Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
Ames Laboratory
Institute for Physical Research and Technology
Iowa State University, Ames, Iowa 50011-3020 U.S.A.

Volume XXXI December 1, 1996 No. 4

Super ¥AG

The most powerful commercial Yttrium-Aluminum Garnet (YAG) laser has reportedly been developed by Sumitomo Heavy Industries Ltd., 5-9-11 Kita-Shinagawa-ku, Tokyo 141 Japan; Tel: 81 3 5488 8000; Fax: 81 3 5488 8056 {*Japan New Mater. Repts.*, 11 [4], 12 (1996)}. The new laser has a power output of 4 KW and is designed to weld aluminum sheet metal. YAG laser welders allow for higher precision than conventional arc and gas welders currently in operation, which saves time, energy, and construction material. The new laser is planned to be used in the automobile manufacturing process and for building high speed railroad vehicles. ▲

Last Issue?

As we announced on page 3 of the September issue of the *RIC News*, March 1, 1997, is the deadline for those wishing to continue their free subscription to send us their complete mailing address. Since the September announcement, RIC has received over 700 subscription requests. Remember, if you have not sent us your mailing address since September 1, 1996, you have until March 1, 1997 to send us this information if you want to remain on the *RIC News* mailing list (Supporters of the Center do not need to send us this information). For those former subscribers not requesting to stay on the *RIC News* mailing list, the March 1 issue will be their last.

Address additions/changes can be sent to: RIC, 116 Wilhelm Hall, Iowa State University, Ames, IA 50129 USA; Tel: 515 294 2272; Fax: 515 294 3709; ric@ameslab.gov. ▲

Some of the participants of REMXIV which was held September 1-5, 1996, São Paulo, Brazil.

REMXIV

The 14th International Workshop on Rare-Earth Permanent Magnets and Their Applications and the 9th International Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys (REMXIV) was held at the Maksoud Plaza in São Paulo, Brazil. The meeting took place from September 1-5, 1996 and was attended by over 150 persons from 25 countries. The Workshop and Symposium were unique because it was the first time that a meeting of its kind was held in South America. The series began in 1974 in Dayton, Ohio, under the chairmanship of the late Dr. Karl Strnat. Prof. J.M.D. Coey presented the Second Karl Strnat Memorial Lecture; "Permanent Magnetism - A Millennial Perspective".

About 125 papers and posters were presented at the four days. About 20% of these dealt with applications, while 15% dealt with nanocrystalline materials and another 15% on Hydrogenation-Decomposition-Desorption-Recombination (HDDR) processing. The remainder of the papers treated other processing techniques, Nd-Fe-B and $Sm_2Fe_{17}N_x$ materials. For further information on REMXIV, contact Prof. Frank P. Missell, Instituto de Física, Universidade de São Paulo, S.P., Brazil; Fax: 55 11 818 6984; fmissell@iif.usp.br.

The Proceedings of the REMXIV are available from: World Scientific Publishing Co., Pte. Ltd., P.O. Box 128, Farrer Road, Singapore 912805. Customers in the Americas may contact the company at: Suite 1B, 1060 Main Street, River Edge, NJ 07661 USA. European customers may place orders through the UK Office: 57 Shelton Street, Covent Garden, London WC2H 9HE. ▲

ICM'97 Update and Satellites

The location of the International Conference on Magnetism 1997 (ICM'97) has been changed. ICM'97 will be held at the Convention Center, Cairns, Queensland, Australia. The dates remain July 27 - August 1, 1997; http://www.physics.monash.edu.au/~icm.97/.

Satellites

The Nuclear Methods in Magnetism satellite conference will be held in Canberra, ACT, Australia July 21-23, 1997; don@phadfa.ph.adfa.oz.au.

The Workshop on High Coercivity Materials (HCM '97) will be held in Perth, WA, Australia July 23-25, 1997; Dr. Liesl Folks, Tel: 61 9 3802751; Fax: -1014; hcm97@pd.uwa.edu.au.

The International Colloquim on Magnetic Films and Surfaces (ICMFS) will be held at Sunshine Coast, Queensland, August 4-8, 1997; shinjo@sci.kyoto.ac.jp.

The 5th International Conference on Research in High Magnetic Fields, Sydney, NSW, Australia, August 4-6, 1997; rgc@newt.phys.unsw.edu.au.

