Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
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SQUIDs Underground

Recent collaboration between Los Alamos National Laboratory and Raton Technology Research Inc. has opened the possibility of a new application for high temperature superconductors (HTS). The researchers are developing portable "underground radio" technology that would enable two-way communications through hundreds of meters of solid rock. The new communications technology would allow mobile underground miners to maintain contact when they are far from installed underground stations. The new technology uses a superconducting quantum interference device (SQUID) detector to receive low frequency radio waves over several hundred kilohertz of bandwidth.

The SQUID-based system uses radios that are hand-held which would greatly reduce the cost of "hard wiring" communications systems in remote areas. The new system would provide miners with a means to remain in voice contact during emergency situations. Existing narrow-band FM radios operate at higher frequencies, requiring the operator to remain within a short distance from the underground electrical conductor. Not only would the SQUID system allow greater movement of a miner, but it operates at a lower frequency, penetrating rock and offering increased sensitivity over existing underground radio systems. The communication system may also allow increased communication through water as well as aid in enhanced mineral exploration.

The experimental SQUID setup incorporates a 3 inch diameter, 8 inch long dewar with a 26 hour liquid nitrogen hold time. The commercial application would include a 2 inch diameter

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dewar which would provide a 12-16 hour hold time, longer than a miner's work shift. The test device had a galvanicly coupled design that had a noise floor of 400 femtotesla per root Hz in the laboratory. It was designed to minimize flux trapping without regard for sensitivity.

The commercial market would be great as there are over 2 million underground miners {*Superconductor & Cryoelectronics*, pp. 33-5, Fall 1998 (1998)}. Contact the publisher; Tel: 415 837 0891; Fax: 415 837 0327; news@superconductorweek.com. ▲

Ti Layer on YSZ Ceramics

A layer of malleable titanium is now being used to prevent fracture in ceramic hip joints. The metal layer reduces localized stresses that are a result of imperfections in the load bearing surfaces of the bore and trunnion. The reduction in stress inhibits crack initiation.

In addition to preventing fracture in the Y_2O_3-doped ZrO_2 (YSZ) ceramic material, the 0.0025 mm-thick titanium layer also reduces friction. Besides titanium and titanium alloys, other coating materials include gold, silver, platinum, and tantalum. The layer must exhibit strong adherence to the YSZ ceramic, malleability, and galvanic compatibility with common trunnion materials such as cobalt-chromium and titanium alloys. This new development will also allow construction of smaller diameter hip heads that further reduce friction and the associated wear debris.

For more information, contact Frank Matthews, Johnson & Johnson Professional Inc., 325 Paramount Dr., Raynham, MA 02767-5110 USA; Tel: 508 880 8100; Fax: 508 828 3070; www.jnjo.com. ▲

Honors!

30 Years!

Indian Rare Earths Ltd., India
Wako Bussan Co., Ltd., Japan

20 Years!

Nippon Yttrium Co., Ltd., Japan

10 Years!

Atlantic Metals & Alloys Inc., USA
Edge Technologies, Inc., USA
Metal Mining Agency of Japan, USA
The Society of Non-Traditional Technology, Japan

This year we wish to honor seven companies for their long and dedicated support. Indian Rare Earths Ltd., India, and Wako Bussan Co., Ltd., Japan, become the second and third companies in history that have supported RIC for 30 years. Congratulations!

Nippon Yttrium Co., Ltd., Japan, joins our elite group of 20 year supporters, and Atlantic Metals & Alloys Inc., Edge Technologies, Inc., Metal Mining agency of Japan (USA), all of the USA, and The Society of Non-Traditional Technology, Japan, join our 10 year supporters.

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

Summer School

The VI International Summer School "Nicolas Cabrera" *Physics of Strongly Correlated Electron Systems* will be held September 14-18, 1999 in Madrid, Spain. The School will consist of a pedagogic introduction and talks about recent problems related to magnetism and superconductivity in *f*-electron compounds and related systems. Discussions will also be held on the possibilities offered by some experimental techniques such as tunnel and point contact spectroscopy, neutron and synchrotron radiation, and high pressures to study the ground state properties of Correlated Electrons.

For more information, contact Farkhad Aliev, Dpto. Fisica de la Materia Condensada, C-III, Universidad Autinoma de Madrid 28049, Madrid, Spain; Farkad.Aliev@uam.es; Tel: 3491 397 4744; Fax: 3491 397 3961. ▲

Bokan Mountain

Bokan Mountain, Alaska, USA, is located near the southern end of Prince Wales Island, the southernmost island in the Alaska panhandle. The mountain rises to 2,510 feet above sea level and receives over 100 inches of precipitation each year that supports a spruce, cedar, and hemlock rainforest which then transitions to tundra at the higher elevations. Uranium was discovered 1955 at Bokan Mountain and mining was carried out between 1957 and 1971. As the occurrence of uranium and thorium in the ore decrease from the mountain, the amounts of rare earths increase.

