Rare-earth Infomation Center NEWS

Center for Rare Earths and Magnetics
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Gd^{3+} Chelate

Magnetic Resonance Imaging (MRI) is a useful diagnostic tool used in medicine to determine and identify the status of specific types of biological tissue. MRI images are based on nuclear spin transitions of water molecules that occur in the tissue to be studied.

Since not all tissues in a biological system or tissue react the same way to the strong magnetic field generated by the MRI, imaging agents are introduced into the specimen in order to enhance the image. In order to display a brighter image, the signal from water is increased by introducing a selective imaging agent. The typical imaging agent contains a paramagnetic metal ion, such as Gd^{3+}, that couples to the water, resulting in an brighter image. However, the imaging agents that are currently used are non-selective, that is, they enhance the MRI image wherever they are introduced, such as a diseased organ or tissue.

Recent work by T.J. Meade et al. {*Angew. Chem. Int. Ed. Engl.*, **36**, 726 (1997)} reports on the development of a Gd^{3+} clathrate that makes possible selective MRI images. The new agent can be activated and deactivated, like a switch, by controlling the access of water molecules to the Gd ion in the chelate. The "switch" consists of a galactopyranose ring that keeps water out of the chelate until removed by the enzyme β-galactosidase. In this way, only the cells or tissues containing the enzyme have enhanced images, allowing the enzyme to be mapped.

New imaging agents of this type may compete with the more expensive and lower-resolution positron emission tomography (PET) devices. PETs are currently used to provide neuronal activation images by detecting Ca ions in active nerve cells. This information is then used to map brain function. ▲

Honor Roll

20 Years!

BOSE Corporation

10 Years!

Auer Remy GmbH
Ford Motor Company

This year we wish to honor three companies for their long and dedicated support. The BOSE Corporation joins the previous twenty six companies who have contributed to the operation of the Center for 20 years or more.

Two additional companies, Auer Remy GmbH and Ford Motor Company join the growing list of companies who have been with us for at least ten years.

We wish to express our appreciation and gratitude to all three companies for their long and continued support. ▲

Thank-You!

We have completed the massive update of the *RIC News* mailing list. If you know of someone who would be interested in receiving the *News*, just let us know and we will add them to our mailing list.

If you would be interested in receiving an advanced copy of the newsletter via e-mail, just send us a notice and we will send you a copy of the virtual *News*.

We wish to thank all those who sent us not only their updated addresses, but for the kind comments that were included in the requests!

If there is any way that we can improve our services to the rare earth community, please let us know. ▲

1997 Mineral Commodity Summaries

Mineral Commodity Summaries 1997 contains the latest estimates dealing with the non-fuel mineral industry in 1996. Most of the estimates are based on at least 6 months of data. It contains information about the domestic industry structure, government programs, tariffs, and 5-year salient statistics for over 90 individual minerals and materials. The rare earths, scandium and yttrium are listed as three separate groups.

The report indicates that the estimated value of refined rare earths that were consumed in the United States was more than US$500 million. Domestic ore production was estimated to be US$64 million. The approximate distribution in 1995 by market sector was: automotive catalytic converters, 44%; petroleum refining catalysts, 25%; permanent magnets, 11%; glass polishing and ceramics, 9%; metallurgical additives and alloys, 8%; phosphors, 3%; miscellaneous <1%.

The salient statistics in the U.S. included production, imports and exports, consumption, prices of bastnasite and monazite concentrate and mischmetal, and net import reliance as compared to apparent consumption. A brief listing of world mine production, reserves, and reserve base is included.

The *Mineral Commodity Summaries 1997* is available by contacting the U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328 USA. The rare earths, scandium and yttrium portion of the summary was provided by the rare earths expert at the U.S.G.S., James B. Hedrick, 983 National Center, Reston, VA 20192 USA; Tel: 703 648 7725; Fax: 703 648 7722; jhedrick@usgs.gov; http://minerals.er.usgs.gov/minerals/pubs/commodity; www.usgs.gov (main site). ▲

Cryogenic Conference

The 1997 Cryogenic Engineering Conference/International Cryogenic Materials Conference (CEC/ICMC) will be held in Portland, Oregon, July 28 - August 1, 1997. Plenary talks on the main theme of the conference as well as oral and poster sessions will be held. Some of the topics that will be covered are: structural materials, composites for cryogenic applications, low and high temperature superconductors, superconducting materials & cryogenic electronics, aerospace cryogenics, superconducting magnets and systems, novel concepts and new devices, and business prospects in cryogenic equipment and materials.

The *Cryo Expo* will feature the latest in cryogenic materials and engineering during the three days of the conference. Short courses and technical tours organized by the Cryogenic Society of America and CEC/ICMC sponsors will be offered on Monday, July 28 preceeding the technical sessions.

