for medical procedures, such as scar-free tissue welding and cancer treatment using tissue-penetrating wavelengths. ▲

Wolf Prize

Pierre-Gilles de Gennes of the College de France in Paris was a co-winner of this year's Wolf Prize in Physics. The $100,000 award was presented on May 20, 1990 by the President of Israel at the Israeli House of Parliament in Jerusalem. According to the prize citation, the winners were selected for a "wide variety of pioneering contributions" to the understanding of complex matter systems.

Dr. de Gennes did his doctoral work at the Nuclear Research Center in Saclay, France, finishing up in 1958. Since then he has worked on type II superconductors, liquid-crystal research, polymer science, and colloid science. He has been at the College de France since 1971 and director of the Ecole Superieure de Physique et de Chimie Industrielles since 1976.

The work which makes his name so familiar to rare earthers was a product of his graduate work. He proposed that the paramagnetic Curie temperature of the rare earth metals from Gd through Tm is proportional to what is now known as the de Gennes factor. ▲

Superconductivity

Superconductivity-Experimenting in a New Technology is one of the books in the Advanced Technology Series. The book was written by Dave Prochnow and published in 1989. This 138-page book contains six chapters with the following titles: Introduction to Superconductivity, Superconductors, Superconductivity Microscopic Theory, Superconductor Thermodynamics, Superconductor Experiments, and Real-World Superconductor Applications.

This book offers you the opportunity to expand your own knowledge and understanding of superconductivity. Included are step-by-step procedures for conducting your own superconductivity experiments, complete with instructions, safety tips, and a guide for obtaining necessary supplies.

Prochnow also provides a time line of events in the research that has been done to date on superconductivity and provides information about leading scientists in the field.

It is available for US$17.60 from the publisher, Tab Books, Inc. Blue Ridge Summit, PA 17294-0850, U.S.A. ▲

Lattice-Matched Heterostructures

The feasibility of growing lattice-matched $Sc_{1-x}Er_xAs$ on GaAs was demonstrated by C. Palmstrom, et al. in *Appl. Phys. Lett.* 56, 382-4 (1990). The heterostructures of these rare-earth monopnictides and also monochalcogenides in semiconductors have room temperature resistivities of about 50 µΩcm. This compares with previous resistivities of about 70 µΩcm in ErAs. Reflection high-energy electron diffraction (RHEED) indicates that the growth of these structures occurs monolayer-by-monolayer.

The authors report that by forming ternaries by mixing either the rare-earth elements or the group V elements or both, almost all groups IV, III-V, and II-VI semiconductors can be lattice-matched. Because of the similarities of the rare-earth elements, complete miscibility is expected.

The lattice-matched samples were prepared using molecular beam epitaxy (MBE) with a base pressure less than 5×10^{-11} mbar. After the $Sc_{1-x}Er_xAs$ layer was deposited on the GaAs substrate it was capped by a 500Å layer of GaAs to avoid atmospheric contamination upon exposure to air.

A minimum yield for $Sc_{.32}Er_{.68}As$ film was about 10 percent compared with 17 percent for ErAs. This may be due to less strain and defects in the lattice-matched sample. Since ErAs is basically a structure of primarily ionic bonding and GaAs structurally covalent, island growth is exhibited by the overgrowth layer. ▲

Magnet Scraps

Ames Specialty Metals, a division of Edge Technologies, Ames, Iowa, will use the "thermite reduction process" for recovering neodymium from scrap materials. The process was developed by Rick Schmidt, an Iowa State University metallurgist at Ames Laboratory, to recycle scrap neodymium for use in producing high-powered permanent magnets.

"There are hundreds of thousands of pounds of scrap piling up at magnet manufacturing plants," said H.R. Dorman, general manager of Ames Specialty Metals. "Through the recovery program, the scrap materials, rejected and broken magnets are recycled and put back into production." Up to 30 percent of the material used to make rare earth permanent magnets ends up as scrap as a result of grinding and cutting materials during manufacture and also from

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magnets that are rejected for flaws or for otherwise not meeting production specifications.