The minerals present at the deposit include rare earths and are located in several vein-like dikes (quartz albite vein-dikes and pegmatite dikes) which extend outward from the main granitic intrusion {*Int. Calif. Mining Journal*, January, 44-46 (1999)}. The dikes have been analyzed and indicate a resource of 6.8 million tons of ore at a yield of 0.264% rare earth oxide, of which about one third is yttrium. The dikes also include zirconium oxide and niobium oxide.

Recovery of Bokan Mountain rare earths have been tested by sulfating the ore at 250°C for 1 hour at a H_2SO_4

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to ore ratio of 1:1, and water leaching the sulfated material at 25°C which dissolves over 74% of the Yttrium, Cerium, and Lanthanum in the ore. Traditional solvent extraction techniques yield 96% Yttrium from the solution.

Additional information on the Bokan Mountain rare earth deposit is contained in U.S. Bureau of Mines Open-File Report 33-89, published in 1989. To order, ontact the U.S. Geological Survey Library, 345 Middlefield Road, MS 955, Menlo Park, CA 94025-3591 USA; Tel: 650 329 5027/5026; Fax: 650 329 5094; men_lib@usgs.gov; www.usgs.gov/library/menlib.html. ▲

Conference Calendar

*** A NEWS STORY THIS ISSUE**

Note: Reach as many potential conference attendees as possible! Send us your conference announcement and we will publish it here. ▲

June '99

IUMRS-ICAM '99
Beijing, People's Republic of China
June 13-18, 1999
RIC News **XXXIII**, [4], 2 (1998)

July '99

3rd Joint UK Magnetics Workshop
York, UK
July 5-7, 1999
RIC News **XXXIV**, [1], 2 (1999)

22nd Rare Earth Research Conference
Argonne, Illinois, USA
July 10-15, 1999
RIC News **XXXIII**, [4], 2 (1998)

Nanotube-99 (nt99)
East Lansing, Michigan, USA
July 24-7, 1999
RIC News **XXXIV**, [1], 3 (1999)

August '99

SCES '99
Nagano, Japan
August 24-28, 1999
RIC News **XXXIII**, [3], 2 (1998)

September '99

Physics of Strongly Correlated Electron Systems
Madrid, Spain
September 14-18, 1999
*This issue ("Summer School")

EUROMAT99
Munich, Germany
September 27-30, 1999
RIC News **XXXIV**, [1], 3 (1999)

Magnetic and Superconducting Materials (MSM-99)
Tehran, Iran
September 27-30, 1999
RIC News **XXXIV**, [1], 3 (1999)

November '99

Magnetism and Magnetic Materials (MMM'99)
San Jose, California, USA
November 15-18, 1999
RIC News **XXXIV**, [1], 3 (1999)

March '00

Rare Earths and Actinides: Science, Technology, and Applications IV
Nashville, Tennessee, USA
March 12-16, 2000
*This issue (below)

September '00

The Third International Conference "Noble and Rare Metals" (NRM-2000)
Donetsk, Ukraine
September 19-22, 2000
RIC News **XXXIV**, [1], 3 (1999)

September '01

Rare Earths - 2001
São Paulo - SP, Brazil
September, 2001
RIC News **XXXIII**, [4], 3 (1998)

Rare Earths IV

The symposium *Rare Earths and Actinides: Science, Technology, and Applications IV* will be held during the 2000 TMS Annual Meeting in Nashville, Tennessee, USA, during the spring meeting March 12-16, 2000. The symposium will provide a venue for presenting the developments and current state of the art in the science, technology, and applications of rare earths and actinides for the next century. Topics to be covered include resources, markets, extraction, processing, purification, precipitation, elec-

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f-Electron Systems

Strongly correlated f-electron systems are one of the most important fields in solid state physics. The outstanding problems include small magnetic moments, heavy electrons with large masses of $10\text{-}200m_0$, exotic superconductivity not following the behaviors of Kondo insulators with energy gaps at low temperatures. They originate from the $4f - 5f$ electrons in Ce and Yb compounds which can easily change their nature between localized and itinerant ones. These characteristic features were clarified in a research project named "Physics of Strongly Correlated Electron Systems" which was sponsored by the Ministry of Education, Science, Sports and Culture, Japan. The results of this research project was published in *Japanese Journal of Applied Physics*, Series 11 (1999).

