Rare-earth Information Center NEWS

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

Volume XXIX | March 1, 1994 | No. 1

E.O. Hulburt Award

Norman C. Koon

Dr. Norman C. Koon, head of the Magnetic Interactions Section of the Naval Research Laboratory's Materials Science and Technology Division, has been named the recipient of the Laboratory's E.O. Hulburt Science and Engineering Award. This award is the highest civilian honor and is presented annually in recognition of scientific and engineering achievement.

Dr. Koon was recognized for his "sustained, important, and continuing contributions to the science and technology of rare earth-transition metal materials. He was also cited for being an 'idea' person, with the proven ability to create an almost entirely new field of endeavor, as he did with the rare earth-iron-boron permanent magnet materials. He was also cited for determining the structural origins of perpendicular magnetic anisotropy in amorphous TbFe films. ▲

Honorary Degree

On November 3, 1993, the Saint Petersburg Mining Institute, Russia, celebrated its 220th anniversary by bestowing an honorary Doctor of Science degree to Fathi Habashi, professor of extractive metallurgy at Laval University in Quebec City, Canada, "for his contribution in the development of the theory of hydrometallurgy". Professor Habashi graduated from the University of Cairo in 1949 and earned a Dr. Techn. degree from the Technical University of Vienna in 1959. He is best known through his three-volume work "Principles of Extractive Metallurgy" and his 700-page book "A Textbook of Hydrometallurgy". ▲

Handbook Volume 17

Seven years in the making, volume **17** of the *Handbook* series is the first of a three-volume set of reviews devoted to the interrelationships, similarities, differences and contrasts of the lanthanide and actinide series of elements. This special set of volumes contains research results of authors who have considerable experience and knowledge of both series of elements. The previous editors of the well-established Handbook series, K.A. Gschneidner, Jr. and L. Eyring, decided that representatives from the *other f*-elements would be needed. Thus, G.H. Lander and G.R. Choppin were invited to be guest editors for these three lanthanide/actinide volumes. The first of the three-volume set appears as Volume **17** of the *Handbook on the Physics and Chemistry of the Rare Earths*, and is entitled: Lanthanides/Actinides: Physics-I.

This volume contains 8 chapters which deal with some of the physical aspects of the lanthanide and actinide series. The first three chapters are theoretical in nature and the last five are more oriented toward experimental studies. These chapters cover: electronic structure, Fermi surfaces, and superconductivity in *f* electron metals; phenomenological approach to heavy-fermion systems; theory of cohesion in rare earths and actinides; structural aspects of high-pressure studies; magnetic measurements on rare earth and actinide monopnictides and monochacogenides; transport properties of rare earth and actinide intermetallics; Mössbauer studies on electronic structure of intermetallic compounds; neutron elastic scattering from actinides and anomalous lanthanides.

The 769-page Volume **17**: "Lanthanides/Actinides: Physics-I" of the *Handbook on the Chemistry and Physics of Rare Earths* was published in 1993 and includes subject and author indices. The cost of the volume is $334.50 US. Customers in the U.S.A. and

Continued in next column ⟲

ACS Award

Tobin J. Marks

Tobin J. Marks, a Charles E. & Emma H. Morrison Professor of Chemistry and Professor of Materials Science and Engineering at Northwestern University, was awarded the American Chemical Society (ACS) Award in Inorganic Chemistry. Prof. Marks has had a major impact on several areas of inorganic chemistry, with seminal work in solid state, rare earth and actinide, organometallic, bioinorganic, and borohydride chemistry. Since the mid-1980's, he has been one of the four most cited inorganic chemists.

Marks' first achievement was in solid-state chemistry, where he created a rational synthetic route to molecular conductors. This method utilized Raman and Mössbauer techniques to trace the fate of the iodine oxidant in iodine-129. This enabled him to show the need for partial oxidation to achieve metallic character. These same techniques were used to clarify the structure of starch-iodine.

Professor Marks has also developed approaches to growing films of several classes of high-T_c superconductors using metalorganic chemical vapor phase deposition (MOCVD). His latest work involved the preparation of YBCO films by organometallic beam epitaxy and the deposition of $Bi_2Sr_2CaCu_2O_{(x)}$ superconducting thin films deposited on $LaAlO_3$ substrates by solid phase epitaxy and MOCVD. RIC congratulates Prof. Marks for receiving the ACS award. ▲

Canada should send their orders to: Elsevier Science Inc., P.O. Box 945, Madison Square Station, New York, NY 10160-0757; Tel:212

Continued on page 7 ⟲

Conference Calendar

*** A NEWS STORY THIS ISSUE**

April '94

Polymer Bonded Magnets 94
Chicago, Illinois, USA
April 12-13, 1994
*This issue

May '94

China Magnetic Materials Conference & Plant Tours
Beijing, China
May 9-11, 1994
RIC News, XXVIII, [3] 2 (1993)
*Also this issue

9th International Symposium on Non-Oxide Glasses (Halide Glasses)
Hangzhou, Zhejiang, People's Republic of China
May 24-28, 1994
RIC News, XXVIII, [4] 2 (1993)

June '94

Interstitial Alloys for Reduced Energy Consumption and Pollution
Il Ciocco, Castelvecchio Pascoli, Italy
June 12-24, 1994
RIC News, XXVIII, [4] 2 (1993)