For more information, contact: CEC/ICMC, P.O. Box 25445, Portland, OR 97225-0445 USA; Tel: 503 292 2114; Fax: 503 292 1375; www.orst.edu/groups/cec-icmc97/ ; ewemeco@europa.com. ▲

4th ESTE'97

The fourth International School on Excited States of Transition Elements (4th ESTE'97) is a continuation of the series of successful triennial meetings that are held in Poland under the auspices of the Polish Academy of Sciences and the State Committee for Scientific Research of Poland. The school will be held September 6 - 12, 1997 in Wroclaw-Duszniki Zdroj, Poland and will provide plenary lectures and a broad overview of the current state of the art in the theory and practical applications of optical phenomena in rare earth and transition metal elements. Contributed lectures will emphasize the most recent developments. Poster sessions will address current problems that have not yet been solved. Topics that will be addressed and covered during the school will be: nanometric structures, activated fibers, nonlinear phenomena in crystals, active sol-gel glasses, vibronic interactions, luminescent sensors, and new laser materials.

Contact Dr. Barbara Nissen-Sobocinska, ESTE97 Secretary, Institute for Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 937, PL 50-950 Wroclaw, Poland; Tel: 48 71 343 5021; Fax: 48 71 44 1029; nissen@highscreen.int.pan.wroc.pl. ▲

Conference Calendar

*** A NEWS STORY THIS ISSUE**

July '97

Nuclear Methods in Magnetism
Canberra, Australia
July 21-23, 1997
RIC News **XXXI,** [4] 2 (1996)

Workshop on High Coercivity Materials (H_c-M)
Perth, WA, Australia
July 23-25, 1997
RIC News **XXXI**, [4] 2 (1996)
RIC News **XXXII**, [1] 5 (1997)

International Conference on Magnetism 1997 (ICM'97)
Cairns, Australia
July 27-August 1, 1997
RIC News **XXXI**, [3] 3 (1996)

Cryogenic Engineering Conference/ International Cryogenic Materials Conference (CEC/ICMC) Portland 1997
Portland, Oregon, USA
July 28 - August 1, 1997
*This issue

August '97

5th International Conference on Research in High Magnetic Fields
Sydney, Australia
August 4-6, 1997
RIC News **XXXI**, [4] 2 (1996)

15th International Colloquium on Magnetic Films and Surfaces (ICMFS'97)
Sunshine Coast, Queensland, Australia
August 4-8, 1997
RIC News **XXXI**, [3] 3 (1996)

International Conference on Neutron Scattering
Toronto, Canada
August 17-21, 1997
RIC News **XXXII**, [1] 5 (1997)

September '97

Fourth International School on Excited States of Transition Elements (4th ESTE'97)
Wroclaw-Duszniki Zdroj, Poland
September 6-12, 1997
*This issue

Third International Conference on f Elements (ICFE3)
Paris, France
September 14-19, 1997
RIC News **XXXI**, [2] 3

October '97

Commercializing Fuel Cell Vehicles 97
Frankfurt, Germany
October 22, 1997
RIC News **XXXII**, [1] 2 (1997)

March '98

International Forum on Rare Earths: Technology and Trade
Beijing, China
March 24-26, 1998
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August '98

15th International Workshop on Rare-Earth Permanent Magnets and Their Applications
Dresden, Germany
August 30-September 3, 1998
RIC News **XXXII**, [1] 5 (1997)

September '98

Tenth International Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys
Dresden, Germany
September 4, 1998
RIC News **XXXII**, [1] 5 (1997)

7th European Magnetic Materials & Applications Conference (EMMA'98)
Zaragoza, Spain
September 9-12, 1998
RIC News **XXXII**, [1] 5 (1997)

HAP Spheres

Sixteen years ago, The Japanese government initiated Exploratory Research for Advanced Technology (ERATO) that was to create advances in scientific research and technology. One of the many projects that are supported by ERATO is the Hirao Active Glass Project (HAP) which was started in 1994. HAP primarily deals with the effects and applications of optical computing systems which utilize optical memory, nonlinear optical switches, upconversion lasers, and rare earth-doped laser glasses.

In the recent article "Laser oscillation of Nd^{3+} doped fluoride glass microspheres" by K. Miura et al. {*J. Mat. Sci. Lett.*, **15**, 1854-7 (1996)} the authors report on the continuous laser oscillation on both the $^4F_{3/2}$ - $^4I_{11/2}$ and $^4F_{3/2}$ - $^4I_{18/2}$ transitions of Nd^{3+} ions in Zr-Ba-La-Al-Na (ZBLAN) glass microspheres. When the microspheres were excited by 800 nm emissions from a Ti:Al_2O_3 laser, the threshold oscillations were 5 mW and 60 mW for the $^4F_{3/2}$ - $^4I_{11/2}$ and $^4F_{3/2}$ - $^4I_{18/2}$ transitions, respectively. The experimental results closely match calculated values of the whispering gallery modes that are caused by multiple internal reflections which occur in spherical objects.