The 277-page hard cover journal contains eight chapters: Metamagnetic Behavior, Exotic Superconductors, Kondo Insulators, Low-Density Carriers, Non-Fermi Liquids, Quadrupole and Charge Orderings, Electronic State of f-Electronic Compounds, and Miscellaneous Problems of f-Electron Compounds. Included is the reported physical, magnetic, electrical, thermal, transport, and other properties of $CeRu_2Si_2$, $Ce_xCu_2Si_2$, $CeCu_6$, $CeRu_2$, CeNiSn, YbB_{12}, Yb_4As_3, GdAs, rare earth binary chalcogenides and pnictides, ternary borides, Yb-Au compounds, among others.

For more information on the report, or to order a copy, contact Publication Office, Japanese Journal of Applied Physics, Daini-Toyokaiji Building, 24-8 Shinbashi 4-chome, Minato-ku, Tokyo 105-0004, Japan. ▲

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trolysis, physics and chemistry in the preparation of magnets, electronic materials, batteries, alloys, films, etc., and modeling the processes in the preparation and manufacture of products that contain rare earths and actinides.

Contact R.G. Bautista, Dept. of Chem. & Met. Eng., University of Nevada-Reno, Reno, NV 89557-0136 USA; Tel: 775 784 1602; Fax: 775 784 4764; bautista@quake.seismo.unr.edu. ▲

Rare Earths in Metallurgy

The book *Rare Earth, Alkaline Earth and Other Elements in Metallurgy* introduces the international rare earth community to the research conducted on the metallurgy of rare earths in China. It attempts to not only be a compilation of comprehensive experimental results on the rare earth and alkaline earth metals used in metallurgy, but a review of some of these materials in industrial applications as well.

The hard-cover book includes 9 chapters and 314 pages. Chapter 1 "Thermodynamics of Rare earth Elements in Iron Metals" introduces the thermodynamic data of rare earth elements in liquid iron, determined by anhydrous electrolysis at low temperature by radioisotope assay. Chapter 2 "Thermodynamics of Alkaline Earth Elements and Bismuth in Liquid Iron, Nickel and Manganese" contains some limited information on the reaction of rare earth oxysulfides with hydrogen in sulfur extraction. The third chapter "State of Existence and Microdistribution of Rare Earth Elements in Steel, Cast Iron, Aluminum and Aluminum Alloy" includes information on chemical stability of rare earths in electrolytes. The next two chapters "Inclusions in Steel, Reaction of Rare Earth with Refractory and Nozzle Blockage" and "Application of Rare Earth Metals in Steel" covers some uses of rare earths in steel making (including stainless steel) and some insights into the effects of rare earths in the physical properties of various compositions. Chapter 8 "Calculation of Thermodynamic Parameters by Solution Models" deals with the evaluation of interaction parameters in ternary alloys, among others, and the final chapter "Diffusion in Melts and Metals" includes a few pages on the diffusion of cerium in slag.

Rare Earth, Alkaline Earth and Other Elements in Metallurgy is based on the research of Qiyong Han in the People's Republic of China but includes some results by others as well.

The book was published in 1998 and is available for NLG120 / £38 /

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Yb Under Pressure

Ytterbium and Europium metals stand apart from other rare earths because of their divalent nature. Most other rare earth metals are trivalent. This divalent character gives Yb a 41% larger atomic volume than its nearest neighbor, Lutetium. Because of this anomaly, extensive theoretical and experimental work on the pressure effects on Yb have been conducted, much of it at physics departments at universities around the world. A recent study indicates that by applying high pressures on Yb metal, an electronic transition occurs which would make it a "regular" member of the rare earth family {*Phys. Rev. Lett.*, **82**, [8], 1712-15 (1999)}.

Ytterbium metal demonstrates a gradual valence transition from $4f^{14}(spd)^2$ to $4f^{13}(spd)^3$ (divalent to trivalent) at pressures up to 30 GPa. The researchers wanted to establish a clear correlation between the high pressure valence transition of Yb, from 2^+ to 3^+, with an increase in pressure so as to be able to identify it with the other rare earth metals. To do this, Yb metal foil was loaded onto a 65 mm diameter anvil cell along with copper powder. The sample was subjected to pressures up to 202 GPa in which the Yb metal shows a sequence of phase transformations from fcc(I) $\rightarrow$ bcc $\rightarrow$ hcp $\rightarrow$fcc(II) $\rightarrow hP3$ with increasing pressure.