For more information on ICM'97 or these satellites, contact: The Meeting Planners, I.C.M.'97 Conference Secretariat, 108 Church Street, Hawthorn Victoria 3122, Australia; Tel: 61 3 9819 3700; Fax: 61 3 9819 5978; meeting@access.com.au; http://www.physics.monash.edu.au/~icm97/. ▲

Conference Calendar

*** A NEWS STORY THIS ISSUE**

January '97
Gordon Research Conference on Superconductivity
Ventura, California, USA
January 12-17, 1997
RIC News **XXXI**, [3] 2 (1996)

February '97
Rare Earths: Science, Technology and Applications
Orlando, Florida, USA
February 9-13, 1997
RIC News **XXXI**, [2] 2 (1996)

April '97
Neodymium-Iron-Boron '97
Chicago, Illinois, USA
April 16-17, 1997
*This issue (Page 5)

12th International Conference on Solid Compounds of Transition Elements
Saint-Malo, France
April 22-25, 1997
RIC News **XXXI**, [2] 3 (1996)

July '97
Nuclear Methods in Magnetism
Canberra, Australia
July 21-23, 1997
*This issue (See "Satellites")

Workshop on High Coercivity Materials (HCM '97)
Perth, WA, Australia
July 23-25, 1997
*This issue (See "Satellites")

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

August '97
5th International Conference on Research in High Magnetic Fields
Sydney, Australia
August 4-6, 1997
*This issue (See "Satellites")

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

September '97
Third International Conference on f Elements (ICFE3)
Paris, France
September 14-19, 1997
RIC News **XXXI**, [2] 3 (1996)

Polymer Waveguides

The interest in the possibilities of high speed optical interconnects has stimulated research on electrooptic (EO) polymeric devices. The nonlinear optical polymers that show promise are those that possess a microwave index of refraction that closely resembles their optical index of refraction, which would make phase matching of both wave types possible. The recent improvements in the fabrication of polymer optical waveguides may be yet another niche for rare earths (rare earth ions work nicely as an amplifying optical medium due to their two filled outer shells, 5*s* and 5*p*, and the wavelength of the inner 4*f* shell metastable transitions are relatively insensitive to the host material).

Continued in next two columns ⇨

A study of Nd^{3+} chelate-doped optical polymer waveguides was recently carried out by S. Lin, R.J. Feuerstein and A.D. Mickelson, Dept. of Electrical and Computer Engineering, University of Colorado, Boulder, CO 80309 USA; lins@spot.colorado.edu {*J. Appl. Phys.*, **79**, [6], 2868-2874 (1996)}. The authors made optical quality slab and channel waveguides by producing a high concentration Nd^{3+} polymer by doping fluorinated polyimide with fluorinated neodymium chelate. Following material preparation, they carried out optical absorption and luminescence studies. The Nd^{3+} concentration in the channel waveguides ranged from between 2.3 x $10^{19}/cm^3$ to 1.0 x $10^{20}/cm^3$, which is about half the value in most glass hosts. For the higher ion concentration, the absorption cross section was calculated to be 1.0 x 10^{-20} cm^2 at a wavelength of 799 nm. Photoluminescence turned out to be weak and was attributed to quenching of the active ions caused by multiphonon relaxation. Photoluminescence ranged from 0.88mm to 1.33mm for the tested samples. This makes it promising to possibly create an optically active device with virtually zero loss. This may be possible by incorporating rare earth ions via doped chelates into a polymer. ▲

RE-Doped Semiconductors II

The second Materials Research Society (MRS) symposium on Rare Earth Doped Semiconductors was held in April during the MRS Spring Meeting in San Francisco. The Symposium received 54 contributions from 18 different countries. Research on rare earth-doped semiconductors is mostly motivated by the fact that internal transitions in the rare earth ions can be used to obtain well defined and temperature independent optical emission from these semiconductors. For example, Si, which does not emit light due to its indirect bandgap, does emit light at 1.54 μm when doped with erbium, which is an important communications wavelength.

The topics in the Symposium included: growth mechanisms, structural, electrical and optical properties, excitation mechanisms, as well as electroluminescence and integration. It was reported that rare earth doping can now be accomplished in sufficiently high concentrations in Si as well as III-V semiconductors using molecular beam epitaxy (MBE), chemical vapor phase deposition (CVD) and ion implantation. The challenge is to sufficiently excite the ions and reduce the nonradiative processes that quench the luminescence at high temperatures. Co-doping with impurities such as oxygen and nitrogen has been shown to be essential in achieving this. It was reported that some impurities actually increase the effective solubility of the rare earth dopants, while reducing the luminescence quenching and increasing the electrical quality of the host material. Optimized Si and GaP diodes that were presented have an internal quantum efficiency in the 0.01% range. Several new ideas were presented that would achieve a further 100-fold increase in the efficiency that is required for practical application of rare earth doped semiconductors.

The symposium proceedings will be published as Volume 422 in the MRS proceedings series. ▲

RIC has over 83,000 documents in the computer database.

