Rare-earth Information Center NEWS

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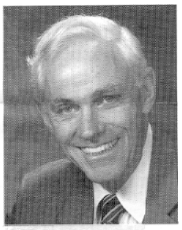
Von Hippel Award



Theodore H. Geballe

Theodore H. Geballe, Professor Emeritus of Applied Physics and Materials Science and Engineering at Stanford University, has been selected as the recipient of the 1991 Von Hippel Award of the Materials Research Society (MRS).

The award was presented to Geballe in December and honors his "ingenious use of chemical principles to synthesize novel materials of technological importance, his careful experiments on a wide range of materials to illuminate fundamental properties and behavior, and his leadership in helping to formulate the modern concepts of interdisciplinarity as a scientist, teacher, and administrator."

Professor Geballe is best known for his work on new materials in areas of potential technological significance and in understanding novel physical properties of superconductors and superconductivity. ▲

Gallium Superconductor

Researchers at Northwestern University and Argonne National Laboratory have discovered a new family of high-temperature superconductors. The new superconductor has the formula $YSr_2Cu_2GaO_7$ and achieved zero resistance at 30K and 73K. It was produced by K.R. Poeppelmeier's group at Northwestern and may be more readily adapted to practical applications than other superconductors.

The $YSr_2Cu_2GaO_7$ was doped with calcium and annealed in high-pressure oxygen at 910°C. The new material is structurally similar to the 93K $YBa_2Cu_3O_7$ superconductor, except that the square-planar copper chains separating the double Cu-O layers are replaced by connecting Ga-O tetrahedra. These gallium layers apparently make the structure more thermally and mechanically stable. For example, it does not lose oxygen when heated in air.

Continued in next column ➪

The new material is the first in which only the Cu-O planes, separated by non-nonconducting chains, carry the supercurrent. The discovery was first presented at M²S-HTSC III, Kanazawa, Japan, this July. ▲

Pr^{3+}-Doped Superfluorescent Fluoride Fiber Laser

A Pr^{3+}-doped superfluorescent fiber laser operating in the 1.3μm band is reported by Y. Ohishi, T. Kanamori and S. Takahashi in *Jap. J. Appl. Phys.* 30, L1282-4, (1991). The authors report an output power of 0.166mW at a peak wavelength of superfluorescence at 1.306μm, which corresponds well with the central wavelength of optical telecommunication trunk line systems.

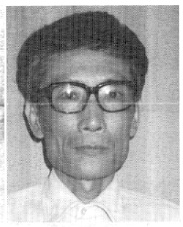
The new Pr^{3+} active ion for fiber amplifiers operating in the 1.3μm band demonstrated effective signal amplification. The authors report that the $^1G_4$-$^3H_5$ transition in Pr^{3+}, which causes the fluorescence at 1.3μm, has a branching ratio of 64 percent, making it unnecessary to suppress saturation due to spontaneous emissions from other transitions, as is required with Nd^{3+} at the same wavelength.

This new superfluorescent fiber laser (SFL) solves the problems of current superluminescent diodes (SLDs) by having a longer lifetime, better wavelength stability, and higher output and coupling power. Nd^{3+}-doped and Er^{3+}-doped superfluorescent fiber lasers, operating at 1.06 and 1.5μm, respectively, have also been reported.

These new broad-band light sources should find work in fiber sensor applications, in particular fiber gyroscope and in some signal-processing fiber systems, as low temporal coherence sources.

Recently, a wavelength division multiplexer (WDM) transmission system was demonstrated which used an SLD in the 1.55μm telecommunication window. Similar experiments have been conducted in the 1.3μm window using high power LEDs. Since broad band sources are attractive for WDM systems, the adoption of the Pr^{3+} active ion for a SFL using fluoride fiber looks promising. ▲

Gold Medal Award



Professor Jun Kondo

Professor Jun Kondo, of Toho University, Chiba, Japan, has received the 1991 Acta Metallurgica Gold Medal Award. The international award was established in 1974 to recognize outstanding ability and leadership in materials research.

Professor Kondo is known for his interpretation of the resistance minimum in dilute magnetic alloys, first published in 1964. The phenomenon of the resistance minimum attracted the interest of metal physicists in the 1930's, and was regarded as a major unsolved mystery in the field. Dr. Kondo developed a successful theory of the resistance minimum in these alloys by examining the scattering of electrons by a magnetic impurity. This revealed the important effect of quantum interference caused by cooperation of the dynamic nature of the magnetic moment of the impurity and the presence of the Fermi surface. This theory is now known as the "Kondo Effect".

