Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
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Volume XXXIII September 1, 1998 No. 3

Spedding Award Nominations

The 9th Frank H. Spedding Award will be presented at the 22nd Rare Earth Research Conference, July 11-15, 1999, in Argonne, Illinois, USA. This prestigious award is given in recognition of distinguished contributions to the basic science and/or technology of rare earths. The award is presented by the Rare Earth Research Conference, Incorporated, with the support of Rhodia Rare Earths and Gallium. Previous Spedding Award recipients are: W.E. Wallace, G. Busch, S. Legvold and W. Koehler, A. Mackintosh and H. Bjerrum Moeller, B.R. Judd, K. Gschneidner, Jr., L. Eyring, and G.R. Choppin.

Nominations are sought from the world wide rare earth community. An individual may nominate more than one person for the award, or may propose a joint award for a group of leaders in a particular subfield. Seconding letters are encouraged, especially if they cover information complementary to the nominating letter.

Send nominations to: Dr. Larry C. Thompson, Department of Chemistry, University of Minnesota, Duluth, Duluth, MN 55812-2496 USA; Tel: 218 726 8716; Fax: 218 726 7394; lthompso@d.umn.edu. ▲

Negative Thermal Expansion

Although we still generally take for granted that materials will expand when they are heated, there are a variety of materials that contract with increasing temperature. The unusual property of negative thermal expansion has been recently extensively investigated in the tungstate compound $Sc_2(WO_4)_3$ {*J. Solid State Chem.*, **137**, 148-160} (A.W. Sleight, Department of Chemistry and Center for Advanced Materials Research, Oregon State University, Corvallis, OR 97331-4003 USA).

Single phase samples were prepared by grinding constituent oxides and firing at 1100°C in a platinum crucible, which formed ceramic bars of $Sc_2(WO_4)_3$. The tungstate samples were then tested for thermal expansion from 10 K to 1073 K. Powder neutron diffraction data from 10 K to 450 K indicated a linear decrease in cell volume as a function of temperature, which resulted in a coefficient of linear expansion of -2.2×10^{-6} K^{-1}. Interestingly, the thermal expansion was discovered to be as high as -11×10^{-6} K^{-1} due to microstructural changes in the material.

The experiment suggests that negative thermal expansion could be related to transverse vibrations of bridging oxygen atoms in the structure. The anharmonic nature of these vibrations leads to coupled tilting of the quasi-rigid framework polyhedra. This tilting causes the structure to become more dense as temperature increases.

The phenomenon of negative thermal expansion could be used in either pure phases, or as composition materials that would have "adjusted" coefficients of thermal expansion to match a particular application, which could include zero thermal expansion. These materials may have applications in electronic components, printed circuit boards, optical substrates, low temperature thermocouples, catalyst supports, and cookware. ▲

AMR Technologies Inc.

Toronto-based Advanced Material Resources Limited underwent a name change that reflects the high-technology applications of rare earth materials. The company is engaged in the processing and development of rare earth materials and will now be known as AMR Technologies Inc.

AMR separates and purifies rare earth materials at two plants in the People's Republic of China which it sells to major consumer electronic, computer, and automotive sectors throughout Europe, North America, Korea, and Japan. AMR's subsidiary, Advanced Magnetic Materials (Thailand) Ltd., Thailand, will manufacture Neodymium-Iron-Boron magnetic powder and magnets.

For more information, contact Leanna Dean, AMR Technologies Inc., Standard Life Centre, 121 King Street West, Suite 1740, Toronto, Canada M5H 3T9; Tel: 416 367 8588; www.amr-ltd.com; amrinfo@amr-ltd.com. ▲

YBM Magnex, Inc.

A report of an independent Audit and Finance Committee, overseen by the company's outside directors, states that YBM Magnex, International, Inc., has been operating consistent with domestic and international trade and business policies. The report details that there have been no criminal acts, hidden financial arrangements, nor disingenuous material financial transactions that were supported by the company.

The company continues to carry on its usual business operations. For information on the company's products and services, contact YBM MAGNEX, INC., 110 Terry Drive, Newtown, PA 18940 USA; Tel: 215 579 0400; Fax: 215 579 3444. ▲

Permanent Magnet Design

The 16th Technology Short Course and Exhibition on Permanent Magnet Design will be held at the Crowne Plaza Hotel, Cincinnati, Ohio, on October 12-14, 1998. The course is designed to appraise the permanent magnet designer, engineer or technical manager of the latest developments in the material properties and processes of permanent magnets, including Nd-Fe-B permanent magnets and magnetic materials. Topics will include magnet behavior, modern methods for magnetic circuit design and analysis, with a number of design studies including motors, actuators and sensors; and applications. An accompanying exhibition on permanent magnet materials, equipment for magnetizing and testing, and the computer modeling of magnetic fields is included.