Handbook Volume 21

The 21st contribution to the *Handbook on the Physics and Chemistry of Rare Earths* series focuses on selected chemical aspects of rare earth materials. The eight chapters in the book cover topics ranging from the basic treatment of crystalline electric field effects and chemical interactions in organic solvents, to separation processes, electrochemical behaviors which impact corrosion, oxidation resistance, chemical energy storage and sensor technology, and to analytical processes.

The first chapter (number 139 in the series) reviews important new solvent extraction procedures as well as emerging alternative separation processes such as photochemical separation, precipitation stripping and supercritical extraction. A simplified flowsheet used at the Yao Long Chemical plant, China, that represents the production of rare earths from monazite is included. The next two chapters deal with corrosion and corrosion control. A wide variety of methods to control corrosion using rare earth solutions and slats that preserve metals and alloys including aluminum and aluminum alloys, steel, magnesium alloys (including alloys processed by rapid solidification) and others, are described. In addition, high temperature corrosion protection, particularly against oxidation, sulfidization and hot-salts is described. The chapter on rare earth inter-metallics, primarily $LaNi_3$-based materials, deals with recyclable, environmentally-friendly, rechargeable, portable metal-hydrogen batteries and their skyrocketing need. This chapter will satisfy anyone wanting a comprehensive, yet readable summary of the current state of rare earth hydride science and its use in batteries. "Chemical Sensors" provides an excellent description of oxygen, fluorine, humidity, SO_2, CO_2, alcohol and hydrocarbon sensors. Many diagrams, tables and figures aid the reader in understanding the operation and applications of these sensors. The last three chapters deal with crystal field in non-metallic rare earth compounds, solvation and anion interaction in organic solvents, and trace determi-

Continued in next column ⇨

Maglev 2000

The development of a maglev (magnetic levitation) transportation test project has been granted US$2 million by the state of Florida {*Superconductor Industry*, **9** [2], 6 (1996)}. The grant calls for a scaled length, fully-operational maglev system that will use superconducting magnets to provide both lift and propulsion. The company that was awarded the grant, Maglev 2000, says that a passenger and freight transportation link to the Kennedy Space Center and the cruise terminal at Cape Canaveral will eventually be built. The test project will also be funded by the National High Magnetic Field Lab at Florida State University and the National Aviation and Transportation Center. The project is estimated to take four and one half years to complete. ▲

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nation of lanthanides in high purity rare earth oxides. The last chapter, "Trace Determination of Lanthanides in High-Purity Rare-Earth Oxides", covers various analytical techniques used to detect impurities and constituent elements in rare earth oxides. This will not only be of interest to research scientists, but should be required reading for those in industry that produce rare earth oxides for the phosphor, garnet, laser glass, bubble memory, and fiber optical industries.

The 436-page hard cover Volume **21** of the *Handbook* series was published in 1995 and contains complete author and subject indexes. The book is available for Dfl 340.00 (US$213.00) and can be ordered from the Elsevier Science Customer Service Department nearest you. 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; E-mail: nlinfo-f@elsevier.nl; in the Americas: P.O. Box 945, New York, NY 10159-0945; Tel:1 212 633 3750; Fax:1 212 633 3764; E-mail: usinfo-f@elsevier.com; in Japan: 20-12 Yushima 3-chome, Bunkyo-ku, Tokyo 113; Tel:81 3 3836 0810; Fax:81 3 3839 4344; E-mail: forinfo-kyf04035@niftyserve.or.jp. ▲

The Magic of Magnets

Among the many books written about magnetism and the uses of magnets, there is at least one that puts the whole field in the perspective of the human experience. *Driving Force* presents the prehistory, history, discovery, development, applications, and the promising future of magnetism and magnets in our world. The 311-page hard cover book was written by James D. Livingston and was published in 1996.

In a lively and lucid style, the author presents the history, principles, and uses of magnetism and permanent magnets in seventeen fun-to-read chapters. Most chapters come supplied with figures, often in the form of cartoons, that illustrate the topic being discussed (a benefit to the magnetically disadvantaged). As the book points out, magnets and magnetism are indeed everywhere, from algae to asteroids, bacteria to Bednorz, rare earths to rail guns and radar, and magnetically-levitated trains to tevatrons. The reader gets the human-element aspect of magnetism as the author relates how magnets were used by William Gilbert, Robert Watson-Watt, James Graham, Emma Hamilton and James Bond.

The book must have a mind of its own. *Driving Force* has found its way into several offices at Ames Laboratory, seemingly under its own power. Once it is part of a library or personal collection, it will be in demand. Actually, the book is hard to put down (perhaps this is a result of biomagnetism?). We highly recommend *Driving Force* for anyone interested in magnetism or permanent magnets. It will be a welcome addition to any high school library, or could be used as an introductory reference book at the college level. However, it has proven to be popular with research scientists as well.