The company is capable of returning materials to manufacturers as neodymium powder or an alloy produced by the reduction process. For more information contact Mr. Hal Dorman, Ames Specialty Metals, 2625 North Loop Drive, Suite 900, Ames, IA 50010 Telephone: (515)294-3614 Fax: (515)232-1177. ▲

Calcium Doped $YBa_2Cu_4O_8$

The two superconducting phases $YBa_2Cu_4O_8$ (1-2-4), containing double Cu-O chains, and $Y_2Ba_4Cu_7O_{15}$ (2-4-7), containing both single and double Cu-O chains, were originally discovered as lattice defects in the 90K superconductor $YBa_2Cu_3O_7$ (1-2-3). The oxygen stoichiometry of 1-2-4 is much more stable than that of 1-2-3, a feature that is important for practical applications. But the lower T_c(80K) of 1-2-4 presents a major obstacle to practical uses of this phase at liquid nitrogen temperature (77K).

T. Miyatake, et al., reported that partially substituting Ca for Y in 1-2-4 increases T_c [*Nature*, 341, 41-2 (1989)]. A superconducting transition temperature of 90 K was achieved for the composition $Y_{0.9}Ca_{0.1}Ba_2Cu_4O_8$.

The samples of $Y_{1-x}Ca_xBa_2Cu_4O_8$ (x=0-0.1) were synthesized by using a high-oxygen-pressure technique. After mixing the starting materials of Y_2O_3, $Ba(NO_3)_2$, CuO and $CuCO_3$, the samples were fired at 900 °C in flowing oxygen for 12 hours, and then ground. The resulting powder was compacted into a rectangular shape at 100 MPa and then lightly sintered in an oxygen atmosphere. The hot isostatic pressing was repeated twice in a gas environment of argon with 20 percent oxygen (oxygen-HIP). The samples were first oxygen-HIP-treated at 950 °C for 6 hours. At this stage, the x-ray diffraction patterns indicated that 1-2-4 was the major phase, but broad diffraction peaks suggested a slightly disordered structure. The second oxygen-HIP treatment, at 1,050 °C for 3 hours, yielded high-quality polycrystalline 1-2-4 with no secondary phases. The resulting sample densities were 50-60 percent of the theoretical density.

The 90 K 1-2-4 superconductors have good potential for technological applications because of the relatively large margin between T_c and liquid nitrogen temperature and because of the thermal stability of the oxygen content. ▲

25 *The Rare Earths and I* 25

This issue we bring you a letter sent to us by Liu Weimin. He is a teacher and researcher at the Shenyang Aeronautical College in Shenyang, People's Republic of China. His area of work involves nondestructive testing of materials.

I WANT TO BE A BRIDGE

I began my research work in the field of science and engineering of materials. Later I was in touch with the rare earths (RE). The marvellous effects that a small amount of the RE elements on the properties and structures of materials make me very interested in the REs.

After finishing my graduate studies in Beijing Institute of Aeronautics and Astronautics under the supervision of Professor Y. Q. Pan, I began my investigations on the REs. However, it was a long time later that I received the first copy of the *RIC News*. It was Vol. 23, No. 3, September 1, 1988.

I attended a conference in Changsha, China in November, 1988 to present some of my work on the superplasticity of Ti-1023 alloy. In the conference the paper "Recent Developments in Rare Earth Physical Metallurgy" was presented, and I met the author, K. A. Gschneidner, Jr. and talked to him. I enjoyed the conference.

From then on I have continued to receive the *RIC News*. As a lecturer in college, I make good use of this information in my teaching and research. In a course on metal materials, I give the RE information to my students since it may be helpful to them who will do RE research in the future. I tell them about "The Story of RE Names", "How Many REs", "Necessity is the Mother of Invention", and so on. I like to play bridge, and I want to be a bridge through which RE information may be passed on to the heart of the student.