Ytterbium metal exhibits increasing compressibility until the maximum, V/V_0=0.26, is reached at 202 GPa. The unusual compressibility (76%) of Yb at 202 GPa is attributed to interconfiguration valence fluctuations ($4f^{14} \rightarrow 4f^{13}$) and $s \rightarrow d$ electronic arrangements in the compressed state.

For amplifying information, contact Yogesh K. Vohra, Dept. of Physics, University of Alabama at Birmingham, Birmingham, AL 35294-1170 USA; Tel: 205 934 6662; Facsimile: 205 934 8042; vohra@phy.uab.edu; www.phy.uab.edu/. ▲

DM107/US$60 from IOS Press, Van Diemenstraat 94, 1013 CN Amsterdam, Netherlands; Tel: 31 20 638 21 89; Fax: 31 20 620 34 19; market@iospress.nl; www.iospress.nl. ▲

Permanent Magnet Materials

A review on the history, production, and uses of permanent magnets, by the world-recognized authority in permanent magnet materials, K.H.J. Buschow, is now available.

Permanent-Magnet Materials and their Applications contains 8 sections. Section one is a brief introduction to the review and covers a short history of rare earth-based magnets. The second section "Basic Concepts and Models" deals with magnetic coupling and magnetocrystalline anisotropy, followed by the main section of the book "Rare Earth Based Permanent Magnet Materials" which contains information on $Nd_2Fe_{14}B$ materials, including physical properties and phase relationships, manufacturing routes and later developments in Nd-Fe-B sintered, hot-formed, and bonded permanent magnets, a mention of the ternary carbides with the $Nd_2Fe_{14}B$ structure. Also included in the section are $SmCo_5$ and Sm_2Co_{17} type magnets, ternary iron-rich $RFe_{12-x}M_x$, interstitially modified R_2Fe_{17} and $R_3(Fe,M)_{29}$ compounds, and nanocrystalline rare earth based permanent magnet alloys. The next four sections contain information on 3*d*-transition metal alloy magnets such as Alnico-type and Fe-Cr-Co alloys, miscellaneous magnet materials based on noble metal compounds and MnAl phases, hard ferrites, and applications of permanent magnets.

The 82-page *Permanent-Magnet Materials and Their Applications* was published in soft cover in 1998 and contains a complete listing of the 224 references used in the review. It is recommended for students studying these materials, or anyone interested in rare earth permanent magnets, and is essential reading for anyone who needs a quick background in the field.

The book is available for US$48.00 (CHF 72.00/£ 30.00) through Trans Tech Publications, Ltd., Brandrain 6, CH-8707 Uetikon-Zürich, Switzerland; Fax: 41 1 922 10 33; ttp@ttp.net; www.ttp.net; Trans Tech Publications Inc., P.O. Box 699, May Street, Enfield, NH 03748 USA; Tel: 603 632 7377; Fax: 603 632 5611; ttp@ttp.net; www.ttp.net. ▲

Gd^{3+} Contrast Agent

The lanthanide ion Gd^{3+} is well known in magnetic resonance imaging (MRI) contrast agents because of its paramagnetic properties and symmetric electronic ground state. Researchers at the California Institute of Technology have prepared a new gadolinium-ion agent that effects the spin relaxation times of water protons that are modulated by calcium {*J. Amer. Chem. Soc.*, **121**, 1413-14 (1999)}. This will allow calcium to be visualized by MRI for the first time and, in addition, may be an ideal template for designing other biochemically activated MRI contrast agents.

The importance of identifying Ca^{2+} in living systems is that it is an important intracellular secondary messenger of signal transduction. Changes in Ca^{2+} concentration trigger changes in cellular metabolism and are responsible for cell growth and regulation.

To be used as a MRI contrast agent, the Gd^{3+} ion in aqueous solution must be chelated to a ligand in order to reduce toxicity. Typically, eight of the nine available Gd^{3+} coordination sites are bound by the chelate, leaving one site available for an inner sphere water molecule. If a water molecule binds to this site, it has a different spin relaxation time than the water molecules within the body and can be detected by MRI. In the new contrast agent the chelating agent is designed so that in the absence of Ca^{2+}, the Gd^{3+} site is blocked. When Ca^{2+} is present the water can bind directly to the Gd^{3+} site enhancing its relaxation time. This process allows the mapping of the Ca^{2+} concentration in the human body.