The book is a steal at US$24.95 and can be ordered from Harvard University Press, 79 Garden street, Cambridge, MA 02138-9983 USA; Tel:617 495 2577/2480; Fax (USA):800 962 4983; (International):617 495 8924. ▲

Various law enforcement agencies use Nd-Fe-B permanent magnets to attach explosives to steel structures.

CREIC Newsletter

The *China Rare Earth Information Newsletter* is published six times each year by the China Rare Earth Information Center (CREIC). The newsletter contains timely news releases on discoveries and developments in the science and technology of rare earths, breakthroughs in new applications, and the development of the worldwide rare earth market. The newsletter emphasizes Chinese rare earth research, industry, product development, minerals production, imports/exports, and markets. This is an excellent channel to access information on the hundreds of smelters, refineries, and producers of various rare earth products in China.

The subscription rate of the four-page newsletter for one year is US$90.00. Stanford Materials Company has been authorized to distribute *CREI Newsletter* and will provide a trial issue upon request. For more information, or to subscribe to the *CREI Newsletter*, contact: 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. ▲

Neomax EH

A new neodymium-based permanent magnet capable of producing a high coercive force at temperatures up to 200°C has been developed by Sumitomo Special Metals Company Ltd., 4-7-9 Kitahama, Chuo-ku, Osaka 541 Japan; Tel: 81 6 220 8821; Fax: 81 75 961 4410. The new permanent magnet material has been dubbed "Neomax EH" and expands the operating temperature range of this class of magnetic materials. Until now, Nd-based magnets were limited in their range of applications because they had poor heat resistance.

The new magnet is made possible by a pulverizing process that produces uniform powder particles with a grain size of 5 μm or less. The company plans to develop electric motors for electric automobiles and electric power generators using Neomax EH. ▲

ETREMA Expands

ETREMA (Edge Technologies Rare Earth Magnetostrictive Alloys) Products, Inc. , Ames, Iowa, has begun the process of expanding their production and laboratory facilities. The process calls for a 20,000 square foot addition that will be completed by August, 1997. Edge Technologies, Inc., the parent company, will also use the new space. Additional construction is planned which will increase floor space to a full 90,000 square feet by 2001. The new space will allow the company to develop and produce TERFENOL-D and devices that utilize the terbium-dysprosium-iron magnetostrictive alloy.

The last time the company underwent growth was in 1993 when a new facility, the "McMasters Systems and Research Center" was completed {see *RIC News* **XXVIII** [4], 7 (1993)}. One of the new laboratories will have a specially constructed floor that will isolate it from the rest of the building, thereby eliminating vibrations that can disrupt delicate measurements in optical or other types of test equipment. TERFENOL-D and devices made from the alloy are used in the automotive, aerospace, medical and other industries with applications in sonar, active vibration control, hydraulics and ultrasonics. For more information, contact Bob Clifford, ETREMA Products, Inc., 2500 North Loop Drive, Ames, IA 50010 USA; Tel: (800) 327 7291/515 296 8030; Fax: 515 296 7168.

Meyer Electronik

ETREMA Products, Inc., Ames, Iowa, continues to expand its worldwide marketing presence. Meyer Electronik, Lengerich, Germany, will represent the company's line of TERFENOL-D magnetostrictive alloys. Mr. Larry Larson, President and Chief Executive Officer of ETREMA Products, Inc., says that Meyer has the ability to provide the company with a strong technical presence in the German market.

For more information, contact Meyer Industrie-Electronic GmbH, Carl-Bosch Str., 8, 49525 Lengerich, Germany; Tel:49 05481/93 85 0; Fax: 49 5481/93 85 12. ▲

Samarium-153 is utilized in the radiation therapy of cancer tumors.

NdFeB 97

The tenth international business development conference, "Neodymium-Iron-Boron 97", will be held April 16-18, 1997 in Chicago, Illinois at the Hyatt Regency O'Hare Hotel. Contact Jennifer Winch; Tel: 207 781 9800; Fax: 207 781 21550; info@intertechusa.com. ▲

YBCO Flexible Tape

The potential for high current superconductors to carry electrical power from generating stations to the end user is perhaps one of the strongest incentives to pursue superconductor technology. Many challenges that face researchers have been opponents such as crystal misalignment, "weak-links", brittle materials, and T_c temperatures that still remain to low for practical applications, seem to persevere. However, recent developments in the development of long continuous high current wires appear promising {*Physics News in 1995*, May, 10-11 (1996) point of contact: Martin P. Maley: Tel:505 665 0189; E-mail: maley@rayleigh.lanl.gov }.