Over the next fifteen years his work stimulated hundreds of investigations clarifying the character of the ground state and thereby permitting analysis of physical properties down to extremely low temperatures. Through Prof. Kondo's study of internal magnetic fields, the Hall effect, and magnetoresistance of ferromagnetic materials, we better understand magnetism in metals and the methods of theoretical analysis in solid state physics. ▲

Rare Earths '92 in Kyoto

The Rare Earth Society of Japan is sponsoring the international conference, Rare Earths '92 in Kyoto, to be held June 1-5, 1992 at Kyoto Park Hotel, Kyoto, Japan. The first announcement appeared on pages 2 and 6 of the September 1990 issue of the *RIC News*. Two plenary lectures: "Systematics and Anomalies" by K.A. Gschneidner, Jr. and "Exchange Interactions in the Rare Earth Compounds" by T. Kasuya will lead the conference.

Proposed symposia include topics on: rare earth metals and metallurgy, rare earth oxide systems, 4*f* electron interactions in rare earth compounds, organometallics of lanthanides, rare earth magnets, solution and coordination chemistry of lanthanides, spectroscopy of rare earths, rare earth luminescent materials in the nineties, hydrogen storage materials and batteries, problems of the rare earth industries, catalysts and actinides.

For more information, contact professor Gin-ya Adachi, Department of Applied Chemistry, Faculty of Engineering, Osaka University 2-1, Yamadaoka, Suita, Osaka 565, Japan, Tel:(06)877-5111 ext.4251; Fax:(06)876-4754. ▲

SCES '92

The second circular of the International Conference on Strongly Correlated Electron Systems indicates that the title of the conference has been changed to SCES '92 and will retain this title as future conferences are held on an annual basis. The first circular referred to the conference as HFSCS '92 and was reported on page 2 of the December 1, 1991 issue of the *RIC News*.

The main topics of the conference will include: electronic properties of metallic rare earth and actinide compounds; the heavy fermion characters in the *f*-electron systems, which include superconductivity, gap state and magnetic polaron formation; physics on the strongly correlated metallic *d*-electron systems including the CuO_2 layered materials; strongly correlated *s-p* electron systems including organic metallic systems; low carrier problems in strongly correlated systems; the related reference systems; theoretical papers related to the above topics; and new materials and technologies.

Invited papers will report on special topics of current interest. 34 invited lectures and 63 oral talks will be presented with other contributed papers presented at poster sessions. Deadline for abstracts is May 15, 1992 and manuscripts should be received by August 1, 1992.

The conference will be held at the Sendai International Center, Sendai, Japan, September 7-10, 1992. For more information contact: Prof. Takemi Komatsubara, Secretariat SCES '92, Department of Physics, Tohoku University, Aoba-ku, Sendai 980, Japan, Tel:81(22)222-1800 ext. 3300; Fax:81(22)225-1891. ▲

Conference Calendar

*** A NEWS STORY THIS ISSUE**

April '92
22nd Journees des Actinides
Dieulefit, France
April 26-29, 1992
RIC News, **XXVI**, [3] 2 (1991)

June '92
Rare Earths '92 International Conference
Kyoto, Japan
June 1-5, 1992
RIC News, **XXV**, [3] 2 (1990)
*Also this issue

July '92
2nd International Symposium on Physics of Magnetic Materials (ISPMM'92)
Beijing, People's Republic of China
July 3-8, 1992
RIC News, **XXVI**, [2] 2 (1991)

12th International Workshop on Rare Earth Magnets and Their Applications and 7th International Symposium on Anisotropy and Coercivity in Rare Earth Metal Alloys
Canberra, Australia
July 12-16, 1992
RIC News, **XXVI**, [2] 2 (1991)

Third International Symposium on Magnetic Bearings
Alexandria, Virginia
July 29-31, 1992
RIC News, **XXVI**, [3] 2 (1991)

September '92
International Conference on Strongly Correlated Electron Systems (SCES '92) *formerly:International Conference on Heavy Fermion and Strongly Correlated Electron Systems (HFSCS '92)*
Sendai, Japan
September 7-10, 1992
RIC News, **XXVI**, [4] 2 (1991)
*Also this issue