For more information, contact Dr. Peter Campbell, Princeton Electro-Technology, Inc., 5874 NW 32nd Way, Boca Raton, FL 33496 USA; Tel: 561 998 4249; Fax: 561 998 3286; www.magnetweb.com/course.htm. ▲

Nano Powders '98

Fine, Ultrafine and Nano Powders '98 conference will be held November 8-10, 1998. The meeting will discuss and evaluate trends toward smaller particle sizes in many industries, ultrafine and nano powder processing issues, including: the production of dispersions, coatings, and consolidated parts, and current and emerging applications and market opportunities. Other topics will include trends and U.S. markets for nanostructured materials, emerging electronic applications for ultrafine and nano ceramic powders, transitioning from the laboratory to commercial-scale production, among others.

Contact Dr. Mindy Rittner, BCC, Inc., 25 Van Zant Street, Norwalk, CT 06855 USA; Tel: 847 298 3754; Fax: 847 298 0524; mrittner@megsinet.net. ▲

Magnequench Website

The URL is: www.mqii.com. Contact Mr. Stan Trout, Magnequench International, Inc., 6435 Scatterfield Road, Anderson, IL 46013 USA; Tel: 765 648 5017; Fax: 765 648 5060; Strout@compuserve.com. ▲

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. ▲

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)
RIC News **XXXIII**, [1], 3 (1998)

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

Metallurgy of the XXIst Century: a Step Into the Future
Krasnoyarsk, Russia
September 22-26, 1998
RIC News* **XXXIII, [2], 3 (1998)

October '98

RE Beijing '98
Beijing, China
October 2-8, 1998
RIC News **XXXIII**, [1], 8-11 (1998)
Formerly ***International Forum on Rare Earths: Technology and Trade***
RIC News **XXXII**, [2], 4 (1997)

16th Technology Short Course and Exhibition on PERMANENT MAGNET DESIGN
Cincinnati, Ohio, USA
October 12-14, 1998
*This page

China Magnets 1998: Supply, Demand, Innovations and Markets for Magnetic Materials in China
Beijing, China
October 18-21, 1998
(Note: Date Change)
RIC News **XXXIII**, [2], 2 (1998)

Rare Earths '98
Freemantle, Western Australia, Australia
October 25-30, 1998
RIC News **XXXII**, [2], 5 (1997)
RIC News **XXXIII**, [1], 3 (1998)

November '98

Fine, Ultrafine and Nano Powders '98
New York, New York, USA
November 8-10, 1998
*This page

August '99

SCES '99
Nagano, Japan
August 24-28, 1999
* This issue (below)

SCES '99

The international conference on Strongly Correlated Electron Systems (SCES'99) will be held in Nagano, Japan from August 24-28, 1999. Various aspects of the strongly correlated systems will be discussed, primarily f-electron systems, but with a perspective in comparison with d-electron and organic systems. Particular emphasis will be placed on: unusual magnetic properties, unconventional superconductivity, metal-insulator transitions, charge and multipole fluctuations, and control of quantum phase transitions by pressure, magnetic fields, and materials.

For more information, contact Prof. Y. Onuki, SCES'99, Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan; www-sces99.mp.es.osaka-u.ac.jp. ▲

ABSTRACT FROM EDITORIAL OF ICM'97 PROCEEDINGS

A total of 656 papers are included in the recently published conference proceedings of the International Conference on Magnetism, ICM'97, which was held in Cairns, Australia from 27 July - 1 August 1997. The proceedings are published in the *Journal of Magnetism and Magnetic Materials* (Vols **177-181** (1998) pp. 1-1508) and comprise 4 plenary papers; 24 invited papers; 3 forum reports and 625 contributed papers.