I am sorry I am only a reader - the user of your product which I thoroughly enjoy - not a producer for you [editor's note - you are now]. Congratulations to all the staff for producing such a useful newsletter. ▲

An Apology

Our apologies to Samsung Electron Devices Company for listing them in the December RIC News as being from Japan instead of South Korea. ▲

North American Markets - NdFeB Magnets

Motor Tech Trends (MTT), in March 1990, published Volume II of a two volume study on permanent magnets with emphasis on neodymium-iron-boron magnets. The first volume was devoted to the technology involved. The second volume, being reviewed here, is entitled, "*North American Markets for Neodymium-Iron-Boron Permanent Magnets 1989-1994. Volume II. Market Assessment and Forecasts*". The 158 page report compares the predicted 1994 market with the 1989 market in 1989 dollars. The principal author was George Gulalo with help from Dan Jones, Mark Pfaffinger, Jean Hayes, and Steve Warrick.

The 1989 sales of NdFeB magnets was $54.55M or 16% of the total permanent magnet market. In comparison rare earth-cobalt magnets had sales of $37.6M or 11% of the market. According to figures released by MTT the 1994 sales of NdFeB magnets should reach $190.1M, accounting for 32% of the permanent magnet market.

The report is divided into five sections: Introduction; NdFeB Executive Summary; the PM Market-Competing Magnet Technologies; The Market by End User Application; and NdFeB Magnet Suppliers to the N.A. market. This study discusses and predicts the markets for all types of permanent magnets and for NdFeB magnets the market was divided into various segments according to magnet type, usage, weight, and area of application. It ends with a list of the major worldwide suppliers of NdFeB magnets to the North American market.

Volume II costs U.S.$3,975.00 and may be ordered from Motor Tech Trends, Airport Office, 1520 Centinela Avenue, Inglewood, CA 90302, U.S.A.: Telephone (213) 674-3445: Fax (213) 674-3463. Inquiries about Volume I. Technology may be addressed to the same address. ▲

Rare-Earth-Bismuth Phase Diagrams

RIC still has copies available of *Bulletin of Alloy Phase Diagrams*, 10, No. 4a, September, 1989. The issue contains evaluations of all the rare earth-bismuth systems (except promethium-bismuth) and six actinide systems. (Ac-Pt, Al-Pu, Al-Th, Ca-Pu, Pt-Pu, Sn-Th). The Rare-earth Information Center will send a complimentary copy to interested readers. Please send you request to the address on the next to the last page of your RIC News or the masthead on page one. ▲

RE Handbook 13

Volume 13 of the *Handbook on the Physics and Chemistry of the Rare Earths* is the latest addition to the comprehensive series that the editors have assembled to keep the technical and scientific communities informed of the rapidly expanding body of knowledge about the rare earths. This latest volume contains five chapters which brings the total number of chapters in the series to 92. Two chapters deal with phase equilibria and crystal chemistry in ternary rare earth systems, one is concerned with RE oxide systems, one with analysis by atomic emission and mass spectrometry, and the final chapter covers rare earth elements in biological systems.

In the first chapter on phase equilibria and crystal chemistry, the authors review the ternary rare earth systems with group III-A and IV-A metallic elements with a transition metal. Since the number of experimental investigations represent an imposing number, the results are described in an abbreviated manner. Many phase diagrams are included along with tables of crystal structures and parameters. The next chapter is related to the first but deals with the description of the compounds resulting from the reactions between the rare earth elements with the chalcogenides and the elements of the main subgroups of the periodic system, from I to VII.

The chapter on RE oxide systems is concerned with the systems R_2O_3-M_2O_3-M'O (where R is In, Sc, Y, or one of the lanthanides, M is Fe, Ga, Al, and M' is a divalent cation element). Phase relationships, thermochemistry, crystal chemistry, electronic structure, and magnetic properties are covered.