8th International Symposium on Halide Glasses
Perros-Guirec, Brittany, France
September 22-5, 1992
*This issue

March '93
International Symposium on Radiation Protection in the Mining, Milling and Downstream Processing of Mineral Sands
Bunbury, Western Australia
March 18-20, 1993
RIC News, **XXVI**, [4] 2 (1991)

April '93
Rare Earth Minerals: Chemistry, Origin, and Ore Deposits
London, England
April 1-2, 1993
RIC News, **XXVI**, [2] 2 (1991)

September '93
20th Rare Earth Research Conference
Monterey, California, USA
September 12-17, 1993
*This issue

Actinides-93
Santa Fe, New Mexico, USA
September 19-24, 1993
RIC News, **XXVI**, [3] 2 (1991)

8th International Symposium on Halide Glasses

The 8th International Symposium on Halide Glasses will be held September 22-5, 1992 in the Palais des Congres of Perros-Guirec on the coast of Brittany, France. The aim of the Symposium is to provide a major international scientific forum for the exchange and circulation of information on halide glasses and non-oxide unconventional glass preparation and characterization. Special emphasis will be given on the application of these glasses.

Continued on page 3

Halide Glasses*/Continued from page 2*

The Symposium will include topics on glass synthesis and structure, physical, chemical, and mechanical properties, optical properties, active fibers, optical fibers, and a section on rare earth-doped halide glasses. The Symposium is organized by the Centre National d'Etudes des Telecommunications (CNET) which is the Research Centre of France Telecom Group.

For submission deadlines and other information contact: Mrs. A. Reungoat or Mrs. A. Le Goff, LAB-OCM, CNET, BP 40, 22301 Lannion Cedex, France Fax:33 96 05 3246 or 1307. ▲

Water-resistant Fluorozirconate Glass

Research scientists Y. Dai et al., report on the properties of a protective surface layer generated by low-energy (15keV) oxygen implantation in fluorozirconate glass [*Appl. Phys. Lett.*, 58, 422-24(1991).] Fluorozirconate glasses have been widely investigated as multi-spectral optical media through 0.2-7 μm in wavelength, but have displayed chemical weakness to aqueous corrosion. Optical transmission tests on their oxygen-ion-implanted glass were almost identical to that of their unimplanted glass in the infrared region; a slight drop in transmittance near the UV edge was said to be due to surface damage induced by ion bombardment. Water corrosion tests on the virgin fluorozirconate glass showed strong infrared absorption at 3450 cm^{-1} after a few minutes immersion and within 2 hours the optically polished surface was completely destroyed. With the oxygen-implanted sample, little change was found after immersion in water for over 200 hrs. Although a slight absorption was observed near 3450 cm^{-1}, the implanted specimen retained its clear optical surface during the duration of the test. ▲

Conference Proceedings

The Proceedings of the 6th International Conference on Valence Fluctuations, held in Rio de Janeiro, Brazil 9-13 July, 1990, is published as Volume 171 of *Physica B, Cond. Mater.* The Proceedings are presented in two sections: Theory and Experiment.

The first section deals with the theory of heavy-fermion compounds, strongly correlated metals, nuclear magnetic relaxation,

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Divalent Rare Earth Ions in Halide Crystals

A review written by J. Rubio O. [*J. Phys. Chem. Solids*, **52**, No. 1, 101-74 (1991)] reports on the results of the extensive research into the properties of divalent rare earth ions in halide crystals. The paper primarily relies on the research of the past 20 years and concentrates on the spectroscopic properties of divalent rare earth ions doped into alkaline earth and alkali halides, and other halide crystals. The author gives special emphasis on the most-studied divalent rare earth species: Eu^{2+}, Sm^{2+} and Yb^{2+}.

The rare earth ions can be present in solids, either in their divalent or trivalent state, but by far the most common valence state of these ions in solids is the trivalent one. Since the absorption and emission spectra of the divalent ions differs considerably from the trivalent ions, this review is a welcome addition to the literature that is currently available.

The spectra are mainly composed of two types of electronic transitions: weak $4f$ - $4f$ at low energies and strong $4f$ - $5d$ at higher energies. In order to understand these transitions, a reasonable knowledge of the energy levels of the $4f^{n-1}5d$ configuration is required.