The high *Q*-value resonance modes are only achievable in spheres that are chemically etched, which is necessary to obtain a clean surface on the sphere, with minimal scattering losses. The etchant, $ZrOCl_2$ - $8H_2O$ in an ultrasound bath, is also used to control the size of the spheres. In addition, by varying the angle of incident laser light on the microspheres, laser emission can be induced at a single frequency. It is hoped that by controlling the size of the microspheres, the angle of incident laser radiation, choice of dopant ions and host glass composition, HAP will be able to create microspheres which are able to lase at a variety of wavelengths, including the blue and ultraviolet, and which can be stimulated by laser diodes.

For more information on this, and other research currently being conducted at the Hirao Project Office, contact: HAP, 15 Morimoto-cho, Shimogamo, Sakyo-ku, Kyoto 606, Japan; Tel: 81 75 702 7810; Fax: 81 75 702 8351. ▲

Bryan Coles (1926 - 1997)

Professor Bryan Randell Coles, died suddenly at his London home on February 24, 1997. He will be remembered for his contributions to the physics of metals, his encyclopedic knowledge, and his intuitive understanding of the physical properties of metallic alloys and compounds. He earned his B.Sc. in 1947 from the University of Wales, and his D. Phil. at Oxford, where he studied with metallurgist William Hume-Rothery. In 1950, he moved to Imperial College, London where he filled several academic and administrative positions throughout his career. Professor Coles coined the well-known phrase "spin glass" that described the state of frozen-in magnetic disorder in dilute magnetic alloys. His most recent work dealt with the semiconducting-to-metal transition in CeNiSn. ▲

Er^{3+} Optical Waveguides

More and more research on rare earth-doped materials that can be used as optical waveguides is being conducted worldwide. An experiment on erbium-doped calcium fluorite layers has been shown to exhibit favorable characteristics for use as laser waveguides by L.E. Bausá et al. in *Appl. Phys. Lett.* **68** [23], 3242-4 (1996). Other rare earth ions such as Nd^{3+} have shown promise as well, but Er^{3+} ions produce emission at 1.5 μm, the wavelength that coincides with the low loss window of standard optical communication silica fibers.

In the experiment, the researchers produced CaF_2:Er^{3+} thin films that were grown by molecular beam epitaxy. Er^{3+} was deposited on the CaF_2 substrates at a concentration as high as 50 mol %. The resulting films not only demonstrated optical activity due to Er^{3+} ion emission, but also a corresponding increase in the refractive index of the material. The increase of the refractive index was saturated at 35 mol % Er ion concentration. The authors explain this by citing previous work which described the appearance of crystalline phases due to the saturation of the solid solutions of ErF_3 in CaF_2.

The optical quality of the thin film, coupled with the high Er concentration,

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Magnetic Refrigeration

A joint project between Astronautics Corporation of America and Ames Laboratory has resulted in a magnetic refrigeration device that has operated longer than any other similar unit. The unit utilizes the magnetocaloric effect to absorb and release heat in a continuous cycle of operation. The rare earth alloys in the system become hot when magnetized and cool when they are subsequently demagnetized. About three kilograms of gadolinium metal are used in the device.

Magnetic refrigeration has several advantages over conventional gas-compression refrigerators: they do not have the losses that are inherent in gas-compression/expansion systems, which increases their efficiency, and they do not utilize chlorofluorocarbons (CFC's) or ammonia, which in some cases may be hazardous. Another advantage is that the refrigeration materials used in the system can be totally recycled.

Dr. Karl Gschneidner, Jr., one of the researchers that has been involved in the project, said that to him, his unveiling of the system in February was "similar to the day when some twenty scientists led by Enrico Fermi witnessed the first nuclear chain reaction at the University of Chicago." However, he admitted that the magnetic refrigeration system has a long way to go before it is accepted for use worldwide, but in the sense of its potential applications, is comparable to the first steam engine invented by James Watt.