The Gd complex was prepared in an 8-step process from monoalkylated nitroresorcinol, including dimerization, the conversion of free hydroxyls to dibromides, and following up with alkylation in a base while hydrolyzed aromatic imino ethyl diacetates. The result was a final Gd^{3+} complex that was formed in good yield and under weakly acidic conditions.

The new technology would be immediately useful for studying fluctuations in intracellular calcium levels in developing embryos and possibly other biological systems. It may also help to resolve uncertainties concerning Ca ion levels of interior cell layers that are not accessible to light microscopy.

For more information, contact W-H. Li, Division of Biology and the Beckman Institute, California Institute of Technology, Pasadena, CA 91125 USA. ▲

Tm-Doped Optic Sensor

A wide range of temperatures may be able to be detected with a promising new rare earth-doped optical thermometer {*Rev. Sci. Instrum.*, **69**, [9], 3210-14 (1999)}. Fluorescence-based optical thermometry have traditionally been restricted to lower temperatures because of stability problems in the upper temperature regime (>500°C). The determination of environments at higher temperatures have been reserved in the past for pyrometry and black body techniques.

A new optical fiber sensor that utilizes the Tm^{3+} ion has been shown to have promise in recording a wide range of temperatures, from 350°C to 1250°C. Intrinsic fluorescence-based Tm-doped fiber optic materials are simple and relatively robust. The Tm^{3+} ion at a concentration of ~280 ppm was doped in a SiO_2 fiber that had a numerical aperture of 0.2. The core diameter was ~15 mm and had a cladding diameter of ~125 mm. The doping level of 280 ppm is similar to that of the lowest value of doping in Er fibers (200 ppm). The lower doping levels and related absorption are associated with a pure exponential decay of the fluorescence emission.

The Tm-doped fiber showed strong optical absorption coefficients on the 690, 800, and 1200 nm wavelength bands. Fluorescence emission was exhibited at the central wavelengths of 1.46, 1.9, and 2.3 mm simultaneously. The lifetime of the Tm^{3+} fluorescence emission at 1.9 mm was measured to be shorter than 200 ms. The sample was heat treated at 1100°C for ~12 hours, and then 1250°C for ~19 hours, and was shown to have no degradation of the fluorescence lifetime. As a comparison, Er-doped fibers degrade at 1100°C and Nd-doped fibers at 750°C. However, there was significant and distinct lifetime ranges of ~63 ms at 100°C to ~15 ms at 1250°C which identify the material as a promising temperature probe.

For more information, contact K.T.V. Grattan, Department of Electrical, Electronic, and Information Engineering, City University, Northampton Square, London EC1V 0HB, UK; k.t.v.grattan@city.ac.uk. ▲

Mount Weld by 2002

Ashton Mining Limited commissioned a comprehensive, in-depth feasibility study in 1990-1 of the rare earth-containing carbonatite mineral deposit that is located 35 km southeast of Laverton, Western Australia. The report describes the occurrence, mining, beneficiation, transportation, processing, and export of monazite ore and the resulting rare earth products {*RIC News*, **XXVII**, [3], 6 (1992)}. Mt. Weld is a world class rare earth mineral deposit that was never developed or commercialized because of the softening of rare earth prices at that time. However, recent improvements in rare earth prices is causing the company to re-think their earlier decision to shelve the project and are now planning on opening the mine for operation.

Since the mine is located some distance from the secondary processing facility and the export facilities at Freemantle, considerable efficiency must be employed in order to make the operation profitable. In fact, since 1994, several improvements in rare earth processing, along with other developments in Australia and with other rare earth producers, are allowing Mt. Weld to once again be a factor in the field of rare earths. The improved prospects include: improved monazite concentration, established chemical/ powder infrastructure in the nearby North Eastern Goldfields, increased demand and prices for rare earth products, an extension of the Project Environmental Approval to mid-2001, and the dewatering step of the carbonatite, which will reduce mine development costs.

A drilling program to collect a representative sample of the mineralization was completed in March and the samples were bench-tested for improved ore beneficiation techniques. As a result of the test, it was determined that high-grade monazite concentrate can then be upgraded to high value rare earth products when transported to a secondary processing plant located at the Meenaar Industrial Park, near Northham, Western Australia, some 760 km west of Mt. Weld.