A team at Los Alamos National Laboratory (LANL) produced a textured coating of $YBa_2Cu_3O_7$ (YBCO) on a flexible nickel alloy tape. The misalignment of the superconducting oxide grains was less than 6 degrees over the 1 cm x 5 cm area. This resulted in a current-carrying capacity of over 1,000,000 A/cm^2 in the superconductor cross section, at liquid nitrogen temperatures, which is about 1,000 times the current density that can normally be carried by copper wire.

Crystal alignment was controlled by growing the YBCO on a zirconia template produced by the ion-beam-assisted-deposition (IBAD) process. Not only does IBAD inhibit the growth of misaligned crystals, but it is compatible with processing long continuous lengths of tape. The IBAD process uses two argon-ion beams guns. The first beam of energetic ions is aimed at a stabilized target and is used to sputter atoms from the target onto the nickel substrate. The resulting cubic zirconia crystals are then bombarded by a second beam of

Continued in next column ⇨

Molycorp

The various offices of Molycorp have recently moved. The latest information on their addresses follows.

- Molycorp's headquarters can be reached at: Molycorp, Inc., 376 Valencia Avenue, Brea, CA 92823, USA.
- The European Sales Office of Molycorp has moved to a new location: Unocal Chemicals, Europe S.a.r.l., 3, rue du, Commandant Riviére, 75008 Paris, France; Tel: 33 1 40 74 01 01; Fax: 33 1 40 74 01 02.
- The Technical Support and Sales staff can be reached at: Molycorp Inc., 710 Route 46 East, Fairfield, NJ 07004 USA; Tel: 201 808 8880; Fax: 201 808 9060.
- Payments should be sent to: Union Oil Company of California, Molycorp, Inc., P.O. Box 65581-MC, Charlotte, NC 28265-1581 USA. ▲

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ions aimed at a chosen angle of the crystal to be grown. The advantage of this system is that when the preferred orientation of the crystal is achieved, further growth of additional crystal occurs because of ion "channeling". Even small crystal misalignment is corrected by the process of etching. The resulting layer of cubic zirconia is textured about two orthogonal directions and contains no large-scale boundaries. This forms the template by which the YBCO layer is next deposited, by a pulsed-laser method.

The LANL team has been able to grow YBCO layers more than 2.0 mm thick while maintaining crystal alignment as well as the high current densities. The 2.0 mm tape that the team produced is 1 cm wide and carries 200 A at liquid nitrogen temperature, which is adequate for most applications. In addition, the superconducting tape is able to maintain current densities above 100,000 A/cm^2 in magnetic fields above 4 tesla, which indicates that the team was able to reduce "giant flux creep" to acceptable levels.

These recent developments may allow the use of tapes of this type in efficient high-energy electrical motors, generators and solenoids that operate at liquid nitrogen temperatures. ▲

Dragon's Teeth

China continues to impact the rare earth industry by producing and delivering rare earth metals, alloys and compounds to customers worldwide. The Chinese government recently reported that all facets of 1995 rare earth domestic production, consumption and export exceeded 1994 figures {*China Rare Earth Information*, **2**, [3] 1-3 (1996)}.

The country's rare earth mineral production reached 48,002 mt rare earth oxide (REO), which is a 56.6% increase from 1994, while metallurgical-processed materials increased nearly 43% at 40,000 mt. The Chinese economy supported 13,000 mt for internal use, an 18% increase, and exports were up almost 69% with 27,000 mt of rare earths leaving Chinese ports. The country is realize that rare earths are important in developing the economy as the total value of export earnings for 1995 was US$271.29 million.

The increase in exports is claimed to be attributed to two primary factors: 1) the increase in demand of rare earths in the world market, and 2) the improved quality of Chinese rare earth products. The earnings increased at a greater rate than export figures because prices increased as well.

The State Planning Committee completed the Ninth Five-Year Plan for Rare Earth Development during July and agreed that rare earths will be an integral part of the Chinese economic development in the future. The new Five-Year plan calls to continue the development of the country's rare earth industry, which includes finding new applications for rare earths, and to further develop China's role in international markets. (The *China Rare Earth Information* newsletter can be ordered from Mr. Weiji Cui, Baotou Steel & Rare Earth Co. (USA), 520 El Camino Real, Suite 200, San Mateo, CA 94402 USA; Tel: 415 343 6644; Fax: 415 343 6266). ▲

Olympic Dam Marketing Pty. Ltd.