International Conference on Nitromagnetics (ICN'94)
Honolulu, Hawaii, USA
June 15-17, 1994
RIC News, XXVIII, [2] 2 (1993)
*Also this issue

6th Joint MMM-Intermag Conference
Albuquerque, New Mexico, USA
June 20-23, 1994
*This issue

Novel Magnetic Structures and Properties
Santa Fe, New Mexico, USA
June 24-25, 1994
*This Issue

July '94

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

August '94

2nd International Conference off-Elements (ICFE-2)
Helsinki, Finland
August 1-5, 1994
RIC News, XXVIII, [3] 2 (1993)

Relativistic Effects in Heavy-Element Chemistry and Physics: Electronic Structure Methods for Lanthanides and Actinides
Helsinki, Finland
August 8-9, 1994
RIC News, XXVIII, [4] 2 (1993)

Strongly Correlated Electron Systems
Amsterdam, The Netherlands
August 15-18, 1994
RIC News, XXVIII, [3] 2 (1993)

International Conference on Magnetism
Warsaw, Poland
August 22-26, 1994
RIC News, XXVIII, [3] 2 (1993)

Fourth International Symposium on Magnetic Bearings
Zurich, Switzerland
August 23-26, 1994
*This issue

4th International Symposium on Research in High Magnetic Fields
Nijmegen, The Netherlands
August 29-31, 1994
RIC News, XXVIII, [3] 2 (1993)

September '94

14th International Colloquium on Ma netic Films and Surfaces
Düsseldorf, Germany
August 29-September 2, 1994
RIC News, XXVIII, [3] 2 (1993)

Thirteenth International Workshop o Rare-Earth Magnets and Their Applica tions and Eighth International Sympo sium on Magnetic Anisotropy and Coer civity in Rare-Earth Transition Meta Alloys
Birmingham, England
September 11-15, 1994
RIC News, XXVIII, [4] 2 (1993)

August '95

The Third International Conference o Rare Earth Development & Application
Baotou, Inner Mongolia, China
August 21-25, 1995
*This issue

September '95

European Magnetic Materials and Ap plications Conference (EMMA 95)
Wein, Austria
September 4-8, 1995
*This issue

1996

21st Rare Earth Research Conference (RERC)
Charlottesville, Virginia, U.S.A.
1996
RIC News, XXVIII, [4] 2 (1993)

Magnet Scrap Recovery

The U.S. Bureau of Mines has recently developed technology to treat and recycle a variety of wastes that contain valuable and strategic materials. Part of this effort concentrated on a process to reclaim neodymium and other rare earths from iron in NdFEB permanent magnet scrap. Scrap material from rare earth permanent magnet production typically contains about 30 weight percent neodymium. Since the demand for this important magnetic material constituent is ever increasing in importance, cost-effective methods of recovery could have a significant impact on the rare earth permanent magnet industry.

The scrap recovery process uses a hydrometallurgical, H_2SO_4 dissolution-precipitation technique for separating rare eartl from the NdFeB scrap material. The pr cess first involves selecting rare earth ma net scrap to be recycled, it is then crushe and dissolved in H_2SO_4. The leachate transported to a reaction vessel containir NH_4OH, mixed, and the resultant precip tate filtered to separate Neodymium doubl salts from the spent leach solution. The N

Continued on page 8

International Symposium on Magnetic Bearings

The Fourth International Symposium on Magnetic Bearings will be held August 23-26, 1994 in Zürich, Switzerland. The '94 Symposium will cover all aspects of magnetic bearings, with special emphasis on field experiences and applications. Session topics include: Applications, Case Studies; Field Experiences; Safety and Reliability Aspects; Components and Materials; Modeling, Dynamics and Control; and Superconductivity, Micro Bearings and other new areas.

The symposium will be accompanied by a product exhibition. Magnetic bearing manufacturers, as well as research labs, are encouraged to present their magnetic bearing systems, as well as products and components to an international community of magnetic bearing specialists. For additional information contact Gerhard Schweitzer, ETH Center/LEO, 8092 Zürich, Switzerland; Tel:41 1 632 35 84; Fax:41 1 252 02 76; E-mail: AMB@ifr.ethz.ch. ▲

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 {*RIC News*, **XXVIII**, [2] 2 (1993)}. Abstracts for this conference should be submitted by March 31, 1994, and manuscripts are to be on hand by June 15-17, 1994. For more information or for the second circular, contact: 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. ▲

Neomax

Sumitomo Special Metals America, Inc., is commercially mass producing one of the highest energy product NdFeB permanent magnet materials. This material has an energy product (BHmax) that surpasses their previous best material (NEOMAX-46) by 18%. This new super high energy NEOMAX exhibits an energy product of 54.2 MGOe, has a remanence of 14.95 kG, and a coercivity of 10.57 kOe ($_bH_c$=10.57 and $_iH_c$=10.62 kOe). This new material will be available next month.

For more information or to place an order, contact: Sumitomo Special Metals America, Inc., 23326 Hawthorne Blvd., Suite 360, Skypark 10, Torrance, CA 90505 USA; Tel:310 378 7886; Fax:310 378 0108. ▲

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 now seeking partners for joint venture operations.