For more information on the project, contact Carl Zimm, Astronautics Technology Center, 5800 Cottage Grove Road, Madison, WI 53716-1387 USA; Tel: 608 221 9001 or Dr. Karl A. Gschneidner, Jr., Ames Laboratory, 255 Spedding, Iowa State University, Ames, IA 5011-3020 USA; Tel: 515 294 7931; Fax: 515 294 9579; cagey@ameslab.gov. ▲

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make this material a good candidate for waveguide lasers operating at single mode for both pumping and emission. For more information on the results of their findings, contact L.E. Bausá, Departmento de Física de Materiales, C-VI, Universidad Autónoma de Madrid, Cantoblanco 28049, Madrid, Spain; lbausa@vml.sdi.uam.es. ▲

"*Extraordinary*" Thermopower

Since the discovery of "colossal" magnetoresistance in mixed valence metallic and ferromagnetic perovskites, the transport properties of these materials have received much attention. Although the research has concentrated on the double exchange mechanism, a detailed microscopic mechanism that is responsible for this phenomenon has not yet been described. The ferromagnetic ordering temperature of these materials have also been explored to find evidence of how colossal magnetoresistance is invoked. Another method to explore carrier dynamics is to monitor the ferromagnetic transition by the use of thermopower.

This was the method was used by J. Fontcuberta, et al., Institut de Ciència de Materials de Barcelona, CSIC Campus U.A.B., Bellaterra 08193, Catalunya, Spain, {*Appl. Phys. Lett.* **68** [16] 2288-90 (1996)} to determine the mechanism of colossal magnetoresistance. The authors prepared their $(La_{1-x}Y_x)_{0.67}Ca_{0.33}MnO_3$ samples by the solid-state reaction of La_2O_3, CaO, Mn_2O_3, and Y_2O_3. The oxides were mixed and heated in air at 900°C for 24 hours, sintered at 1400°C and then confirmed by x-ray and neutron diffraction.

Measurements indicated that the ferromagnetic ordering temperature lowered when maximum resistance occurred in the samples. A strong correlation existed between the size of the lanthanide constituent and the resistivity and ferromagnetic ordering temperature of the material. The thermopower developed in these extraordinary magnetoresistive $(La_{1-x}Y_x)_{0.67}Ca_{0.33}MnO_3$ ceramic oxides increased by as much as 460% as the content of yttrium, with respect to lanthanum, increased. The authors propose that the enhanced thermopower results from a combination of reduced charge carrier mobility and band narrowing as Y content varies. ▲

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International Forum

"The International Forum on Rare Earths: Technology and Trade" will be held in Beijing, China from March 24-28, 1998. For more information, contact Prof. Yu Zongsen, Secretary General, Rare Earths: Technology and Trade, The Chinese Society of Rare Earths, Xueyuan Nanlu 76, Beijing 100081, People's Republic of China; Fax: 86 10 62181018. ▲

Latin American Workshop Proceedings

The proceedings of the III Latin American Workshop, held in Mérida, Venezuela from November 20-24, 1995, *Magnetism, Magnetic Materials and Their Applications* is now available. The volume is a collection of 45 papers (one-fourth deal with rare earth materials) that were presented by over sixty participants from America and Europe which report on the recent research on magnetic materials. Particular attention is paid to fundamental properties, materials preparation, characterization techniques and applications.

The following contributions, among others, should be of interest to rare earthers working in this field: magnetocrystalline anisotropy in rare earth intermetallics, ferromagnetism vs. Kondo effect in normal and superconducting CeT_yX_{4-y}, magnetic phase transition and magnetocrystalline anisotropy of rare earth-transition metal alloys, giant magnetoresistance and related effects in multilayer and granular magnetic materials for practical applications, structural and magnetoelastic studies of TbFe amorphous thin films, exchange interactions in ferrimagnetic rare earth-transition metal multilayers, thermomagnetic and x-ray diffraction analysis of $Nd_3Fe_{29-x}Ti_x$ and $(Nd_{1-x}Y_x)_3Fe_{27.3}Ti_{1.7}$ alloys, electron paramagnetic resonance above ordering temperature in $La_{1-x}Ca_xMnO_{3+\delta}$, and magnetic interactions in enhanced-remanence permanent magnets.

The 366-page hard cover *Magnetism, Magnetic Materials and Their Applications* was published in 1996, was edited by F. Leccabue & V. Sagredo, and contains indexed authors and subjects. The proceedings is available for £61 (US$100.00) through World Scientific Publishing Co. Pte. Ltd., P.O. Box 128, Farrer Road, Singapore 912805; USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661; UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE. ▲

High T_c Series 17 & 18

Studies of High Temperature Superconductors Volumes **17** & **18** are devoted to microwave investigations of ceramic high temperature superconductors. Volume **17** contains 7 chapters in 262 pages which emphasize the experimental techniques and instrumentation that experimental researchers should find useful. All contributions are from established experts in this area and have demonstrated the potential of microwave techniques to meet the basic and applied challenges posed by high temperature superconductors.