The bar charts of the distribution by subject category of the papers published in the proceedings of the present and past ICM conferences provide a convenient way of tracking the evolution of interest in the various subfields of magnetism. A comparison of the data for ICM'97 with the data for ICM'94 in Poland shows remarkably little difference in the dominant categories. The heavy fermion category showed the largest increase in number of papers, at least partially because of the integration of the previous satellite meeting into ICM'97. Otherwise, the largest differences occur in: low dimensional magnetism (~ +5 %); photoemission and electronic structure (~ +4 %); transition metal compounds (~ +3 %); superlattices (~ -3 %); critical phenomena and phase transitions (~ + 3 %) with remaining categories revealing slight differences of only ~ û1 %. Interest in low dimensional magnetism remains at a high level along with high temperature superconductors. Superlattices and thin film structures are joined with nanostructural materials to comprise an expanding category, partly reflecting the continuing intense interest in giant magnetoresistance phenomena.

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Rare earth research, also bolstered by the burgeoning subject of colossal magnetoresistance, remains a significant part of the conference. Overall it is evident that the field of magnetism, while historically evolving in areas of changing emphasis, remains a very healthy discipline worldwide. The graph and the accompanying table show the

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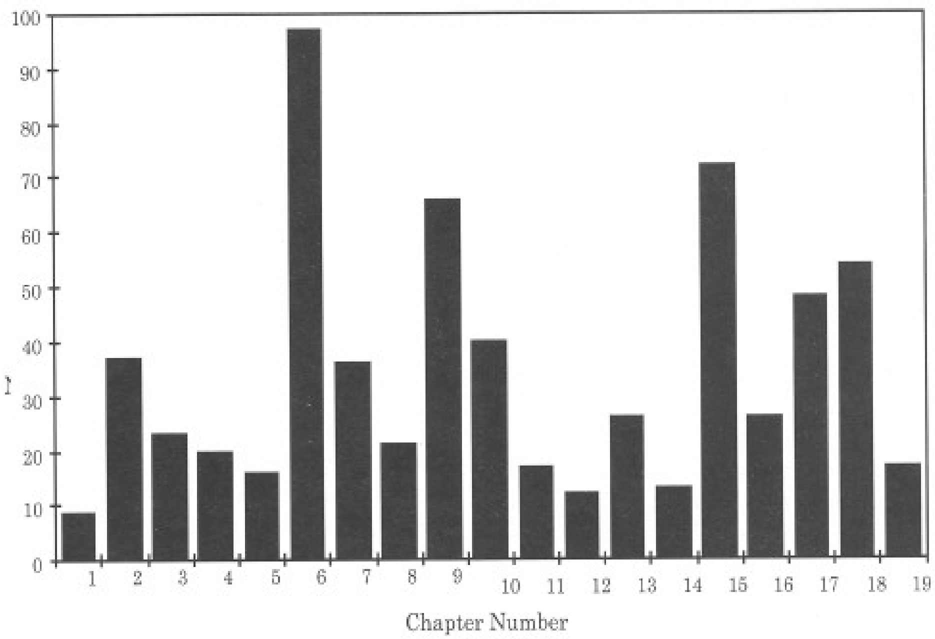
numbers of papers published in each of the chapters. The next International Conference on Magnetism, ICM 2000, will be held in Brazil.

Information from Stewart Campbell on behalf of the Publications Committee:
S.J. Campbell (Australia, Chair); J.G. Booth (UK), J.M. Cadogan (Australia), T.J. Hicks (Australia), J.J. Rhyne (USA), T. Shinjo (Japan) and G. Wiesinger (Austria).

Papers Published in ICM-97 Proceedings



1. Actinides
2. Amorphous magnetism and spin glasses
3. Critical phenomena and phase transitions
4. Domain walls and hysteresis
5. Oxides, ferrites and garnets
6. Heavy fermion and intermediate valence systems
7. High TC and conventional superconductors
8. Itinerant magnetism
9. Low dimensional magnetism
10. Magnetic interactions and ordering; magnons, solitons and fluctuations
11. Colossal magnetoresistance systems
12. Magnetic recording and other applications.
13. Nano-crystalline systems and small particles
14. Permanent magnets
15. Rare earth elements, alloys and compounds
16. Superlattices
17. Surfaces and films
18. Transition metal alloys and compounds
19. Geomagnetism, biomagnetism and other systems

Fig. 1. Distribution of papers by chapter.

Superconductor Technology

Superconductor Technology: Applications to Microwave, Electro-Optics, Electrical Machines, and Propulsion Systems is a book that identifies and describes the applications of low-temperature superconductor/high-temperature superconductor (LTSC/HTSC) technologies. These technologies are used in components and devices that are used in radar, satellite communications, space, electronic warfare, medicine, electrical, and mechanical systems.