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If the plan progresses on schedule, then construction of the mine and processing plant would commence in 2001 with the aim of complete operations beginning in late 2002. The increased rare earth production from Mt. Weld will help diversify the world's supp;ly of these materials. ☛

For more information, contact Mr. Dudley J. Kingsnorth, Project Manager, Mount Weld Rare Earths Project, Ashton Mining Limited ACN 005 466 964, 21 Wynyard Street, Belmont, WA 6104, Australia; Telephone: 61 08 9334 6444; Facsimile: 61 08 9334 6480; mt.weld@ashton.net.au. ▲

Letter to the Editor

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I read with great interest your column in RIC News of June 1, 1997 (Vol. ***XXXII*** *No. 2) about a* Gd^{3+} *chelate that has been developed as an imaging agent for medical MRI. It reminded me of a publication by Bau and Dulski (Earth Plan. Sci. Lett.* ***143****, 245-255, 1996), who attribute observations of widespread Gd-contamination of German rivers to a similar compound, the non-specific MRI imaging agent Gd(III) dihydrogen diethylenetriaminepentaacetic acid (*GdH_2DTPA*, also referred to as gadopentetic acid). While zeolite oil-cracking catalysts had previously been identified as an anthropogenic source of REE in southern California marine sediments (Olmez et al., Env. Sci. Technol.* ***25****, 310-316, 1991), this is to my knowledge the first report of REE-contamination of surface waters as a result of human activity. It is not presently known what the potential toxicological or health effects of the Gd-contamination may be.*

Bau and Dulski base their conclusions on several lines of evidence: (i) while Gd-anomalies (see below) of about 1-2 have been reported for most natural waters, many German and several American rivers show Gd-anomalies of 3-240. No anomalies were found in pristine rivers in Sweden and Japan; (ii) a large Gd-anomaly was found in the lower Dhünn River which is heavily impacted by farming and industry, but not in the pristine upper Dhünn River; (iii) the largest Gd-anomaly (1680) was found in the effluent of a sewage treatment plant in Berlin; (iv) experiments indicated that the Gd-contamination is very stable in solution. This and the fact that the contamination is not removed by sewage treatment suggests that it is due to a very stable organic Gd complex, presumably gadopentetic acid. Bau and Dulski estimate the medical consumption of GdH_2DTPA *at 100 kg/yr in the Berlin area alone.*

Because of their chemical similarity, the REE always occur in nature as a group and their concentrations generally show very smooth and predictable behaviour as a function of atomic number when normalized to a suitable standard. Any deviation from this smooth behaviour is termed an anomaly. Whereas anomalies of Ce and Eu are known to be caused by their unique redox chemistries, small anomalies are thought to be caused by the lower relative stability of its complexes due to the exactly half-filled 4f-shell of Gd^{3+}*. These anomalies have been used by geochemists to obtain information on the identity of its natural complexes. Bau and Dulski point out that ongoing widespread Gd-contamination of surface waters may soon render Gd-anomalies useless as a geochemical indicator.*

Sincerely,

Johan Schijf

Eu Sensor Detects Nerve Agents

Chemical warfare nerve agents were developed during WWII and considerable testing was conducted by scientists and the military. Later, these nerve agents and their derivatives proliferated to nations around the world. Nerve agents are anticholinesterase compounds that are intentionally designed to disrupt the nerve impulses in humans and animals. Many tons of nerve agents were produced over the years and are stockpiled in several locations worldwide. The major concern with stored nerve agents is leakage of the compounds from aging storage containers and weapons that could lead to potential contamination of the environment. Portable sensors that can detect even trace amounts of nerve agents in water quickly are needed for timely clean up and remediation of the site.

When the nerve agents sarin and soman hydrolyze in water, they produce pinacolyl methylphosphonat (PMP). If a luminescence sensor is designed using a complexing agent that selectively binds PMP, spectrometric measurements can detect trace amounts of the compound. Due to the relative simplicity of the Eu luminescence spectrum, it is the rare earth of choice for such a sensor. The design of a sensor based on an optical fiber coated with an Eu containing complexing agent in a porous polymer sensing layer has recently been reported {*Anal. Chem.*, **71**, [2] 373-8 (1999)}. The fiber is connected to a spectrometer and a light source. Light is directed to the end of the fiber in the sample being tested and the luminescence that returns from the tip is analyzed by the spectrometer. The benchtop version of the sensor is able to detect sarin and soman in water at concentrations as low as 660 parts per quadrillion (660 parts in 1×10^{15}).