The People's Republic of China is fast developing its resources and the plans that will impact the producers of permanent magnets world-wide. To de-mystify the Chinese magnetic materials industry and to identify the best opportunities for outside investors, Intertech Conference is planning a two-day international conference May 9-10, 1994, in Beijing, China. In conjunction with this conference will be tours of four manufacturing plants May 11, 1994.

For more information on the 1994 China Conference and Plant Tours, contact Intertech Conferences, 411 US Route One, Portland, ME 04105 USA; Tel:207 781 9800; Fax:207 781 2150. ▲

Polymer Bonded Magnets 94

Would you like to:

Learn about the exiting new Hydrogenation Decomposition Desorption Recombination (HDDR) process for anisotropic NdFeB permanent magnets? Discover what new high energy ferrite embedding powders will soon be available? Get a balanced assessment of the bonded magnet industry and where the new business opportunities are? Hear how rapid growth in high torque motors, office automation and sensors will affect bonded magnets? Have face-to-face meetings with the leading bonded magnet suppliers and users from around the world? If so, then the two-day conference and business forum *Polymer Bonded Magnets 94* (PBM 94) will interest you. the conference will focus on the fastest growing segment of the global magnetics industry and will be held April 12-13, 1994 in Chicago, Illinois, U.S.A.

For a complete conference agenda, speakers, hotel arrangements and other information on PBM 94, contact: Jennifer Winch, Intertech Conferences, 411 U.S. Route One, Portland, ME 04105 USA; Tel:207 781 9800; Fax:207 781 2150. ▲

The Third International Conference on Rare Earth Development and Applications

The Third International Conference or Rare Earth Development and Applications will be held in Baotou, Inner Mongolia China, August 21-25, 1995. The Confer ence will cover all aspects of rare earth sci ence, technology and applications, with spe cial attention on rapidly developing fields The conference will be represented by thre main sections of rare earth science and tech nology; rare earth materials and applica tions, rare earth chemistry, and rare earl resources and metallurgy. The topics i these three sections include: recent devel opments in permanent magnet materials hydrogen storage materials; high T_c super conductivity; materials of luminescence phosphors and lasers; and rare earth applica tions in steel, cast iron and nonferrous met als. Other topics to be covered in the confer ence are: recent developments in rare earl chemistry, including separation chemistr and new technology for the preparation c high-purity rare earths; catalysts; applica tions in medicine and agriculture; and rar earth resources and metallurgy.

To receive more information, contact: Th Chinese Society of Rare Earths, 76, Xu Yuan Nan Lu, Beijing 100081, P.R. Chin Tel:86 1 8312536;86 1 8312541; Fax:86 2181018; Telex:222297 CISRI CN. ▲

EMMA '95

The European Magnetic Materials an Applications Conference (EMMA '95) wi be held in Wien, Austria, September 4- 1995. The conference will cover all aspec of magnetic materials technology, includin fundamentals and technical applications magnetism.

The broad scientific program will incluc such topics as: amorphous and nano-crysta line magnetic materials; permanent ma nets and their applications; magnetic thi films, multilayers; basic problems of ma netization processes; magnetic semicondu tors, magnetic insulators and microwa applications; magnetic anisotropy, magn tostriction and related phenomena; strong correlated systems, heavy fermions, fluct ating valence, Kondo system and relat topics.

For more information contact: EMMA Vienna, Conference Secretary, Technisc Universität Wien 131, Wiedner Hauptstras 8-10, 1040 Wien, Austria; Fax:43 1 586 31 E-mail:emma95@email.tuwien.ac.at. ▲

Proceedings on Halide Glasses

The 8th International Symposium on Halide Glasses was held in Perros-Guirec, France in September, 1992. The conference was attended by 150 participants including scientists, engineers and chemists from universities & industrial and government research laboratories from over 20 countries around the world. The proceedings of this symposium appear as Volume **161** of *J. Non-Crys. Solids*, (1993). The 333-page soft-bound volume contains 75 papers presented at the conference, was edited by R.A. Weeks and D.L. Kinser, and is complete with subject and author indices.

Much research continues on halide glasses, mostly because of the wonderful properties and potential applications of these materials. Ultralow-loss glass fibers will find increasing uses in long-distance telecommunications, providing scattering and absorption of the signal is effectively controlled. Scientists at British Telecom Laboratories have made progress in this area by decreasing losses from attenuation in halide glass fibers to 0.45 dB/km at 2.35 μm.

An interesting aspect of these glasses is their ability as hosts for optically active dopant components. This interest has produced a series of papers investigating the basic aspects of rare earth dopant ion fluorescence in the glass and reporting on the successful lasing of doped heavy metal fluoride optical fibers. These developments appear in one complete section, "Rare-earth-Doped Glasses and Fibres; Optical Fibre Amplifiers; Spectroscopy" which presents the state of research in rare earth-doped halide glasses in 18 papers. Twenty-five percent of the total number of papers in the book deal with emerging technologies in doping rare earth ions with active halide glass hosts. Other sections includes coverage on raw materials; purification; analysis; glass preform and fabrication; crystallization and defects analysis; structure and glass formation, thermodynamics; properties of glass fibers, corrosion, new glasses and applications; and chalcochlorohalide-TeX glasses.