Chapter One deals with field modulated microwave absorption, harmonic vibration and magnetic properties of Y-Ba-Cu-O thin films. The next chapter explains magnetic field induced microwave losses in High T_c superconductors and the next two chapters report on the results of microwave magnetoabsorption and dissipation in magnetic fields. Chapters five and six cover surface resistance measurements and techniques in superconducting films. The book finishes with measurements on the microwave penetration depth in high T_c superconductors.

Volume **18** forms the sequel to the previous volume, by providing six chapters in 271 pages, with further microwave studies of superconductors. The first chapter reports on the theoretical and experimental results of radio frequency investigations of superconductors. Chapters two and four deal with surface impedance of superconductors and device applications, as well as circuits and systems. The remaining contributions report on microwave studies of mixed state and superconducting fluctuation in YBaCuO single crystals, zero-field and magnetic field dependent microwave and radio frequency absorption, and anomalous low magnetic field dependence of non-resonant microwave and radio frequency absorption in high temperature superconductors.

Both Volumes were published in 1996, were edited by Anant Narlikar, and are hard cover bound. The cost to receive each volume is US$89.00 and can be ordered from Nova Science Publishers, Inc., 6080 Jericho Turnpike, Suite 207, Commack, NY 11725 USA; Tel: 516 499 3103; Fax: 516 499 3146. ▲

Scandium Films

Recently, aluminum, gallium, and indium-based materials and alloys have made possible new electronic and optoelectronic devices such as field emission transistors (FET) and efficient blue and green light emitting diodes (LED). The use of metals in these devices is essential to their operation.

In a program tasked to explore the feasibility of using group-III nitride metallization and surface epitaxial metals as compliant buffer layers for improved thin film deposition, R. Kaplan et al., from the Naval Research Laboratory, Washington DC 20375, {*Appl. Phys. Lett.*, **68** [23] 3248-50 (1996)} investigated Sc growth on GaN. The team chose scandium metal for four reasons: it has a good lattice match to the basal plane of the wurtzite GaN, it is relatively soft, has good thermal stability, and it is easy to deposit onto a substrate.

The Sc was vaporized at a temperature of ~1600°C and deposited onto *c*-axis oriented GaN/sapphire substrates (1000°C) at a rate of 0.5 nm min^{-1}. The GaN/sapphire substrate was interfaced with a Aluminum nitride buffer layer, while a scandium nitride buffer layer formed at the GaN/Sc interface.

Sc	
==========	ℜ ScN layer
2 μm GaN	
==========	ℜ AlN buffer layer
Sapphire	

The procedure resulted in highly reflective metallic epitaxial films that were used to fabricate electrical contacts that exhibited a 1.0 eV barrier height. This property makes the Sc/ScN/GaN films promising for high temperature applications. ▲

South African Database

The Foundation for Research Development is compiling a database of South African and former South African scientists and researchers who are working at academic institutions and research laboratories in the United States. Respondents should be willing to become involved in human resource development for the benefit of South Africa. For more

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information, contact Mrs. Alanta van Vuuren, Directorate for Science and Technology Policy, Foundation for Research Development (FRD), P.O. Box 2600, Pretoria 0001, South Africa; Tel: 27 12 481 4135; Fax: 27 12 349 1179; alanta@frd.ac.za. ▲

Stable Catalyst

The production of synthesis gas (H_2/CO) is necessary for the production of certain chemical products by using relatively inexpensive and plentiful carbon-based raw materials such as methane and carbon dioxide (CH_4/CO_2). Another factor in utilizing CH_4 and CO_2 in the production of hydrocarbon compounds is that both are surplus environmental greenhouse gases. One of the current methods to produce synthesis gas is by using nickel-based catalysts such as Ni/γ-Al_2O_3, Ni/CaO/γ-Al_2O_3, and Ni/CaO. However, the chemical reactions that take place generate activated carbon species that eventually cover the entire Ni surface, which degrades catalytic activity.

A rare earth-based catalyst, Ni/La_2O_3, was stable in the production of synthesis gas and did not exhibit the continuous deactivation with time on stream as did the previously mentioned Ni-based catalysts. In further contrast to conventional non-rare earth-based catalysts, the Ni/La_2O_3 catalyst showed an *increase* in catalytic activity in the first 2 - 5 hours of conversion, then stabilized regardless of time on stream. The oxidized carbon that formed and deposited on this catalyst did not passivate the Ni surface. The research was conducted by X.E. Verykios et al., Department of Chemical Engineering and Institute of Chemical Engineering & High Temperature Processes, University of Patras, P.O. Box 1414, GR-26500 Patras, Greece and was published in *J. Phys. Chem.*, **100**, 744-54 (1996).