A device based on a miniature version of the spectrometer has a footprint of 3.5 ft x 2.5 ft and has a detection limit of 7 ppt (7 parts in 1×10^{12}). This system uses ~1 mW of 465.8 nm laser power and an integration time

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of 500 ms. A high degree of selectivity is obtained by combining both chemical and spectroscopic selectivities, increasing accuracy. The response time of the sensor is reported to be 80% in 8 min. The size of the device is limited by the argon laser and its power supply, so possible substitutes for the Ar laser are being studied, including blue light-emitting diodes. As the system evolves in development, it is expected to detect a wide range of chemical agents or species. Likely users will be the military and industry (A.L. Jenkins, The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland 20723 USA). ▲

La:CaB_6 Wigner Crystal

A new state of matter, long known through the theoretical work of Nobel Laureate Eugene Wigner, has been discovered by researchers from the National High Magnetic Field Laboratory, Tallahassee, Florida {*Nature*, **394**, 412-14 (1999)}. Wigner predicted that if a metal could be made with a sufficiently low number of conduction electrons, these electrons would arrange themselves in an ordered array, a lattice of conduction electrons. As each electron carries a magnetic moment as a result of its spin, it is possible for this lattice of conduction electrons to order ferromagnetically.

The new experimental results start with semi-metallic CaB_6 and then add conduction electrons by replacing the Ca^{2+} with La^{3+} so that each La^{3+} contributes one conduction electron. For a conduction electron density of .005 electrons per formula unit the magnetic ordering temperature of the ferromagnet electron lattice is 600K. This electron-spin structure leads to another unique property: the electrons flow while maintaining a crystal formation. The crystal structure has not yet been determined, but it is thought to fall into one of the six common crystal systems.

The new structure is not limited to La:CaB_6, the conduction electrons can come from La or Th and the matrix can be CaB_6, SrB_6 or BaB_6. ▲

High-Temperature Alloy

A new nickel-based yttrium-containing alloy, claimed to be the first formable material that contains 8% tantalum, has been developed by Krupp VDM GmbH, Werdohl, Germany {*Adv. Mater. Proc.*, **155**, [2], 9 (1999)}. In addition to Ni and Ta, the new alloy contains 25% chromium, 3% aluminum, 0.3% carbon, 0.1% Yttrium and is designated Nicotan 6325hAlC-alloy 2100 GT. It was specifically designed for high-temperature applications in combustion chambers, heat shields and thrust reversers for gas turbines.

Engineers achieved the high-temperature strength characteristics of the new alloy through solid solution strengthening by tantalum, carbide hardening from the formation of primary precipitated tantalum carbides, and γ'-precipitation hardening by aluminum and tantalum. Excellent corrosion resistance is provided by a surface coating of Al_2O_3. High creep strength is maintained even when subjected to temperatures between 600°C and 900°C higher than comparable materials, which allows reduced flow of unproductive cooling air through the engine core which results in increased performance and fuel efficiency.

For more information contact Don Wenschof, Krupp VDM Technologies Corporation Corp., 10 Sylvan Way, Parsippany, NJ 07054 USA; Tel: 973 267 8545; Fax: 973 292 4919; don@vdmt.com. ▲

Energen, Inc.

Energen, Inc. develops and markets precision positioning and motion control products for cryogenic applications. The company now has a website (www.EnergenInc.com) that the user can access information about the company's products and services, as well as up-to-date information on the Cryogenic Engineering Conference/International Cryogenic Materials Conference that is scheduled to be held July 16-20, in Montreal, Canada.

For more information, contact: Energen, Inc., 17D Sterling Road, Billerica, MA 01862-2518 USA; Tel: 978 671 5400; Fax: 978 670 9876; chad@EnergenInc.com. ▲

Rare Earth Consultants

We receive referral requests from interested clients from time to time about consultants in the rare earth field. Several years ago we kept a list but it now needs updating. If you would like us to refer prospective customers to you for consulting services, just send us the following information:

- ▲ Contact Name
- ▲ Company Name
- ▲ Mailing Address
- ▲ Telephone Number
- ▲ Facsimile Number
- ▲ Electronic Mail Address
- ▲ URL
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This listing is provided at no cost as part of the RIC's service to the worldwide rare earth community.

The information should be sent to: LaVonne Treadway, 116 Wilhelm Hall, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515 294 2272; Fax: 515 294 3709; RIC@ameslab.gov. ▲

Nd-Fe-B Production

TDK Corporation has reportedly doubled its production capacity of NdFeB permanent magnets at its Narita plant in Chiba Prefecture, Japan {*The Kagaku Kogyo Nippo*, April 28, 1999}.