The offices of Olympic Dam Marketing Pty. Ltd., have moved to a new location. They can be reached at: P.O. Box 474, Marleston SA 5033, Australia; Tel:61 8 8405 8200; Fax:61 8 8405 8240. ▲

Thermoelectric Skutterudites

Skutterudites are cobalt arsenate minerals in the cubic crystal system which approximate (Co,Ni)As_3 and exhibit an octahedral habit. The name skutterudite comes from the type locality of the mineral, Skutterude, Norway. When rare earth ions are located in the crystal structure of these minerals, the result is a class of thermoelectric materials that equal the best thermoelectric devices available. Accordingly, B.C. Sales, D. Mandrus, and R.K. Williams [*Science*, **272**, 1325-28 (1996)] of the Solid State Division of Oak Ridge National Laboratory, Oak Ridge, TN 37831 USA claim that these rare earth-filled skutterudites possess the potential for further improvement in thermoelectric efficiency.

Thermoelectricity, or Seebeck effect, occurs when a temperature difference in a particular device results in electrical potential difference, or voltage. This phenomena is primarily utilized in thermocouples for temperature measurement and instrumentation. Other less common uses of the thermoelectric effect are in electronic refrigeration and heating, and to produce electrical power.

Although skutterudites by themselves are very good electrical conductors, they are considered poor candidates to be thermoelectric materials because their thermal conductivities are too high. The Oak Ridge group created skutterudites that were filled with cerium or lanthanum by annealing the compound with these rare earths, effectively "trapping" the ions inside the crystal lattice structure. These ions absorb thermal energy in the lattice which decreases thermal conductivity, an essential characteristic of any thermoelectric device.

Compounds with the "filled" skutterudite structure have the general formula RM_4X_{12} (R= La, Ce, Pr, Nd, or Eu; M= Fe, Ru, or Os; and X= P, As, or Sb). The rare earth skutterudite compounds that were studied were $CeFe_{4-x}Co_xSb_{12}$, $LaFe_3CoSb_{12}$, and $CeFe_3CoSb_{12}$. Other rare earth-skutterudite compounds may yield important improvements in thermoelectric efficiency. ▲

New Piezoelectric Material

Piezoelectric materials are made of the class of crystalline substances that do not posses a center of symmetry. They expand and contract along a crystallographic axis when subject to an electric field. When an AC electric field is applied to the materials they serve as transducers for sonar systems, ultrasonic devices, and loudspeakers. Conversely, they can generate an electric impulse when subjected to physical force, and so have also been used in phonograph needles and as fuses in ordnance.

The Metal Materials Research Laboratory of Tohoku University, Japan, recently developed a new, high-performance piezoelectric gallium lanthanum niobate single crystal {*Japan New Mater. Rept.*, **11**, [3], 5 (1996)}. The laboratory has produced crystals which have a diameter of 70mm and a length of 250mm but they are currently working on larger, higher quality, crystals. The new gallium-lanthanum-niobate material has better piezoelectric properties than langasite, which requires high purity lanthanum oxide.. The new crystal has superior high frequency characteristics which make it an outstanding candidate for the new generation of digital communications equipment. ▲

Sumitomo Boosts Production

Sumitomo Special Metals Co. increased monthly production capacity of their Nd-Fe-B NEOMAX permanent magnet by 30% this summer (*Nikkei Daily*, May 2, 1996). The company produces NEOMAX at its wholly-owned subsidiary Kinki Sumitoku Electronics Co. located in Hyogo Prefecture, Japan. Nd-Fe-B magnets are used in voice coil motors, linear and rotational electric motors in computer disk drives, and the automotive industry. They have advantages over their Sm-Co magnet counterparts by having a higher energy product at their operating temperature range, increased physical durability, and are cheaper to produce. ▲

Miniature Er-Doped Optical Amplifier

Erbium-doped optical fiber amplifiers are essential in telecommunications networks where the amplification of 1.5 μm optical signals is required. However, current optical amplifiers are relatively large and can not be easily integrated with other optical devices. The need for a smaller, more easily integrated optical amplifier has stimulated interest in finding a replacement for existing devices.

Recently, a research team from The Netherlands developed an erbium-doped optical waveguide amplifier that has a cross section of 1 μm^2 and operates at 1.54 μm. The resulting optical gain increased by nearly a factor of two while requiring a much lower pumping power. The work was a collaboration between the FOM Instituut voor Atoomen Molecuulfysica in Amsterdam and the Technical University in Delft.

The team produced the new fibers by depositing aluminum oxide films that were 600 nm thick onto an oxidized silicon wafer and then implanting the film with Er ions. Lithographical techniques were them employed to cut the film into waveguides that were 2 μm wide. A 4 cm long Er-doped waveguide patterned in the form of a spiral that occupied 1 mm^2 on a chip. Wavelength division multiplexers that combined pump and signal wavelengths were then added to the same chip. The result was an optical amplifier that exhibited a net gain of 2.3 dB at a 1.48 μm pump power of 10 mW. Other Er-doped optical amplifiers require pump powers greater than 50 mW and need to be much larger, up to several cm^2.