The authors determined that the increase in catalytic activity correlated with increasing concentrations of $La_2O_2CO_3$ and formate species on the catalytic support, suggesting that these species may participate in the surface chemistry to produce synthesis gas. They concluded that the interaction between Ni and La-species created a new type of synergetic site at the Ni-La_2O_3 interfacial area, which assists in the formation of synthesis gas from CH_4 and CO_2. ▲

Erbium Luminescence

Since 1983, when H. Ennen et al. {*Appl. Phys. Lett.*, **43**, 943 (1983)} reported low temperature luminescence at 1.54 μm in erbium-doped silicon (Er:Si), much interest has been given, and research conducted, on the photoluminescent and electroluminescent properties of Er^{3+}-doped silicon and silicon compounds. The impetus behind this interest has been the hope that practical optoelectronic integrated circuits could be developed which could lead to important applications such as chip-to-chip interconnects, parallel computer processing, and the integration of photonics on silicon chips.

A review of the published literature in this area reveals that room temperature luminescence from Er-doped Si-based materials has been accomplished by using: *c*-Si coimplanted by oxygen (Si:O:Er), semi-insulating polycrystalline Si, amorphous Si (*a*-Si), and porous Si (PSi) that had been prepared by electrochemically etching *c*-Si and an electroplating technique used to implant Er^{3+} in PSi. The latest method was demonstrated by L. Tsybeskov et al. {*Appl. Phys. Lett.* **70**, [14] 1790-2 (1997)} and features the doping of Er^{3+} in silicon-rich silicon oxide (SRSO). The paper reports on the photoluminescence from Er-doped SRSO and the electroluminescence from a light emitting diode (LED) that had an active layer made of Er:SRSO.

The porous silicon was doped by Er ions using electroplating and thence converted to SRSO by partial thermal oxidation at 900°C. The resulting room temperature photoluminescence at ~1.5 μm was intense and narrow (≤15 meV) and decreased by less than 50% from 12 to 300K. The authors report that the photoluminescent spectrum revealed no luminescent bands related to Si-band edge recombination, point defects, or dislocations. In addition, they report that Er^{3+} centers are the most efficient radiative recombination centers. The LED, which had an active layer made of Er-doped SRSO, was also manufactured and it exhibited room temperature luminescence at ~1.5 μm.

For more information on their research, contact the authors at the Department of Electrical Engineering, University of Rochester, Rochester, NY 14627 USA; fauchet@ee.rochester.edu. ▲

Handbook Volume 22

The 22nd Volume of the *Handbook on the Physics and Chemistry of Rare Earths* series covers, in six chapters, the various physical aspects of a wide range of rare earth materials. Magnetic phenomena dominate the contents of the first four chapters which deal with thin films and layered structures, and intermetallic and nonmetallic compounds. The last two chapters contain calculated results of coherent emission and electronic structure of lanthanide molecules.

The first chapter (#147 in the series) "Synthesis and properties of single-crystal nanostructures" covers the state-of-the-art of thin films of two rare earth metal systems. The basic properties of lanthanide metals, epitaxial growth of rare earth systems, magnetism of epitaxial rare earth crystals, and two rare earth metal superstructures, including Er-Y, Dy-Y, Ho-Y, Er-Y, and Lu-based superstructures are included. The second chapter "Nanoscale rare earth-transition metal multilayers: magnetic structure and properties" reviews, as well as describes, recent advances in our understanding of magnetic structure, interfacial magnetism, and origin of perpendicular magnetic anisotropy of lanthanide-transition metal nanoscale multilayers. The systems covered in the chapter include Dy-Fe, Dy-Co, Tb-Fe, Gd-Co and Gd-Fe. "The $ThMn_{12}$-type compounds of rare earths and actinides: structure, magnetic and related properties" deals with one of the important series of rare earth intermetallic compounds, including rare earth-aluminides, gallides, and compounds with Si, Ti, Cr, Mn, Mo, W, and Re. The following chapter "Magnetic properties of nonmetallic lanthanide compounds" reviews the specific magnetic and magnetoelastic properties of certain crystals, which are determined by the localized electronic magnetic moments of the lanthanide ions in the crystal lattice and their interactions with each other and surrounding ions. "Coherent emission in rare-earth materials" deals with the broader issues of superradiance, superfluorescence, amplification of spontaneous emission by stimulated emission other than the laser effect and coherent spontaneous emission. The final chapter "Electronic structure calculations for

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molecules containing lanthanide atoms" describes the progress that has been made in electronic structure calculations of lanthanide-containing molecules during the last ten years.