The Proceedings of this Symposium on Halide Glasses is available for Dfl.423.00 (~$235.00 US) by ordering from the publisher, Elsevier Science Publishers B.V., P.O. Box 103, 1000 AC Amsterdam, The Netherlands, Tel:31 20 586 2911; Fax:31 20 586 2580; Telex:10704. The quoted price includes shipping and handling charges, but does not include Value Added Tax (VAT) applicable to non-VAT customers. ▲

Physical Properties of Actinide and Rare Earth Compounds

A research group to promote studies on the physical properties of actinide and rare earth compounds was organized by Prof. Tadao Kasuya of Tohoku University, Sendai, Japan, in 1988. The group involved in the research included 121 scientists from 29 universities. The project was completed officially in 1991 and the results were recently published. Before research commenced, the group was divided into three sub-groups whose responsibilities were: production of needed compounds and discovery of new actinide materials; measurement of solid-state properties and interpretation of observed results; and development of theory to explain or predict the observed results. Theory, in many cases, proceeded first on rare earth compounds. There, the *c-f* interaction model, in which 4*f* electrons are regarded as localized in atomic many- electron states and interact with the conduction electrons through the intra-atomic *c-f* Coulomb-exchange interaction, as well as through the *c-f* mixing interaction, has been successfully applied for explaining observed phenomena.

Two publications resulted from the efforts of these research groups. The first one included mostly experimental results and the second one mostly theoretical papers. The first book was published in 1993 by the Japanese Journal of Applied Physics' Publication Office as part of *J. Japanese Appl. Phys. Series 8*. It is entitled *Physical Properties of Actinide and Rare Earth Compounds: Search for Heavy Fermion Characters*. It contains seven chapters which include 36 separate papers. Twenty-two of these papers include information on the rare earths, including: new developments in the physics of heavy fermions; heavy fermion behavior in large coordination compounds; optical properties and optical conductivity; observation of Fermi surfaces; and magnetic properties of some cerium and uranium compounds under extreme conditions.

The 290-page book was edited by T. Kasuya, T. Ishii, T. Komatsubara, O. Sakai, N. Môri, and T. Saso. To obtain a copy send ¥10,000 or $85.00 US to Prof. T. Komatsubara, Department of Physics, Faculty of Science, Department of Physics, Tohoku University, Sendai 980, Japan; Tel: 81 22 222 1800; Fax: 81 22 225 1891; Telex: 85256 THUCOM J.

The theoretical aspects of the research was published in *Progress of Theoretical Physics, Supplement Number* **108** in 1992. It is entitled *Physics of f-electron and Related Ph nomena in Strongly Correlated Systems*, ar was edited by O. Sakai and T. Saso. Th volume can be regarded as an activity repo on the theoretical results of the researc group but also was published to commem rate the retirement of Professor Tad Kasuya from Tohoku University in Marc of 1991. He was the main force behind th organization of the research group in 19 and is a pioneer in the study of rare earth an actinide systems, which include strongl correlated 4*f* and 5*f* electrons, and a leadin physicist in solid state physics.

The volume begins with a critical revie on various issues in the heavy Fermion sy tems by Professor Kasuya, followed by ban theoretical approaches for some *f*-electro compounds, which are compared with ex perimental observations on Fermi surface Then, recent developments in the applica tion of the renormalization group metho to the dynamics of the single- an double-impurity Kondo problems and t the Kondo systems with complicated shel structures are reviewed. Some of these ar also treated by the variational approach an the self-consistent perturbation method Next comes a detailed theoretical analysi of the spectroscopic properties of some ac tinide and rare earth ions, through whic most parameters of the ions can be fixed This is followed by a theoretical descriptio of the ground state and low temperatur properties of heavy Fermions by variou methods, including the Fermi liquid theory 1/N expansion, duality theory and others Mechanism and character of the supercon ductivity in heavy Fermion materials are reviewed, mainly in UPt_3, which is interesting because of the possibility of unusual pairing. Progress on the precise understanding of the static properties of the impurity Kondo systems and the strongly correlated one-dimensional electron systems, in terms of the Bethe-Ansatz and/or the conformal field theory are reviewed in subsequent papers. Finally, some basic features of the high Tc cuprate oxides, which are related to the strongly correlated f-electron systems are reviewed.

Progress of Theoretical Physics, Supplement **108** can be ordered from the Publications Office, Progress of Theoretical Physics, c/o Yukawa Hall, Kyoto University, Kyoto 606-01, Japan; Tel:075 722 3540 or 753 7051; Fax:075 722-6339. The price is ¥8,000 abroad and ¥5,000 for individuals (Organizations ¥7500) in Japan. If abroad and paying in dollars add ¥2,500 (to cover bank charges) for a total of ¥10,500 (~$100.00 US) ▲

Workshop and Symposium on Permanent Magnets

The Rare-earth Information Center still has a limited supply 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*.

The cost of the two-volume set is $150.00 US, or $75.00 US for either volume alone. For ordering information, check page 7 of the September 1, 1993 issue of the *RIC News*, or contact the Rare-earth Information Center, Institute for Physical Research and Technology, Iowa State University, Ames, IA 50011-3020, USA; Tel:515 294 2272; Fax:515 294 3709. ▲

Sm-Co for Magnetic Storage

Sustained growth in the areal density of rigid disk magnetic recording media has increased by a factor of ten every decade for the past forty years. Present day high performance magnetic disks operate with a density of 130-150 Mb/in^2 (megabits per square inch) which was unheard of just a few years ago. Recently, new technologies have demonstrated memories of 1 to 2 Gb/in^2 (gigabits per square inch). If these advances continue at the present rate, magnetic memory products with areal densities of 10 Gb/in^2 will be available by 2010 {E.S. Murdock, *IEEE Trans. Magn.*, **28**, [5], 3078-83 (1992)}.