In the fourth chapter, R.S. Houk describes how trace elemental determinations are made using atomic emission (AES) and mass spectrometry (MS) with inductively coupled plasmas (ICP). He describes the instrumentation and basic analytical capabilities of ICP-AES and ICP-MS. Some illustrative analyses involving rare earths as either analyte or matrix are described.

"Rare Earth Elements in Biological Systems" concerns the use of the lanthanides as biological probes, as markers to trace the movement and deposition of elements in tissues, and to investigate the role of Ca^{2+} in muscle and nerve activity. The chapter is broken down into the role of REE in biological systems, physiology of REE in plants, and REE in agriculture.

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Shock Compression of Condensed Matter

Shock Compression of Condensed Matter - 1989 is a book which contains the Proceedings of the American Physical Society Topical Conference held in Albuquerque, New Mexico, U.S.A., August 14-17, 1989. The 1,060-page book presents the most up-to-date collection of research activities in the area of high-pressure shock compression.

The topics of interest to rare earthers are the current reviews and original research papers given on theoretical and experimental aspects of high T_c superconductors, microscopic mechanical properties, explosives, experimental techniques, stress gauges, and optical studies. With other topics that include: the equation of state, phase transitions, energetic and nonenergetic materials modeling and simulation macroscopic aspects of mechanical properties, shock-induced modification and material synthesis, geological materials, impact phenomena, and high velocity launchers, there is enough interesting material to keep any industrious reader occupied.

The book was published in 1990 and is edited by S.C. Schmidt, J.N. Johnson, and L.W. Davison and contains 6 plenary, 13 invited, and 203 research papers. The cost is US$180.00 and is available from Elsevier Science Publishing Co. Inc., P.O. Box 882, Madison Square Station, New York, NY 10159 U.S.A. or from Elsevier Science Publishers, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. ▲

Volume 13 of the *Handbook* continues to promote the interactive approach to the science of the rare earths. Insights won from focused study of some aspect of the field are presented in critical and authoritative reviews. Some of these chapters add important archival material of general and lasting interest while others on topical areas will promote new understanding of active areas.

Volume 13 of the *Handbook of the Physics and Chemistry of the Rare Earths*, edited by K.A. Gschneidner, Jr. and L. Eyring was published in 1990 by North-Holland and contains 480 pages. It costs Dfl.395.00 (US $202.50) and it and any of the previous 12 volumes can be ordered from Elsevier Science Publishers P.O. Box 211, 1000 AE Amsterdam, The Netherlands; or in the U.S.A. and Canada from Elsevier Science Publishing Company, P.O. Box 882, Madison Square Station, New York, NY 10159, U.S.A. ▲

Rhône-Poulenc Chemical Division Moves

The Fine Inorganic Chemical Division of Rhône-Poulenc, which includes the Rare Earth Department, has transferred to the Rhône-Poulenc Basic Chemical Company (RPBCC), headquartered in Shelton, Connecticut. The change was made to conform with the organization of the French parent company, Rhône-Poulenc SA. The move was completed November 12, 1990.

The new address of the company is: Rhône-Poulenc Basic Chemicals Co., Fine Inorganic Chemicals, One Corporate Drive, Box 881, Shelton, CT 06484. For sales information telephone: (203)925-3685 Fax: (203)925-3670 Telex: 4750055.

To contact the Fine Inorganic Chemicals Division Research and Development Laboratories, the new address is: Rhône-Poulenc Inc., Fine Inorganic Chemicals Division, Building B, 2nd Floor, Prospect Plains Road, CN 7500, Cranbury, NJ 08512. Telephone: (609)395-4549 Fax: (609)395-4557. ▲

Superconducting Wires

General Atomics announced that its Pacific Superconductors Division has successfully produced up to 1000-meter-long high-temperature superconducting fibers using rare earth-barium-copper oxide superconducting material. Flexible, multifilamentary, high-temperature superconducting wires over 20 meters long were made using these fibers. The announcement was made at the 1990 Applied Superconductivity Conference at Snowmass Village, Colorado, held last September.