The 816-page hard cover Volume 22 was published in 1996, and in addition to the outstanding quality that we have come to expect from North-Holland publications, comes complete with author and subject indices which make the *Handbook* series such a useful reference tool. The book is available for Dfl. 545.00 (US$341.00) and can be ordered from the Elsevier Science customer service department. Customers in Europe should send their orders to: P.O. Box 211, 1000 AE Amsterdam, The Netherlands; Tel: 31 20 485 3757; Fax: 31 20 485 3432; nlinfo-f@elsevier.nl; in the Americas: P.O. Box 945, New York, NY 10159-0945 USA; Tel:1 212 633 3750; Fax:1 212 633 3764; usinfo-f@elsevier.com; in Japan: 20-12 Yushima 3-chome, Bunkyo-ku, Tokyo, Japan 113; Tel: 81 3 3836 0810; Fax: 81 3 3836 9434 4; forinfo-kyf04035@niftyserve.or.jp. ▲

CREI Newsletter

The China Information Center (CREIC) is located in Baotou, China, near the huge rare earth mineral deposit in Inner Mongolia. CREIC is a non-profit organization that is authorized to provide information concerning the country's rare earth industry and development policies to the world through the bimonthly publication "China Rare Earth Information" (*CREI Newsletter*). The *CREI Newsletter* releases timely information concerning important news in rare earth science and technology, development and application, market and industrial reviews, opportunities, and other topics dealing with rare earths in China.

CREI Newsletter costs US$90.00 per year. For a free sample issue and to request a subscription, contact: CREIC, Mr. Junxi Yan, Director, P.O. Box 131, Baotou, Inner Mongolia 014010, P.R. China; Tel: 86 472 515 4411; Fax: 86 472 515 2008. The authorized distributor is Mr. James Chen, Stanford Materials Co., 120 West Third Avenue, Suite 1110, San Mateo, CA 94402-1502 USA; Tel: 415 348 3482; Fax: 415 348 4263; newsletter@stanfordmaterials.com; http://www.stanfordmaterials.com. ▲

Rare Earth Autos

The demand for permanent magnet materials is at an all-time high, with sales in 1995 exceeding US$3.6 billion ($\times 10^9$) worldwide and a projected annual growth rate of 11%. By 2005, sales of permanent magnet materials is expected to exceed US$10 billion. A major consumer of permanent magnets is the automotive industry, which is under increasing pressure to improve energy efficiency, miniaturization, safety, and vehicle performance. These improvements can be made by increased use of permanent magnets in motors, sensors, and acoustic systems. Hence, Nd-Fe-B permanent magnet materials are poised to solve many of the engineering and marketing challenges in the worldwide automotive industry. Two multiclient studies by Gorham/Intertech Consulting address the part that rare earths will play in future automotive technologies, hybrid vehicles, and the increased use of permanent magnets in automobiles.

Hybrid Electric Propulsion

Hybrid vehicles employ batteries and electric motors in the final drive system, but utilize electric generators powered by an internal combustion engine. The study "Hybrid Electric Propulsion Systems for Future Ultra Low Emission, Fuel-Efficient Vehicles" is a techno-economic assessment and market forecast for new business opportunities to 2010. The 559-page study analyses and evaluates propulsion motors, generators, engines, fuels, power electronics, energy storage systems and control systems that are being considered for use in hybrid vehicles.

Permanent Magnets in Automobiles

The 465-page report "Permanent Magnets in Automobiles - Market Forecasts, Technical Analysis and Strategic Outlook to 2005" addresses future automotive demand for Nd-Fe-B permanent magnets and how this demand will impact the pricing and availability of ferrite magnets.

For more information on these multiclient studies, contact Catherine Murray, Gorham/Intertech Consulting, 411 U.S. Route One, Portland, ME 04105 USA; Tel: 207 781 9800; Fax: 207 781 2150. ▲

Rare-Earth Iron Permanent Magnets

The research and development of rare earth permanent magnet materials has been responsible for the recent progress made in this fascinating field. The energy product, (*BH*), of all types of permanent magnets over the past century, including steel, Alnico, ferrite, and rare earth permanent magnets, has increased exponentially, doubling every twelve years. The leading authorities on rare earth permanent magnet theory, production, applications, and processing have joined forces and produced a book that covers the state of current knowledge of permanent magnet materials that utilize iron as the major component, *Rare-earth Iron Permanent Magnets*.