Excellent candidates for future Gb/in^2 recording material are Sm-Co alloys. E.M.T. Velu and D.N. Lambeth {*IEEE Trans Magn.*, **28**, [5], 3249-54 (1992)} have shown that $SmCo_4$ thin films, sandwiched between two Cr layers ~100 nm in thickness, exhibit far superior recording characteristics than any existing recording medium. A thin Cr underlayer (<100 nm) gave the lowest noise of the SmCo media. The $SmCo_4$ films, sputtered onto a Cr (110) film, contain nanocrystallites in an amorphous matrix that were separated by void space and the nonmagnetic Cr layer. This microstructure reduces the noise level in the recording medium because of the large reduction of interparticle exchange interaction. These SmCo nanocrystallites also develop a coercivity of ~3000 Oe, more than twice as large as that of the CoNiCr and CoCrTi materials used in current hard disks, which also suffer from high noise levels. The new SmCo/Cr hard disks were found to have an isolated pulse to integrated noise ratio of 44 dB and an overwritability of better than 45 dB. ▲

Plastic Magnets

Research and development for better rare earth permanent magnets continues, resulting in materials that can be used in a variety of new applications. Two Japanese companies report on breakthroughs that could increase the markets for neodymium-iron-born (Nd-Fe-B) magnets {*Japan New Materials Report*, 8, [3], 10-11 (1993)}. Plastic magnets are produced by forming metallic magnetic powder in a plastic resin matrix.

Thin Ones

Ultra-thin rare earth permanent magnets with thicknesses of 0.5mm are now in production. Seiko-Epson Corporation uses what it claims is the first extrusion process for forming plastic rare earth permanent magnets. This represents nearly half the thickness of rare earth plastic magnets obtained by previous methods.

Rare earth plastic permanent magnets are easily formed into complex shapes as compared to solid ferrite magnets, and at a lower cost. This enables these magnets to be used in applications previously occupied by ferrite magnets, such as in electric motors. This market has been growing at an average annual rate of approximately 20 percent and presents excellent opportunities for rare earth materials.

Most Nd-Fe-B magnets are produced with compression and injection molding techniques. The new extrusion process uses a mixture of magnetic powder and polyamide-based resin. Extrusion takes place by passing the material through a metal mold at a temperature between 200 and 250°C. This technique is also capable of producing tubular and arc-shaped magnets with lengths exceeding one meter. Using these magnets, new long, thin motors are now practical. With uses in DC, stepping and other motors, these magnets will find niches in a wide range of end-uses including cameras and other electronic products.

Hot Ones

Daido Steel Company has started commercial production of plastic Nd-Fe-B magnets that can withstand temperatures of up to 180°C. This compares with a previous maximum temperature of 120°C for the same type of magnet. Low temperature magnets have limited the uses to electronic office machinery, such as printers and fax machines, as well as portable consumer products. Higher temperature magnets can be used in automobiles and other types of heavy machinery. The magnet can withstand the higher temperatures by coating the material with a special resin which prevents oxidation from the higher heat.

The company currently produces 2 mt monthly, but plans to increase production to 10 mt monthly within 3 years. Major applications for these magnets are expected to be in automotive and related industries. ▲

6th Joint MMM-Intermag Conference

The 6th Joint Magnetism and Magnetic Materials (MMM)-Intermag Conference will be held at the Albuquerque Convention Center in Albuquerque, New Mexico, June 20-23, 1994. The Conference will include all areas of basic and applied science and technology related to magnetism. The technical subject categories include: Cooperative Phenomena and Fundamental Magnetic Properties, Transport Properties and Elastic Effects, Magnetic Excitations and High Frequency Phenomena, Soft Magnetic Materials and Applications, Hard Magnetic Materials and Applications (rare earth-transition metal borides, nitrides and carbides), and Magnetic Recording.

The conference will also include a session on interdisciplinary topics and applications to address the areas of: biomagnetism, magnetochemistry, magnetic separation, applied superconductivity, magnetic levitation and propulsion, power and control magnetics, magnetic fluids and other topics.

For more information contact the conference chair: Stanley H. Charap, Department of ECE, Carnegie Mellon University, Pittsburgh, PA 15312 USA; Tel:412 268-3563; Fax:412 268 3497.

Acta Metallurgica Meeting

An Acta Metallurgica Meeting on "Novel Magnetic Structures and Properties" will take place at the Picacho Plaza Hotel, Santa Fe, New Mexico, USA, June 24-5, 1994. This satellite meeting will take place immediately after the Joint 3M-Intermag Conference (see above). Some of the topics to be covered in the meeting include: magnetic granular solids, giant magnetostrictive materials, permanent magnets, magnetic multilayers, soft nanocrystalline materials, magnetic recording media, giant magnetoresistance, magneto-optic multilayers, magnetic heads, magnetic multilayers, and microstructure and magnetic properties of permanent magnet materials.