The dimensions of the wire are 0.9mm x 5.7mm. Each wire contains twelve 0.3mm diameter superconducting fibers embedded in a copper casing. The wire is configured so that bending does not degrade its superconducting properties. The wire can be looped into a 15cm diameter coil without any reduction in current-carrying ability.

The 20-meter lengths of wire are capable of of carrying superconducting currents up to 10 amperes when the wire is cooled to 50K. Current density is typically 4000-6000 A/cm^2 at 50K in zero magnetic field, with current density dropping a factor of 10 in magnetic fields of 100 - 200 gauss. The near-term goal is to achieve superconductor current density of 20,000 A/cm^2 in zero applied field by the end of this year.

The manufacturing process for produc-

Continued in next column ⇨

ing the 1000-meter fibers and 20-meter lengths of wire are directly usable for producing multi-kilometer lengths of wire. The Pacific Superconductors pilot production facility in San Diego is proceeding to make wires over a kilometer in length and has a production capability of three kilometers of wire per month. For more information contact: Dr. Robert A. Olstad, Director, Pacific Superconductors Division, at (619)455-4060. ▲

Side-pumped solid-state lasers now have efficiencies approaching those of diode end-pump systems. According to D. Caffey and R. Utano [*Appl. Phys. Lett.* 56, 808-10 (1990)], the side-pumped design enables scaling to higher energies by increasing the number of diodes and lengthening the laser media. Plans are being made to make diode-pumped solid-state lasers operate at a level of 1.0 J. The authors report that neodymium-doped gadolinium scandium gallium garnet (Nd:GSGG) material allows higher energy densities to be achieved as compared with solid state Nd-YAG. The Nd:GSGG has a smaller stimulated emission cross section thus having a higher output pulse energy. These higher energy densities can be achieved by using shorter rods and slabs and pumping with high brightness arrays and fiber-coupled arrays. Nd:GSGG has many advantages over Nd:YAG material: GSGG can be grown in large diameter core-free boules allowing large aperature rods and slabs to be produced, and it can be doped over a wider range of Nd concentrations than YAG without degrading optical quality while at the same time maintaining the Nd^{3+} fluorescence lifetime. These advantages are probably a result of the larger lattice parameter of GSGG. A large lattice parameter results in increased separation between neighboring Nd^{3+}, and less fluorescent quenching, and reduced phonon energies due to the high atomic masses of Gd and Ga. ▲

Appointment

Dr. K. S. V. L. Narasimhan has been appointed vice president, Technology of Hoeganaes Magnetic Operation. He previously served the company as general manager. In his new position, he will be responsible for 60 metallurgists, laboratory personnel and quality control technicians. ▲

$NdGaO_3$ Single Crystal Substrates

Marketech International now offers single crystal neodymium gallate for use as a substrate for superconductor thin films. $NdGaO_3$ is reported to have a dielectric constant and crystal structure similar to $LaAlO_3$ but does not undergo a phase transition in the normal processing temperature range for superconductor films. The transition and the accompanying volume change can be disruptive to the deposited films when the system is cooled to room temperature or below. The transition temperature for neodymium gallate of 1350°C is well above most film deposition temperatures as well as the transition temperatures for lanthanum aluminate of 500°C.

$NdGaO_3$ has a distorted perovskite crystal structure and can be produced twin free. The substrates can be polished on one or both sides with an epitaxial polish and are currently available in sizes up to one inch in diameter. Larger sizes are under development.