The book presents the important topics of rare earth iron permanent magnet materials in eleven chapters. The first chapter introduces the reader to the basic concepts of magnetism by explaining the units used in describing the strength and magnetic properties of these materials, and their resulting magnetic fields. Atomic scale magnetism, intermetallic compounds, and applications are also included. The next chapter contains experimental methods that are used to determine the intrinsic magnetic properties of primarily $R_2T_{14}B$ compounds, where R=Y, Nd, Gd, Lu and T=Fe and Co. The next two chapters cover phase relations in binary systems, the ternary Nd-Fe-B system, quaternary systems, and additions to Sm-Co. The interstitial modification of the compounds by adding carbon, nitrogen and hydrogen are introduced. The chapter on magnetic coercivity explains the theory behind the experimental results of magnetization reversal of the $R_2Fe_{14}B$ hard magnetic phase, sintered Nd-Fe-B magnets and those magnets prepared from ribbons, and a discussion of the coercivity mechanisms of R-Fe-B magnets. Chapter six explores microstructure and magnetic domains of rare earth iron permanent magnets, and the following chapter describes Nd-Fe-B and Sm-Fe-N magnet processing. The final four chapters will be of interest to those not only involved in research, but those interested in the uses and industrial applications of rare

Continued in next column ☛

earth permanent magnets. Static applications of permanent magnets, magnetomechanical devices, permanent magnet motors, and permanent magnet actuators, will be interesting reading for those involved in manufacturing devices that utilize these materials, as well as those companies that provide the raw materials for the production of rare earth permanent magnet materials.

The authors have assisted the reader by providing as many diagrams, tables, graphs, photographs, and figures as is practicable. The photographs of single crystal $Nd_2Fe_{14}B$ and $Y_2Fe_{14}B$ samples, the sintering process, and diagrams of resin coating and of gas atomization will interest those unfamiliar with the industry.

The 522-page *Rare-earth Iron Permanent Magnets* contains a subject and formula index, was published in 1996, and was edited by J.M.D. Coey, Trinity College, Dublin. The book is hard bound and is available for US$135.00 by contacting Oxford University Press, Inc., 2001 Evans Road, Cary, NC 27513 USA; Tel: 919 677 0977 (in the USA: 800 451 7556); Fax: 919 677 1303. ▲

Element Sixty-One
Pm

In 1902 Branner predicted the existence of an element between neodymium and samarium on the periodic table of the elements. This was confirmed by Moseley in 1914. Later, several workers attempted to find detectable quantities in naturally-occurring rare earth concentrates, and even assigned the names "illinium" and "florentium", independent of each other, to element 61. However, these claims were not allowed.

The first positive identification of element 61 was performed by J.A. Marinsky, L.E. Glendenin, and C.D. Coryell in 1945 at the Clinton National Laboratory (now the Oak Ridge National Laboratory). These workers used cation exchange to isolate and identify radio tracer quantities of element 61 from fission fragments of uranium and by the neutron bombardment of neodymium. They originally named the "new" element *prometheum* {*Chem. Eng. News*, **26**, 2346-8 (1948)} but this was changed to

Continued in next column ☛

☛ *Promethium from previous column*

promethium when their claim was recognized and adopted by the International Union of Pure and Applied Chemistry (IUPAC) [promethium is named after *prometheus*, who, according to Greek mythology, stole fire from heaven and gave it to mankind for their benefit, which upset Zeus enough that he condemned Prometheus to an eternity of feeding vultures].

Searches for Pm in the earth's crust have been in vain and it now appears that it does not occur in nature (with the possible exception of naturally-occurring nuclear reactors). However, Pm has been identified by spectrographic analysis near the surface of the star HR^{465} in Andromeda. There are thirteen known isotopes of promethium and none has a half life of longer than 17.7 years (Pm^{145}). Pm^{147} has a half life of 2.5 years and is the most useful while Pm^{145} is the longest lived and is a soft β emitter, although no γ rays are emitted. Salts of promethium, because of their high radioactivity, glow in the dark.

Promethium can be used as a β source for thickness gages and it can be absorbed by a phosphor to produce dependable light for signs and signals. Watch makers have used promethium to make the faces readable in the dark (promethium compounds replaced the use of radium for this purpose since adverse health affects caused it to be banned). The radiation strikes a fluorescent material which causes light to be given off. A wearer of the watch would receive about the same radiation over a year's time as four chest x-rays, provided the face of the watch were worn against the skin without a glass cover {*RIC News*, **XXV**, [2] 7 (1990)}.

Promethium can also be used as a nuclear powered battery, for portable x-ray units, and as auxiliary heat sources for space craft. Work has also been conducted to determine the feasibility Pm^{147} as a heat source for use in artificial hearts. Even though not much is known about promethium metal and promethium compounds/alloys, very little research is currently being conducted. ▲

We will gladly publish any announcement concerning a conference, workshop, forum, short course, or symposium that has rare earth content. Just send us the information. ▲

RECORD QUARTER !

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Since the March issue of the RIC News went to press, RIC has received support from 7 new family members and renewed support from 44 other organizations and individuals. The supporters from the third quarter of the 1997 fiscal year 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.

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