The book presents the history, fundamentals, recent research, current applications and possible future uses of superconductors in eleven chapters. The first five chapters cover the topics of phenomenology and theory of superconductivity, superconductor forms and their critical microwave properties, superconducting substrate materials, application of superconducting technology to passive components, applications of superconducting thin films to active rf (radio frequency) components and circuits, and performance improvement of solid state devices at cryogenic temperatures. The next four chapters deal with the applications of superconductor technology to components used in radar, communication, space, and electronic warfare, and electrooptical components and systems. The last two chapters consider the applications of LTSC and HTSC technology to medical diagnostic equipment, generators, motors, and transmission lines, and the uses of superconductor technology in cryogenic refrigerator systems.

The book suggests that since LTSC/HTSC systems have benefits that neither discipline alone can achieve, greater gains may be possible when the components are effectively integrated. The book addresses the issues related to the application of superconductor technology to selected passive and active components and devices, such as electrical signal converters, filters, electrically small printed-circuit antennas, optical detectors, phase shifters, mixers, oscillators, eye-safe infrared lasers, amplifiers, and high power rf switches.

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Superconductor Technology will be useful to students, scientists, and engineers working in the various fields of superconducting materials. The 308-page hard cover book was published in 1998 and includes a subject index. The cost is US\$85.00 and it can be ordered from Wiley Publishers, 605 Third Avenue, New York, NY 10158 USA; Tel: 212 850 6336. ▲

Dy
1886

Dysprosium was discovered in 1886 by Lecoq de Boisbaudran, but was not isolated in relatively pure form until 1949. Separation and purification of Dy_2O_3 from a concentrate was made possible by ion-exchange methods employed and perfected by Frank Spedding's group at Ames, Iowa, USA {*Discuss. Faraday Soc.*, [7], 214-31 (1949)}. Dysprosium metal was produced via metallographic reduction techniques in 1953 {*J. Electrochem. Soc.*, **100,** [10], 442-4 (1953)}, but a 60% dysprosium Dy-Cd metal alloy was prepared by electrolysis of a fused-salt bath in the mid-forties {*Compt. Rend.*, **220**, 603 (1945)}. Today, high purity dysprosium is prepared by reducing DyF_3 with calcium.

Dysprosium metal has a metallic, bright silver luster and is soft enough to be cut with a knife. The metal can be machined if care is taken, but if impurities are present, it can be pyrophoric. Fine particles ignite readily and burn white hot in air.

There are three main rare earth-containing ores that produce dysprosium: xenotime, monazite, and bastnasite. Other less important Dy-minerals are fergusonite, gadolinite, euxenite, polycrase, and blomstrandine, among others. Xenotime and monazite are both phosphate minerals which can contain up to 9% Dy_2O_3, and 0.8% Dy_2O_3, respectively. Bastnasite is a fluorocarbonate mineral often associated with igneous intrusive carbonatite deposits and typically contains about 0.1% Dy_2O_3.

The highest concentrations of dysprosium occur in Chinese xenotime and rare earth ion-absorbed clays. High concentrations are also found in

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Russian apatites located in the Kola Peninsula. Monazite coexists with other heavy minerals such as rutile (TiO_2) and zircon ($ZrSiO_4$) and is usually found in alluvial or beach deposits. These deposits are mined by suction dredging or bucket excavation. The heavy minerals are then separated by gravimetric, magnetic or electrostatic means. This concentrate then undergoes a series of caustic and acid leaching steps in order to isolate the rare earths. Bastnasite is mined by open pit methods (such as at the Baiyun ebo mine in Inner Mongolia) and beneficiated by flotation, then acid leached, filtered, and calcined to produce a rare earth concentrate. The dysprosium oxide fraction is one of the last to be separated from the ion exchange and solvent extraction solutions. Current reserves of Dy_2O_3 stand at 580,000 mt. The world markets consume 120 mt annually which generates US\$10 million {*Elements*, **6**, [1], 13-14 (1997)}.

Dysprosium has a high thermal neutron absorption cross section and is used in nuclear reactor control rods. A dysprosium oxide-nickel cermet has been developed to absorb neutrons without a corresponding volume change under constant neutron bombardment.