For more information contact Marketech International, 414 South Craig Street, Suite 300, Pittsburgh, PA 15213 Tel:(412)421-3103. ▲

Er Luminescence

Although Er-doping has never before led to the emergence of narrow line luminescence structures, T. Oestereich, C. Swiatkowski, and I. Broser [*Appl. Phys. Lett.* 56, 446-7 (1990) report the observation of a sharp peak in the broad luminescence spectrum of hydrogenated amorphous silicon (a-Si:H). The semiconducting a-Si:H material is primarily used as a photovoltaic cell. One of the main interests is in improving solar cell efficiency. Another application is the development of amorphous IR light-emitting diodes or lasers in a frequency range compatible with fiber optic transmission.

The experiment was carried out by exciting the Er-doped a-Si:H sample inside a cryostat with an argon laser or a xenon lamp. It was found that even at room temperature, Er^{3+} luminescence could be detected.

This discovery enables scientists to investigate the structure of amorphous solid-state systems including a-Si:H. In this method, the splitting of 4f levels by the crystal field of the amorphous host can be investigated. This information in turn allows one to study the structure of the amorphous solid. ▲

25 *The Rare Earths and I* 25

A story contributed for the 25th anniversary of the RIC by

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"EXPLODING" RARE EARTHS- MY FIRST DELVE INTO THE RARE AND EARTHY WORLD OF RARE EARTHS

In fall 1972 I had just accomplished my German diploma at Karlsruhe University under the care of Professor Baernighausen and started working at Ames Laboratory in Dr. Corbett's group on an exchange visitor scholarship to complete experimental work on my thesis. External work for a local diploma was rather unusual at the time and arrangements for the visit, projected to run for eight months, had been made in a rather sudden manner. So, not even having tasted science in Germany, I quite unexpectedly found myself entrenched with a new culture at a sizable American research institution.

From the beginning I was impressed by the amount of technical support given to the smooth functioning of science at the Laboratory and the dedication and diligence of the staff - something unheard of and unthinkable for a German university from those days up to now. This ranged from the workshops and the storeroom for consumables, over the glass cleaning service, the guards, the in-house medical doctor (who thought I could "lose an inch", which I subsequently did), the automatic-lock back door for the untiring night-owls, the drafting room and the library service, to the computation center of ISU and, naturally, RIC. Karl Gschneidner gave me a warm welcome there, not to mention, of course, Dr. Corbett's expert and friendly guidance. Nancy Kippenhan and Jennings Capellen are names from the RIC staff I can still recall from memory.

Procuring a nice chunk of metallic Ho from the vaults (filled with overwhelming piles of rare earth metal ingots) with a note personally signed by Frank H. Spedding involved a visit at the great scientist's office and a chat for which he took almost half an hour of his precious time. After having settled in and having given the lab assigned to me a twice-over with the vacuum cleaner and soap and brush (a chore, I think, no graduate student will ever escape), I set to work on the Ho-$HoCl_3$ phase diagram. Within two weeks (the culture shock was to hit me, but two months later) I learned the technique of arc-welding the tantalum containers necessary to handle rare earth halides at high temperatures and produced a good sized amount of beautifully crystalline anhydrous $HoCl_3$ from Ho and HCl. That reaction, by the way, is always to be favored over all other halogenation and dehydration techniques when purity of the halides is at stake.

Shortly after came the day, or better, the night, when I received the very first call on the telephone I had had installed within a day after placing the order (a service virtually unobtainable back home). At 3:20 AM it rang and jolted me out of bed. One of the guards, friendly him, called. My English being not very workable yet, especially that early in the morning, it took one or two minutes to get the message. An "explosion", as he called it, had occurred in my lab and I'd better check, although no immediate danger was imminent as far as he could judge.

Drowsily I scrambled into my clothes and made my way from my off-campus home across the ISU campus to the Research Building (now known as Spedding Hall). What had happened was this: I had hooked up a quartz tube within a vertical furnace at 850°C to a vacuum line under dynamic vacuum, with a sealed Ta crucible containing the sample inside the tube, suspended from a Ta wire. The lower end of the tube outside the furnace sat in a dry ice cold trap and held a reservoir of silicon oil about eight inches deep. In that thick and slushy 80° C oil the crucible was supposed to be quenched by releasing the wire from a turnable glass hook reaching sideways into the interior through a taper at the top.