This technology will most certainly be utilized in telecommunications systems in the future. For more information, contact: Prof. Dr. A. Polman, FOM-Instituut AMOLF, Kruislaan 407, 1098 SJ Amsterdam, The Netherlands; Fax: 31 20 668 4106; polman@amolf.nl. The results were published in *Appl. Phys. Lett.* **68** [14] (1996). ▲

RIC will answer more than 700 requests for information in 1996. Requests originate from industry, government, academia, small business, and private individuals on six continents.

RIC

The Rare-earth Information Center (RIC) The Rare-earth Information Center (RIC) was established at the Ames Laboratory by the U.S. Atomic Energy Commission's Division of Technical Information in January 1966 to serve the scientific and technological communities by collecting, storing, evaluating, and disseminating rare earth information from various sources. In 1968, the support of RIC was transferred to Iowa State University's Institute for Physical Research and Technology through grants from the worldwide rare earth industry.

The Database

The RIC Database contains over 82,000 references to information collected by qualified scientists from all available sources (books, journals, reports, conference notes, etc.). This information has been custom indexed by topics, chemical formulas and compositions to allow for fast, accurate searches tailored to the needs of the rare earth community. RIC maintains a file of the available references concerned with the metallurgy, solid state physics of metals and alloys, analytical, inorganic and physical chemistry, ceramics, technology, geochemistry, and toxicity of the rare earth elements and their

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Institute for Physical
Research and Technology,
Iowa State University,
Ames, IA 50011-3020
Telephone: 515 294 2272
Facsimile: 515 294 3709
INTERNET: ric@ameslab.gov
http://www.ameslab.gov/mat_ref/ric.html

R.William McCallum ..... Editor
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compounds. Furthermore, the personnel of the Center have access to more than 17,000 journals and 400,000 U.S. government reports that are available at the Iowa State University library.

Publications

The Center publishes two newsletters, maintains files on activities of interest to the rare earth community, and maintains a custom data base of relevant scientific publications and reports. The *RIC News* is a quarterly newsletter containing items of interest concerning the science and technology of rare earths. Subscription to the *RIC News* is free. The *RIC Insight* is a monthly newsletter that reports on late-breaking news in the field of rare earths and how these might impact the rare earth industry. *RIC Insight* is slanted toward the technological and commercial aspects of the rare earth field. *RIC Insight* is available only to supporters of the Center as a membership benefit.

Becoming a supporter of RIC

A minimum annual contribution of $300.00 qualifies a company as a supporter of RIC. Supporters, including individuals, are classified as to the level of support as listed below. Supporters may remain anonymous if they desire.

Support Categories

Benefactor	$10,000 or more
Donor	$4,000 to $9999
Sponsor	$2,000 to $3,999
Patron	$1,000 to $1,999
Sustaining	$400 to $999
Contributor	$300 to $399
Individual	$100

Services

All information inquiries are kept confidential unless otherwise directed by the requester. Inquiries are routinely answered within two working days; however, exceptional circumstances or the volume of information requested may require additional response time.

Costs

	Supporters	*Non Supporters*
▲ General Information	no cost	no cost
▲ RIC News	no cost	no cost
▲ RIC Insight	no cost	NA
▲ RIC Database Searches	no cost	$50 minimum ▲

Need Some Information?

The Rare-earth Information Center maintains a data base of over 83,000 documents that contain information on rare earths. Topics of interest range from physical properties, metallurgy, physics and chemistry, geochemistry, mineral deposits, toxicity, etc. of rare earth metals, compounds, and alloys. Our earliest document on file was printed in 1887 and we are continually updating our collection from all available sources.

This year alone we have answered more than 600 requests for information from individuals, companies, government, and academia who needed specific information on the rare earths. A typical request may originate from a middle school student doing a report on simply what a rare earth is, to an exploration company looking for a particular ore body that may contain rare earths. We receive as many requests from research scientists as we do from premier companies that are manufacturing goods that take full advantage of the many properties of rare earths. On occasion, we receive esoteric requests from companies involved in special projects. Recent inquiries have dealt with the use of rare earths as dietary supplements, their use in explosives and ordnance, and in dental prosthetics.