One of the most promising uses of Dy is in the magnetostrictive alloy TEFENOL-D, (Dy,Tb)Fe. This alloy is many times more powerful than ceramic piezoelectric materials and is be studied for use in long-range sonar systems, and to actuate flight control systems in missiles and high performance aircraft. Dy-doped oxysulfides are used to produce blue and green phosphors for cathode ray tubes and other visual display devices. High purity Dy_2O_3 is used in the electronics industry as an antireflection coating in photoelectric devices in order to increase efficiency. NdFeB permanent magnets can benefit from the addition of Dy as the Curie temperature is raised and the temperature coefficient improves, but these benefits are for the present offset by Dysprosium's high price. As with many of the rare earths, price of the metal is more determined by processing costs rather than that of availability. ▲

Er^{3+} Polydendate Complexes

The optical properties of Er^{3+} doped polymers continue to attract attention because the intra 4f shell transition from its first excited state ($^4I_{13/2}$) to the ground state ($^4I_{15/2}$) occurs at a wavelength of 1.54 μm. This property, along with a luminescence lifetime of several ms, makes the Er^{3+} ion ideal for use in lasers and optical amplifiers that can be used in telecommunications. Er-doped planar optical amplifiers have shown to work in SiO_2, Al_2O_3 and $LiNbO_3$ hosts, but polymer waveguides are garnering an increasing share of interest because of their intrinsic properties.

A recent study {*J. Appl. Phys.*, **83**, [1], 497-503 (1998)} reveals the optical properties of Er-doped polydentate cage complexes. The hope is that organic compounds hosting rare earth ions could someday be incorporated into existing optical polymer amplifiers such as splitters, switches, and multiplexers with low coupling losses.

After preparing the Er^{3+} complexes, the solutions were dried, mixed with KBr and formed into 1.2 cm x 1mm tablets. Photoluminescence measurements were conducted using the 488 nm line of an Ar ion pump laser at 100 mW in order to induce excitation. The laser beam was modulated at 20-40 Hz and a closed cycle helium cryostat was used for the temperature dependence measurements from 15 K to room temperature.

Room temperature photoluminescence at 1.54 μm was observed, which is due to the intra-4f transition of Er^{3+}. The ion can be directly excited into one of the 4f manifolds at 488 nm, or indirectly at 287 nm via the aromatic portion of the polydentate cage complex. The resulting luminescence spectrum is 70 nm wide FWHM (full width at half maximum) which is the highest known for any Er-doped material. The absorption cross section at 1.54 μm is 1.1×10^{-20} cm^2 which allows the attainment of high gain. Luminescence lifetime was measured to be 0.8 μs.

For more information, contact L.H. Slooff, FOM Institute for Atomic and Molecular Physics, Kruislaan 407, 1098 SJ Amsterdam, The Netherlands; sloff@amolf.nl; www.amolf.nl. ▲

Seeing Red with Pr^{3+} Glass

Luminescence in rare earth-ion chalcogenide glasses have been attracting increasing attention, especially those doped with the Er^{3+} ion. The interest lies in emission in the 1.54 μm region, which is an important telecommunications operating wavelength. However, there are also other rare earth ions that may be able to be used in optical fibers for this purpose. Recent work by a research group in Belgium have reported 82% efficient luminescence at 1.3 μm in Pr^{3+} -doped sulfide glass, which was pumped at 1.02 μm {Appl. Phys. Lett., 71 [19], 2740-2 (1997)}.

The authors believe that this is the first time that visible luminescence has been reported on a Pr-doped sulfide glass, and that no work was conducted previously because these glasses are considered to be transparent only in the infrared portion of the spectrum. The reason that sulfide glasses are such favorable hosts is three-fold: they possess low phonon energies (<340 cm^{-1}), a large atomic mass as compared to oxygen and fluorine, and the large internal electric field, which result in a high refractive index (~2.1 in the transparency region). The low phonon energies of fluoride glasses facilitate efficient luminescence from Pr^{3+} as the $^1G_4$-$^3H_5$ transition at 1.3 μm is due to the small distance between energy levels.

The authors doped Pr^{3+} into germanium-gallium-sulfide glass and then pumped it with 488 nm and 457 nm wavelengths from an Ar^+ laser. The $Pr{:}Ge_4Ga_2S_{15}$ yellow-colored glass, which has an optical gap of ~3.0 eV, was effectively excited at the $^3P_0$ level. The resulting decay to underlying levels gave the most intensive transition at 635 nm and 660 nm. This red luminescence was easily seen by unaided vision at room temperature. The edge photoluminescence from the host glass occurs in the red or infrared and competes with Pr- photoluminescence. The team reports that the edge photoluminescence is of a different origin than that of the well-known photoluminescence from intrinsic defects of

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chalcogenide glasses, which can be observed at low temperatures with a large Stokes shift. Excitation wavelength and temperature dependencies as well as the polarization memory of Pr^{3+} and host photoluminescence indicate the presence of energy transfer from defect states of the glass to Pr^{3+} ions.