For reasons governed by Murphy's Law the vacuum had gone bad through a grease channel along one of the unused stopcocks of the line. The Ta wire had slowly oxidized in the hot zone and finally given in to the weight of the crucible suspended from it. Governed by Newton's Law, in spite of its mere 15g, the crucible, redhot, had shot down some 20 inches (50 cm) into the bottom, quickly liquefied the silicon oil sludge along its passage and knocked out the lower end of the cold trap. Newton's Law overruled by the power of the running vacuum pump, the silicon oil had been sucked up into the hot tube and been pyrolized there by what is known as a liquid-gas decomposition reaction. The gases, finally, by action of a combination of Boyle-Marriott's, Gay-Lussac's and Henry's Law, had escaped the scene by blowing the top of the tube, hook, top taper and all, up into the air, carrying a spray of unburnt oil into the surroundings and leaving a big, greyish stain on the ceiling. The sample itself was not hurt.

This was, in a way, funny (the cleaning round wasn't), especially because it would have happened the same way had I deliberately turned the hook in the morning, and, it taught me a lesson. The remedy was, of course, to take better care of the vacuum line and to use steel wool in the oil for the future experiments. These, eventually, led to my introducing the Ta welding technique back at my German institute and the subsequent structural characterization and understanding of the crystallography of the reduced rare earth halides. ▲

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Thermite Reduction Process/*Continued from page 1* ⇨

utilizes scrap instead of expensive raw materials, produces neodymium-iron alloys needed to make high-energy magnets used in appliance motors and automobiles. The cost-effective process makes available neodymium-iron alloys for US$44.00/kg. The developers of the process are Rick Schmidt, David Peterson, and John Wheelock. ▲

CEAM

A book entitled *Concerted European Action on Magnets* edited by I.V. Mitchell, J.M.D. Coey, D. Givord, I.R. Harris, and R. Hanitsch is a compilation of 63 papers dealing with rare earth permanent magnets. The book brings together 120 scientists and engineers from 58 laboratories and their research during a 30-month period. Every aspect of iron-based high performance magnets, from theoretical modeling of their intrinsic magnetic properties to the design and construction of novel electrical devices and machines, is presented.

The 928-page book organizes the presented papers into the areas of: new phases, structures and properties; magnetic properties; atomic scale magnetism; phase relations; microstructure; ingot materials; production of magnetic materials; new processes; rotating machines; and static permanent magnet devices. The chapters are arranged under three main headings: Materials, Magnet Processing, and Applications. The importance of Nd-Fe-B magnets and the use of other rare earths in magnetic materials is reinforced by the sheer volume of material published. Rare earthers interested in these subjects will appreciate the summary of discussion that is presented at the end of each of the 10 chapters. The book is complete with 113 tables and 533 illustrations.

Concerted European Action on Magnets was published in 1989 and is available in the U.S.A. and Canada from Elsevier Science Publishing Co., Inc., 655 Avenue of the Americas, New York, NY 10010, U.S.A. Outside the U.S.A and Canada; Elsevier Science Publishers LTD, Crown House, Linton Road, Barking Essex IG11 8JU, England. The cost of the book is US$171.00. ▲

Russian Acquisition

The RIC has received the Russian book *Teplofizicheskie Svoystva Metallov Pri Vrsokikh Temperaturakh (Thermophysical Properties of Metals at High Temperature).* The book includes articles, tables, and graphs on the results of thermophysical research on the rare earths and other metals.

The 384-page hard cover book was published in 1989 and was written by V.E. Zinov'ev. No information is given on the price of the book but interested parties can contact the author at Sverdlovsk Mining Institute, Kuybishev str., 30, Sverdlovsk 620001, USSR. ▲

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Since the last issue of the *RIC News* went to press, RIC has received support from 9 new family members, and renewed support from 31 other organizations.

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