For more information contact George C. Hadjipanayis, Department of Physics and Astronomy, University of Delaware, Newark, DE 19716, USA; Tel:302 831 2736; Fax:302 831 1637; E-mail: hadji@strauss.udel.edu. ▲

Quality Assurance ISO-9000 Series

In recent years, the increasingly competitive economic environment has created the need for a formal and standardized approach to quality assurance. Commerce of materials and products is made easier with common, mutually acceptable quality standards. A set of standards produced by the International Organization for Standardization (ISO, Switzerland), is the widely accepted approach and will be mandated by many countries for companies planning to establish and implement quality management systems.

RIC will acknowledge those companies that achieve an ISO-9000 series rating for their rare earth and rare earth-containing products. One of the first rare earth companies to achieve this noteworthy accomplishment is Johnson-Matthey Rare Earth Products. If your company has been certified as meeting an ISO-9000 standard, please inform us of this achievement for future listing in this column.

Johnson-Matthey Rare Earth Products, Widnes, Cheshire, England, recently became certified by the British Standards Institute for having met the ISO-9002 quality standards in their product line of rare earth materials. The company continues to develop long term supply arrangements with raw materials suppliers worldwide and has recently established local offices in Moscow and Shanghai. They also annonce that their new Widnes production facility will double by the end of 1994. ▲

Advanced Material Resources Ltd.

Advanced Material Resources Ltd. (AMR), announces the acquisition of an 80% joint venture interest in a rare earth factory on Zibo, Linzi District, Shandong Province, China. The Zibo factory is capable of processing 1,000 tonnes per year of rare earth chloride to produce a variety of high value separated rare earth oxides and metals. The factory already has most of the equipment in place to double its capacity. AMR has invested $3.75 million US in the joint venture.

Mr. Leslie Heymann has been appointed General Manager of the Zibo factory. This is the second of AMR's joint venture in China. In October, AMR acquired a 60% interest in a rare earth factory in Jiangyin, Jiangsu Province {*RIC News*, XXVIII, [4], 6 (1993)}. ▲

Emtech Technology

A Canadian group has teamed up with a major research and development institute in Ukraine to market technology and advanced materials {*The Northern Miner*, August 2, 1993, p.11 (1993)}. Among the new materials to be marketed is a scandium aluminum alloy designed specifically for the aerospace industry.

Emtech's partner in the venture is the I.N. Frantsevich Institute for Problems of Materials Science (IPMS) which was established in 1955. IPMS has been a major source of advanced materials for military and aerospace applications for the U.S.S.R. and Warsaw Pact nations.

Emtech will mine scandium from an underground deposit in central Ukraine. The deposit is located in an operating iron mine and is reported to contain 7.3 million metric tons (mt) ore with a grading of 105 grams scandium per mt. The company plans on increasing scandium production at the mine from two mt, at the present, to 13 mt per year within 24 months. For more information contact: Emtech Technology, 2486 Dunwin Dr., Mississauga, Ontario L5L 1J7 Canada; Tel: 416 820 3030; Fax: 416 820 6060. ▲

New Magnetic Refrigerator Material

U.S. Department of Energy researchers at Iowa State University have developed a material that can be used in magnetic refrigerators that are designed to liquify hydrogen and other cryogenic gases more efficiently. Commercial realization of this new process could lead to less expensive liquid hydrogen. The new material, $(Dy_{0.5}Er_{0.5})Al_2$, uses the magnetocaloric effect to achieve this cooling as a magnetic field in alternately turned on and off. This Dy-Er-Al alloy, when used in magnetic refrigerators, are expected to replace conventional cooling units that use compressors to compress and expand gases in their heating-cooling cycles.

Current designs of active magnetic regenerative (AMR) magnetic refrigerators (MR) for the liquifaction of hydrogen gas are based on a modified Joule-Brayton cycle using GdPd in the low temperature stage. The low-temperature magnetic properties of GdPd made it the material of choice. However, the magnetocaloric properties of $(Dy_{0.5}Er_{0.5})Al_2$ have been shown by K.A. Gschneidner, Jr., H. Takeya, J.O. Moorman, and V.K. Pecharsky {*Appl. Phys. Lett.* 64 [2], 253-5 (1994)} to be 30% larger than that of the currently-used material, GdPd.

Two serious problems are associated with GdPd, the high cost of Pd and the ductility of the compound, making it difficult to crush into a fine powder, which is necessary for efficient heat transfer during the various heating and cooling cycles.

The new Dy-Er-Al material is not only cheaper than GdPd by 75%, it is also more brittle, and exhibits a much larger

Continued page 8 ➲

OSMC

The Ovonic Synthetic Materials Company, Inc. (OSMC) recently received a world-wide license from Philips Electronics N.V. to use patented technology related to a new class of lower cost, higher performance rapidly solidified magnetic materials. The new material is called HIREM 12L and has the composition $Nd_4Fe_{75}B_{20}$. The material is produced as a -60 mesh powder and exhibits a maximum energy product BH_{max} of 12.5 MGOe, B_r 11.0 kG, H_{ci} 3.3 kOe and has a density of 7.7 g/cm^3.