The authors suggest that this strong red luminescence could be used for manufacturing highly luminescent sealing glasses that would be compatible with silicon photodetectors and solar cells that would be more sensitive in the red than in the higher energy part of the spectrum. For more information on this research, contact V.K. Tikhomirov, Laboratorium voor Halfgeleiderfysica, K.U. Leuven, Celestijnenlaan 200 D, B-3001 Heverlee-Leuven, Belgium; guy.adri@fys.kuleuven.ac.be. ▲

Superconductor Market Study

Business Communications Company, Inc. (BCC) announces the availability of RGB-106R "The Superconductor Industry - A Technical/Economic and Market Analysis". The BCC study reports that there are two important market segments for low temperature superconductors (LTS): magnetic resonance imaging (MRI) machines and electromagnets that are used in high energy physics. In 1997, the LTS market was US$445 million and is expected to grow to US$653 million by 2002 which represents an average annual growth rate of 8%. Although the world market for high temperature superconductors (HTS) is less than LTS, it is expected to grow at an average annual growth rate of 32.8% as sales increase from US$15 million in 1997 to US$62 million by 2002. Demand from the U.S. Department of Energy and a large military market will drive the research and development of superconductor technology.

The study is available for US$3,250.00 by contacting Dr. Thomas Abraham, BCC, Inc., 25 Van Zant Street, Norwalk, CT 06855 USA; Tel: 203 853 4266; Fax: 203 853 0348; tombcc@aol.com. ▲

Zirconia Engineering Ceramics

Over the last 25 years, zirconia ceramics have been proven to be a remarkable group of materials. Their properties range from electrically insulating, mechanically weak pure monoclinic zirconia (ZrO_2) through the fast ion conduction of stabilized cubic and tetragonal forms to the advanced mechanical properties of partially-stabilized zirconia (PSZ) and tetragonal zirconia polycrystal (TZP). *Zirconia Engineering Ceramics: Old Challenges - New Ideas* is a bound version of Volumes **153-154** of the journal *Key Engineered Materials* (1998) and is a collection of eleven reviews that track the progress in the materials science and materials engineering of zirconia compounds.

The books' reviews start with the early work in phase stability to later work that utilize sophisticated models for the transformation toughening associated with the tetragonal to monoclinic phase transformation. The first chapters deal with crystal structures and the relationships between phases, thermodynamics, phase diagrams, microstructure, and mechanical behavior including the tetragonal to monoclinic phase transformation, high temperature plastic deformation and ferroelasticity of Y and Ce zirconias. The book then covers electrical and transport and related properties of bulk and interfacial zirconia, and finishes up with the chemical preparation of zirconia powders and the optimal means for their densification into CeO_2- and Y_2O_3 zirconia ceramics.

The book is both a reference and as a starting point for those wishing to advance the understanding of zirconia ceramics, and in the latter sense will serve those students working in the field. The 325-page *Zirconia Engineering Ceramics: Old Challenges - New Ideas* was published in July and is available for US$168.00 by contacting the publishers: Trans Tech Publications Ltd., Brandrain 6, CH-8707 Uetikon-Zuerich, Switzerland, Fax: 41 1 922 10 33; E-mail: ttp@ttp.ch. Detailed information on this book, including a full table of contents, is available on: http://www.ttp.ch/titles/793.htm.

Russian Loparite

The rare earth ore *loparite* is a complex oxide (Ce,Na,Sr,Ca)-(Ti,Nb,Ta,Fe^{3+})O_3 that has a perovskite (ABO_3) structure. It is a black colored oxide mineral that commonly crystallizes in a complex cubic form or as pseudo-cubic twin crystals about 0.2-0.6 mm which will streak red-brown. The ore is the primary source of rare earths from Revda, Kola Peninsula, Russia, where it occurs in association with alkaline rocks of magmatic origin such as feldspar, apatite, and titanite, among others. The ore is a major source of light rare earth oxides (REO), which is composed of primarily cerium (50% REO equivalent) and lanthanum (25% REO equivalent). Thus, the light REO composition of Revda loparite compares with that of apatite from Khibiny, Russia.