The expansion is expected to meet future demand of voice coil motors, and magnetic rollers used in printers. The company plans to increase production of NdFeB permanent magnet materials by 50% to 130 tons per month by July of this year, and to 200 tons per month by spring 2000. This is good news for what many think is a slumping rare earth market. ▲

For only US$100.00 per year Individual supporters can receive the same benefits as corporate supporters: access to the RIC data base and subscription to the monthly newsletter ***RIC Insight****, (However, any employee of a corporate supporter can utilize our services).*

Consultant's Corner

To appear in our Consultant's Corner, any individual, company, or group must be involved in rare earth or rare earth-related consulting activities. Just send us the appropriate information: contact name, company name, mailing address, Tel/Fax number(s), e-mail and web address, and areas of expertise.

Tom Pool, Mining & Metals Advisory Service, 2024 Goldenvue Drive, Golden, CO 80401 USA; Tel: 303 278 2124; Fax: 303 278 1076; tpool@csn.net.

Technical and economic analysis of the mineral industry, mineral resource development, operation and markets. Skills: geology, mining engineering, beneficiation, marketing and mineral economics, feasibility studies, valuations, optimization of production methods, market analysis, and due diligence investigations.

RIC Database

The total number of documents referenced in our system is now over 100,000. The documents are stored as citations in the RIC data base and represent books, journal articles, government, company, and laboratory reports, patents and theses which contain information on rare earth metals, their alloys and compounds. A typical citation from a search contains the author(s) name(s), title of paper or contribution, reference line, and keywords that we have assigned to the citation after we have reviewed the document (see below).

199901150

KOCH;R MORRIS;DG LU;K INOUE;A
Ductility of Nanostructured Materials
MRS Bulletin, **24**, [2], 54-58 (1999)

1999	DUCTILITY	NANOSTRUCTURE
PHASE	MELTING-TEMP	MECHANICAL-PRO
NANOCRYSTAL	ELONGATION	GRAIN-SIZE
CRYSTALLIZATIO	INTERMET-COMPD	STRENGTH
TOUGHNESS	CERAMICS	YOUNGS-MODULUS
(R,AL,MN)	(CEALCOCR)	GRAIN-BOUNDARY
ATOMIZATION	MELT-SPUN	ALLOY
SOLIDIFICATION	BIBLIOGRAPHY	

The minimum cost to receive the results of a computer search is US$50.00 (for 25 citations and US$2.00 for each citation over 25 per search). However, many organizations become supporters which allows them to not only receive as many searches as needed for one year, but as an added benefit, they receive the monthly two-page newsletter *RIC Insight*. *RIC Insight* provides a provocative view into recent developments of rare earth science and technology and how these may impact the rare earth industry. The cost to become a supporter is US$100.00 for an individual, or US$300.00 for a corporate membership.

Send requests to: Rare-earth Information Center, 112 Wilhelm Hall, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515 294 5405; Fax: 515 294 3709; ric@ameslab.gov. ▲

1999 Mineral Commodity Summaries

The U.S. Geological Survey has released the 1999 edition of *Mineral Commodity Summaries*. This printed report provides up-to-date summaries of about 90 non-fuel commodities. It contains information on domestic industry activities, government programs, tariffs, world reserve base data, and 5-year salient statistics.

Of the minerals used in international trade and commerce, there are three that are of interest to rare earthers: Rare Earths, Scandium, and Yttrium. The rare earths section contains, in two pages, domestic production and use, U.S. salient statistics, recycling, import sources, tariffs, depletion allowances, events, trends, and issues, world mine production, reserves, and reserve base, world resources, and apparent substitutes. The Scandium and Yttrium sections contain information on the same topics, but with the appropriate concentration of information for these two elements in a snapshot.

The cost to receive the report is US$17.00 (U.S. customers) or US$21.00 (others) and is available from Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954 USA; Tel: 202 512 1800; Fax: 202 512 2250; http://minerals.er.usgs.gov/minerals/. ▲

1999 Supporters

Since the December issue of the RIC News went to press, we have received support from 4 new family members and renewed support from 26 other organizations.

The supporters from the second quarter of the 1999 fiscal year who wish to be listed, grouped according to their appropriate category, and with the number of years that they have contributed to RIC in parenthesis, are listed in the next column.

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Clyde A. Morrison 1927-1999

Dr. Clyde A. Morrison died on February 10th of cancer. He began his career as a physicist at Willow Run Research Center in 1951 to develop a 32-bit electrostatic memory for the computer in the command guidance system for missiles. He then became a key figure in the theory of ferrite devices, and in the analysis of electrostatic and noise fuses at the Diamond Ordnance Fuse Laboratory (DOFL). He is best known for his work at DOFL on the spectra of impurities in laser host materials which increased our understanding of rare earth-doped lasers. ▲

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