To utilize our data base (affectionately referred to as the Rare-earth Information Center Information Retrieval System, or RICIRS) contact us at: 112 Wilhelm Hall, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515 294 2272; Fax: 515 294 3709; ric@ameslab.gov. Of course, all requests for information are kept confidential. ▲

Albright & Wilson

The corporate headquarters and the Richmond laboratories of Albright & Wilson Americas moved to a new location. Their new address is: 4851 Lake Brook Drive, Glen Allen, VA 23060 USA; Tel: 804 968 6300; Fax: 804 968 6385. Correspondence and orders can be sent to: P.O. Box 4439, Glen Allen, VA 23058-4439. ▲

NEOLOR™

A new generation of red and orange-colored inorganic pigments, named NEOLOR™, are being commercially developed by Rhône-Poulenc. The pigment is to be used in plastics as a substitute for heavy metal pigments currently in use world wide. The new pigment is made of cerium sulfide (Ce_2S_3) and is designed to replace cadmium and lead-based pigments that are thought to be harmful to the environment and human populations.

NEOLOR™ was primarily developed to be used in plastics, primarily because of its thermal stability, lightfastness, opacity, hiding power and dispersibility. But these properties may also allow it to be used in the paint, ink, and paper industries. The new pigment has already been marketed on a limited basis, but wholesale production and marketing is expected by the end of 1997. Initial production of pigments using the rare earth sulfide is planned to be 500 mt per year. The company is researching a wider range of colors for the product.

Cerium sesquisulfide, Ce_2S_3, has the cubic Th_3P_4-type structure and was initially tested as a red pigment in polypropylene plastic {*RIC News*, **XXVII**, [3], 1 (1993)}. Ce_2S_3 is chemically stable up to 1500°C in inert and reducing atmospheres, and stable to 350°C in an oxidizing atmosphere. The average particle size of the Rhône-Poulenc's cerium sulfide powder ranges from 1.5 to 5.0 mm and has a theoretical density of 5.0 g/cm^3 while specific area is said to be <5 m^2/g. It is estimated that about 0.5% of Ce_2S_3 is sufficient to obtain the desired red color in polypropylene {*RIC Insight*, **6**, [8], 1 (1993)}. NEOLOR™ may impact the cerium market in the near future since over 2,600 mt of pigments were used in Europe and USA alone in 1993.

For more information, contact: Rhône-Poulenc Inc., Corporate Communications, CN 5266, Princeton, NJ 08543-5266 USA; Tel: 908 821 3639; Fax: 908 422 8297. ▲

NEODYMIUM, atomic number 60, was discovered in 1885 by C.A. von Welsbach to be the other major component of didymium.

Supporters 1997

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Since the September issue of the RIC News went to press, RIC has received support from four new family members and renewed support from 30 other organizations and individuals. The supporters from the second 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.

Benefactor ($10,000 or more)
- Rhône-Poulenc Chimie, France (27)

Donor ($4000 to $9999)
- Santoku Metal Industry Co., Ltd., Japan (27)

Sponsor ($2000 to $3999)
- Indian Rare Earths Ltd., India (28)
- Shin-Etsu Chemical Co., Ltd., Japan (27)

Patron ($1000 to $1999)
- GE Lighting, USA (21) [1996]
- Rhône-Poulenc Basic Chemicals Co., USA (17)
- Treibacher Auermet Produktionsges m.b.H., Austria (25)

Sustaining ($400 to $999)
- Advanced Material Resources Inc., Canada (7)
- Atlantic Metals and Alloys Inc., USA (8)
- Ferro Corp., USA (21)
- Korea Institute of Geology, Mining and Materials, Korea (9)
- Neomet, USA (11)
- Nippon Yttrium Co., Ltd., Japan (18)
- North-Holland Physics Publishing (a Department of Elsevier Science Publishers), The Netherlands (7)
- Sophisticated Alloys, Inc., USA (1)
- Sumikin Molycorp, Inc., Japan (4)
- Ugimag AG, Switzerland (12)
- Ugimag, Inc., USA (9)
- USR Optonix, Inc., USA (26)
- Vacuumschmelze GmbH, Germany (13)
- Yue Long-Non-Ferrous Metals Limited, PRC (16)

Contributor (less than $400)
- Crucible Materials Corp., USA (23)
- Dongjoo Co. Ltd., Korea (2)
- Ekkehard Greinacher, Germany (5)
- ENUSA, Spain (3)
- Future Industrial Limited, Hong Kong (2)
- Hi-Z Technology, Inc., USA (3)
- North Carolina State University, USA (1)
- Parkans International, Inc., USA (11)
- Sinko Resources, Inc., USA (4)
- Wheeler Associates, USA (11)

Individual
- Keith W. Forsyth, USA (3)
- John Mester, USA (1)
- A. Brian Peckford (1)

Indian Rare Earths Ltd.

On August 17, Dr. T.K. Mukherjee was promoted to Chairman and Managing Director of Indian Rare Earths Ltd. Their offices are located at: Sherbanoo, 6th Floor, 111 Maharshi Karve Road, Mumbai 400 200, India; Tel:206 26 51/201 58 87; Fax:200 44 30. ▲

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