The ABO_3 structure of loparite is characterized by its coupled substitutions, polymorphism, defect chemistry, and tendency to become metamict (lack of crystalline structure). The breakdown of the ABO_3 structure is thought to be caused by long-term exposure to alpha radiation from radioactive impurities in the mineral, such as uranium and thorium.

Mine production of rare earths from the central Kola Peninsula originates from the Lovozero Alkali Massif that provides about 6,500 mt REO per year, mostly from loparite. The ore is mined from underground operations and beneficiated to a 95% loparite concentrate via gravimetric and electromagnetic separation techniques. The concentrate then undergoes chlorination and acid dissolution to extract rare earths (La, Ce and Nd oxides), titanium, niobium, and tantalum. The chlorination process involves gaseous chlorination of the concentrate at 750-850°C in the presence of reducing agents coke and charcoal. The less volatile rare earth chlorides remain in the chlorinator and are dissolved with water which is further separated and purified by the acid process. The acid process consists of dissolving the concentrate feed in an 85% solution of sulfuric acid at 150-200°C in the presence of ammonium sulfate. The resulting double-salts of rare

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earths are filtered out and converted to carbonates and then dissolved by nitric acid. The remaining rare earths in the nitrate solution are separated and purified by selective precipitation and solvent extraction.

For more information on loparite or other rare earth ores, contact Mr. James B. Hedrick, US Geological Survey, 983 National Center, Reston, VA 20192 USA; Tel: 703 648 7725; Fax: 703 648 7722; jhedrick@usgs.gov. ▲

"Super" CRADA

A Cooperative Research and Development Agreement (CRADA) involving Los Alamos National Laboratory, 3M Corporation, Southwire Co., and Oak Ridge National Laboratory, will explore commercially-viable superconductors which have current densities 100 times greater than that of those previously produced. A current density of 100 million amp/cm^2 will be the goal of the research group that will work with yttrium-barium-copper-oxide (YBCO) ceramic compounds.

The YBCO ceramic will be deposited onto a strip of nickel and cubic zirconia, which is based on the successful "Super Tape" announced by Los Alamos National Laboratory in April of 1995 {*RIC News*, **XXX**, [2], 5 (1995)}. Hopefully, tapes in excess of one meter, the length previously produced but too short for many commercial applications, will be produced. Not only must the new tapes have a much higher current-carrying density, but must also be made readily available at a lower cost.

Low cost superconductors could be used in large markets, including electric motor applications, generators, and underground power cables. By using superconductors, lighter transformers that operate without oil or other coolants such as the toxic polychlorobiphenyls (PCB's) could be produced. In addition, more efficient electric motors would run quietly and produce more power while consuming less energy.

For more information on the "Super CRADA" or the "Super Tape", contact James E. Rickman, Los Alamos National Laboratory, Los Alamos, NM 87545 USA; Tel: 505 665 9203. ▲

YBCO News

Recent experiments conducted by research groups from the University of Illinois Urbana-Champaign and Northwestern University, USA, on $YBa_2Cu_3O_7$ (YBCO) high-T_c superconductors may provide a new way of looking at the mechanisms of superconductivity in these rare earth cuprates. The experiments deal with the pairing state of electrons that are responsible for superconductivity {*Physics Today*, **50**, [11], 19-21 (1997)}.

Symmetry Breakdown

The dominant symmetry of YBCO superconductors is *d*-wave. However, if two different pairing mechanisms would coexist in the same material at the same time, this would create spontaneous currents. These currents could affect the zero-bias conductance peak of the superconductor (the conductance peak represents excess current that flows even when no voltage is applied to the material). This peak is a function of bias voltage and splits when a magnetic field is applied. A peak that splits without an external magnetic field would indicate a break in time-reversal symmetry, a significant discovery in the study of superconductors.

To determine the zero-bias conductance peak of the superconductor, thin films of YBCO were first grown by off-axis magnetron sputter deposition. The researchers then used planar tunneling spectroscopy to measure the tunneling conductance across different junctions as a function of crystallographic orientation, temperature, and magnetic fields. They found that at 90 K, the YBCO has *d*-wave symmetry, while at 7 K, *s*-wave symmetry also exists {*MRS Bulletin*, **22**, [11], 14 (1997)}. Due to the coexistence of these two symmetries, the differences between their phases spontaneously generate a current, which, in turn, creates a magnetic field, splitting the zero-bias conductance peak. According to the researchers, it is this current that breaks the guage symmetry and time-reversal symmetry of the solid superconductor, hinting that a new form of matter exists. ▲

Piezoelectric LTG Single Crystals

As a result of a program aimed at developing improved-performance piezoelectric materials, researchers from Metals Materials Research Laboratory (Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980 Japan; Tel: 22 217 4844; Fax: 22 217 4846) have produced large, high quality lanthanum tantalate gallium (LTG) single crystals. These new piezoelectric crystals may lead the way for a new generation of high frequency digital electronic devices.