These powders will be available to bonded magnet manufacturers whose molded Nd-B-Fe magnets can be used in permanent magnet applications where ease of magnetization, high remanence, and dimensional precision of parts is crucial. For more information about HIREM 12L powders, or the company, contact Jim Flasck, Ovonic Synthetic Materials Company, Inc., 1788 Northwood Drive, Troy, MI 48084 USA; Tel:313 362 1290; Fax:313 362 4043. ▲

Westlake Rare Earth Industries

The Westlake Group has announced the formation of Westlake Rare Earth Industries. The new company will be headquartered in San Mateo, California, USA, and will be in the business of manufacturing and selling rare earth metals, oxides, compounds, phosphors, and glass polishing powder. The company has ten joint ventures in China, including one with Baotou Steel and Rare Earth Company, and another with Boatou Rare Earth Smelting Company. These rare earth smelting plants will employ the latest in advanced manufacturing techniques.

For more information on the company's products and services, contact Dr. J.J. Lin, Westlake Rare Earth Industries, A Division of Westlake Development Co., Inc., Westlake Building, 520 El Camino Real, 9th Fl., San Mateo, CA 94402 USA; Tel:415 579 1010; Fax:415 340 8459. ▲

Success Continues!

1993 was another record year for RIC. During the past year, the Center processed more than 660 separate information requests concerning rare earth metals, compounds, alloys, and other materials, a 34% increase from 1992! Most of the requests came from U.S. industries and academic institutions. Other-than-U.S. industrial concerns made up about 44% of the total, which include U.S. and foreign universities, governments, private individuals, and foreign industries. World-wide industrial requests far outnumbered all others in all categories which is in line with our day-to-day experience of referring customers to rare earth producers and suppliers around the world.

During 1993 we added an additional 7,721 new documents to our data base, a 12.8% increase, which brings the total number of documents in our computer to nearly 70,000. The nature of RIC continues to be truly international as we assisted people from 30 different countries on six continents. Over 12,115 people receive the *RIC News* each quarter (5,126 from the U.S. and 6,989 from other countries).

RIC is able to provide assistance to the rare earth community through the financial support from 185 companies, other organizations, and individuals.

The first quarter of calendar 1994 is promising to be another record year as we have already assisted 10% more companies and individuals than we did during the same time period in 1993. ▲

RIC News

Vol. XXIX, No. 1 March 1, 1994
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

Professor V.P. Zhuze (1904-1993)

Prof. V.P. Zhuze of Ioffe Physico-Technical Institute, Russian Academy of Science, St. Petersburg, Russia, passed away October 1, 1993 at the age of 89. Prof. Zhuze was born in Kazan, and attended Azerbaidzhan University (Baku) in 1925. In 1972 he joined the Physico-Technical Institute, Institute of Semiconductors at St. Petersburg. He eventually became head of the Technical Institute. He was a member of other institutes of the Academy of Sciences of the U.S.S.R. and Russia.

Prof. Zhuze was an apprentice of A.F. Ioffe and studied closely under his guidance. He is best known to rare earthers for his studies of semiconductors and rare earth compounds. He published research results on the optical properties and transport properties of rare earth sesquioxides, chalcogenides and semiconductors, as well as be-

Franklin F.Y. Wang (1928-1993)

Franklin F.Y. Wang, professor of materials science and engineering at the State University of New York at Stony Brook, died on August 30, 1993, after a short illness.

A native of Nanjing, China, he moved to the United States and graduated from Pomona College with a BA in chemistry, earned a master's degree from the University of Toledo, and a PhD degree in ceramics at the University of Illinois.

He worked for several companies, including the A.O. Smith Corporation and the Sperry Research Corporation, before he joined Stony Brook in 1966 to help build the Materials Science Department. In 1978, he helped initiate a National Science Foundation program, Women in Science, which provided graduate training in materials science for women. In 1983 he founded *Materials Letters* and is best known by rare earthers for his research in the electric and magnetic properties of ferrites and related rare earth compounds. Since 1991, he had been on leave to the Materials Research Division of the National Science Foundation. ▲

Handbook*/Continued from page 1* ⇨

633 3650; Fax:212 633 3680; elsewhere: Elsevier Science B.V., P.O. Box 211, 1000 AE Amsterdam, The Netherlands; Tel:31 20 5803 642; Fax:31 20 5803 598. The other two volumes will be in print soon. ▲

Aerosol Doped RE-Silica Waveguides

J.A. Bebbington, G. Barbarossa, J.R. Bonar, and J.S. Aitchison report in *Appl. Phys. Lett.* **62**, 337-9 (1993), the use of Flame Hydrolysis Deposition (FHD) in doping rare earth ions into silica glass on Si. The authors report that the doping levels in the glass were dependent on the nebulized solution strength and the delivery rate of the aerosol to the burner. This technique makes selective area doping possible.

Since there has been growing demand for rare earth integrated optical waveguide lasers and amplifiers, there exists a need for monolithic integration of active and passive optical functions in these materials. The conventional method of fabrication involves partially sintering the deposited soot, and then incorporating rare earth ions into the porous structure, using either solution doping techniques or by vapor phase transport of a rare earth chelate.

This paper descibes FHD doping, the aerosol doping technique, which is similar to that employed to fabricate multicomponent glass fibers by vapor axial deposition (VAD), outside vapor deposition (OVD), and rare earth doped silica fibers by modified chemical vapor phase deposition (MCVD). According to the authors, they used this process for the first time in the planar format which enables regional selective doping and control over the vertical doping profile.

FHD has advantages over conventional methods because doping can be accomplished in one fabrication step during deposition, without needing partial sintering and drying after immersion, as is required in solution doping. In addition, the chemicals are cheaper and the aerosol system is simpler as compared to methods involving vapor phase transport of rare earth chelates.