Piezoelectric LTG crystals exhibit a greater electric coupling coefficient than langasite, yet have about the same temperature characteristics. The LTG crystals were 50 mm x 170 mm and were drawn by a crystal drawing method. Reportedly, the crystals can be produced in relatively large sizes and in crucibles made of platinum-rhodium alloys. The researchers are now attempting to prepare 3-inch diameter LTG crystals. ▲

New H-Storage Facility

Mitsui Mining & Smelting Company, Limited, is building a new 1,500 m^2 (15,850 ft^2) facility at its Hiroshima Prefecture plant at a cost of 3 billion yen (US$21.7 million). The plant is being built to meet the projected demand for hydrogen storage materials needed for the automobile industry. Currently, about ten percent of the company's production of hydrogen storage materials is used in automobiles.

Toyota Motor corporation is using the alloys in the batteries of its new hybrid electric motor-gasoline engine cars. Since each hybrid automobile requires a large amount of the alloys, large-scale production of the vehicles could result in a substantial increase in the demand for these materials. For more information, contact: Mitsui Mining & Smelting Company Ltd., 2-1-1 Nihombashi, Chuo-ku, Tokyo 103, Japan; Tel: 3 3246-8000; Fax: 33275 5611. ▲

RIC Database

The total number of documents referenced in our system is now over 95,000. 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).

199801440

HUANG;Z TODD;MA WATTON;R WHATMORE;RW
Sputtered lead scandium tantalate thin films: a microstructural study
Journal of Materials Science, 33, pp. 363-70 (1998)
1998 TANTALATE THIN-FILM SPUTTERED
(SC,PB)TAO3 MICROSTRUCTURE SC-COMPOUNDS
(SCOPBTA)

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. ▲

Rare Earth Specialists

Import/Export

The National Commodity Specialist (NCS) Division of the Department of the Treasury, U.S. Customs Service, serves as a knowledgeable technical resource for individuals desiring to import rare earth metals, compounds, and alloys into the United States. The duties of the NCS include: coordinating technical commodity information, promoting legal and procedural national uniformity in the classification and value of merchandise for Customs purposes, assisting the importing public, and the promotion of compliance in the importing and exporting community.

Rare earth metals and compounds are classified in chapter 28 of the Harmonized Tariff Schedule (HTS) and have been assigned to the National Import Specialist , Mr. V. Gualario. For more information, contact Mr. Gualario, U.S. Customs Service, NCS Division, 6 World Trade Center, CIE, Rm 437, New York, NY 10048 USA; Tel: 212 466 5744.

U.S. Geological Survey

The rare earth and rare earth minerals specialist at the U.S. Geological Survey is James B. Hedrick. He can be contacted at: 983 National Center, U.S. Geological Survey, 12201 Sunrise Valley Drive, Reston, VA 22092 USA; Tel: 703 648 7725; Fax: 703 648 7722; Jhedrick@usgs.gov. ▲

Zhuhai Shining Metals Group

The Zhuhai Shining Metals Group (SMG) is a large scale shareholding company in the Zhuhai Special Economic Zone, People's Republic of China. SMG is a merger of Guangzhou Zhujiang Refinery, Inner Mongolia Shining Metals Rare Earth Co., Ltd., and the Jiaozuo Shining Rare Earth Factory.

The company offers rare earth concentrate, chlorides, oxides, mixed carbonate, metals, alloys, polishing powders, ceramic pigments, and Nd-Fe-B and Sm-Co permanent magnet material. The company is reportedly in the process of completing ISO 9002 quality assurance standards.

To receive details on the products and services of SMG, or for additional information on the company, contact Zhong Hong, Zhuhai Shining Metals Group RE Marketing Center, Room 2460, Dongfang Hotel, Liuhua Road, Guangzhou, China; Tel: 20 86669900 ext. 2458, 20 86688311; Fax: 20 86665438. ▲

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The supporters from the fourth quarter of the 1998 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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