The system consisted of feeding $SiCl_4$ and PCl_3 to a four-port oxy-hydrogen burner, and then hydrolyzing to form a low density glass soot which is deposited on a Si substrate, which had a 10μm thermally grown SiO_2 buffer layer. Rare earth ions were incorporated into the soot by feeding the burner with the aerosol of an aqueous solution of a rare earth chloride. A polyvinyl chloride pnuematic atomizer and N_2 gas was used to atomize the solution and deliver the droplets to the burner. When the aerosol entered the flame reaction zone, the water evaporated leaving a submicron particle of RE chloride which was oxidized in the oxygen-rich flame. ▲

Supporters 1994

****

Record Quarter!

Since the December issue of the RIC News went to press, RIC has recieved support from 14 new family members, and renewed support from 29 other organizations, making this quarter a record setter! The supporters from the third quarter for 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 parenthesis, are listed below. RIC thanks all of the companies and individuals listed.

The response to our advertisement for new supporters in the December issue of *RIC News* is somewhat satisfactory, reaching about one-third of our goal of 25 companies or organizations as new supporters-we would like to hear from a few more (15) of you in the next few months. It is also very gratifying that five more individuals became supporters of the Center during the last quarter-we really appreciate their financial assistance and confidence in our work and efforts.

Benefactor ($10,000 or more)

Donor ($4000 to $9999)

Sponsor ($2000 to $3900)

Wako Bussan Co., Ltd., Japan (25)

Patron ($1000 to $1999)

Concord Trading Corp., U.S.A. (4)

Nissho Iwai American Corp., U.S.A. (13)

Sustaining ($400 to $999)

Albright & Wilson Americas, U.S.A. (6)

Arnold Engineering Co., U.S.A. (9)

BOSE Corp., U.S.A. (17)

Boulder Scientific Co., U.S.A. (7)

Cabot Corporation, U.S.A. (2)

Daiden Co., Ltd., Japan (3)

Highways International, The Netherlands (2)

Johnson Matthey-Rare Earth Products, U.K. (20)

Magnequench, Delco Remy, a division of General Motors, U.S.A. (9)

Mitsui & Co. (U.S.A.) Inc., U.S.A. (9)

Morgan and Associates, U.S.A. (1)

R.E.M. s.p.r.l., Belgium (1)

Research Institute of Industrial Science & Technology, South Korea (3)

Sausville Chemical Co., Inc., U.S.A. (6)

Schlumberger-Doll Research, U.S.A. (4)

Westlake Rare Earth Industries, U.S.A. (1)

Subscriber (less than $400)

Australian Nuclear Science & Technology Organisation, Australia (3)

Centro de Technologia Mineral, Brazil (2)

Crucible Materials Corp., U.S.A. (20)

Elektro-Thermit GmbH, Germany (22)

Emtech Technology Centre, Canada (1)

F. G. Jones Associates, Ltd., U.S.A. (10)

Ford Motor Company, U.S.A. (7)

H.T.I.E., Inc., U.S.A. (1)

Hicks Dome Corporation, U.S.A. (8)

HJD Intnl, U.S.A. (6)

Kasei Optonix, Ltd., Japan (1)

Kawasaki Steel Corp., Japan (3)

MINTEQ International Inc., U.S.A. (8)

National Institute for Resources and Environment, Japan (2)

Noah Technologies Corp., U.S.A. (1)

Office of Atomic Energy for Peace, Thailand (4)

Princeton Electro-Technology, Inc., U.S.A. (3)

Regional Research Laboratory, Trivandrum, India (6)

Tomen Corporation, Japan (1)

Universidad Nacional de San Luis, Argentina (2)

YBM Technologies Inc., U.S.A. (2)

Individual Supporters

James A. Dresser, U.S.A. (1)

Robert D. Jenkins, U.S.A. (1)

Leon A. Luyckx, U.S.A. (1)

Rod Ruoff, U.S.A. (1)

Scrap Recovery*/Continued from page 2*

double salts are converted with HF to commercially-valuable NdF_3 and the spent leach solution is converted to iron jarosite ($KFe_3(SO_4)_2(OH)_6$) and boron.

United States Patents No. 5,129,945 on *Neodymium Recovery From Magnet Scrap* and No. 5,238,489 on *Treatment for Rare Earth Recovery From Mixed Magnet Swarf* have been awarded for this process. Additional patent information may be obtained by contacting the U.S. Bureau of Mines, Office of Technology Transfer, 801 Seventh Street, NW, Washington, DC 20241 USA; Tel:202 501 9323. For a more detailed description of the process, consult USBM Report of Investigations RI 9481 or contact Jane W. Lyman, Salt Lake City Research Center, U.S. Bureau of Mines, 729 Arapeen Drive, Salt Lake City, UT 84108 USA; Tel:801 584 4151. ▲

New Material*/Continued from page 6*

magnetocaloric effect. The combined effects of increased efficiency and cheaper material makes the total cost of the unit up to 40% cheaper than magnetic refrigerators which use GdPd. ▲

PROMETHIUM, atomic number 61, was discovered in 1947 by J.A. Marinsky, L.E. Glendenin, and C.D. Coryell in the fission products of uranium. The name, from Greek mythology, was derived from Prometheus, who stole fire from heaven and gave it to man.

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