The author reports on the optical and physical properties of Eu^{2+}, Sm^{2+} and Yb^{2+}, which include absorption and emission spectra, fluorescence, photoionization energies, binding energies, quantum efficiencies and energy levels. The 73-page review effectively uses 68 figures, 39 tables, and 324 references to summarize the most significant information concerning the spectroscopic properties of halide crystals doped with divalent rare earth ions, mainly Eu^{2+}, Sm^{2+} and Yb^{2+}. ▲

electron-lattice interaction in $Sm_{1-x}Y_xS$-like systems, electronic structure and magnetization in Ce-compounds, and magnetism in Kondo lattices. The experimental section reports the results of work primarily with Ce- and Yb-compounds such as $CeFe_2$, $CeRh_2Ge_2$, $YbAs_3$ and $YbPd_2Si_2$. The nuclear magnetic relaxation, magnetism and superconductivity, along with electronic instabilities and Hall effect of these and other heavy-fermion systems are revealed.

The 402-page proceedings contains 73 papers and was published in 1991 by Elsevier Science Publishers, P.O. Box 103, 1000 AC Amsterdam, The Netherlands Tel:(31-20)5862911; Fax:(31-20)5862580; Telex: 10704. The cost is $183.00 US. ▲

Workshop Proceedings

The conference proceedings of a workshop entitled Semiconductors and Rare Earth Based Materials, covers two important branches of materials science: semiconductor physics and solar cells, and rare earth based materials and their applications. In both sections, introductory talks on the fundamental concepts are followed by up-to-date reports on the basic aspects of various applications of solar cells and supermagnets, all given by well-known specialists in the field.

About one-half of the book deals with semiconductors and solar energy cells. Of particular interest to rare earthers is the second part, which deals with industrial processing and applications, structure and properties of rare earth magnets and magnetic materials. Included are descriptions on the processing of permanent magnets from rare earth-transition metal compounds and the uses of rare earth-boron materials in industry.

The 373-page book contains lectures given at the International Workshop on Materials Science, held October 15-26, 1990 in Hanoi, Vietnam, and was published in 1991. It is published by World Scientific Publishing Company, Inc., Suite 1B, 1060 Main Street, River Edge, New Jersey 07661 USA Tel:(201)487-9655; Fax:(201)487-9656. To order in the U.S.A. and Canada, call 1-800-227-7562, in Europe, fax:44-81-4463356 elsewhere, fax:65-3825919. The cost of the book is $68.00 US. ▲

Superconductor Degrades

The world's first photograph of the breakdown process of an Y-Ba-Cu-O superconductor was taken by the Inorganic Materials Research Laboratory of the Science and Technology Agency of Japan [*Jpn. New Mater. Report* 6, [3], 9 (1991)].

A piece of yttrium, barium, copper oxide ceramic was first crushed into a powder and a particle with a thin edge was selected. It had a diameter of 3mm and a thickness of about 100 Å. The particle was then subjected to a 1000KV electron beam, which impacts with atoms in the crystals and causes the crystals to degrade into an amorphous form. This transformation of individual crystals was clearly photographed using an electron microscope with a resolution of 1 Å.

Laboratory officials said that the observation is important for the development of radiation resistant superconducting materials. ▲

25 *The Rare Earths and I* 25

In this issue we bring you the following contribution sent to us by Dr. H.B. Lal. He is currently associated with the Department of Physics, University of Gorakhpur, Gorakhpur, India.

HOW I GOT STARTED IN THE FIELD OF RARE EARTHS

At the end of 1966 I submitted my Ph.D thesis at Allahabad University, India, and was making plans for post-doctoral research. My advisor suggested that I concentrate on the electrical and magnetic properties of rare earth compounds. However, before I could start any experiments, I was offered a teaching position at Gorakhpur University, India, a place about 250 km from Allahabad and thus lost the experimental facilities which I had assembled there.

At that time, Gorakhpur had no experimental facility, no books on rare earths, and a very meager literature base on solid state physics. In such a situation I had no alternative but to sit in the library in my off time. It was there that I came across an article by S. Methfessel and D.C. Mattis in *Handbuch der Physik*, 18/1, 389 (1968). This article inspired me to work on rare earth materials. In time I managed to set up an apparatus for magnetic susceptibility measurements, and managed to purchase one gram of $Er_2(WO_4)_3$ for $50.00 and a small single crystal of $EuWO_4$ for $150.00.

In 1974 I joined Prof. Olaf Beckman of Uppsala University, Sweden, as a fellow of International Seminar (INTSEM) [INTSEM is run at Uppsala University, for research workers from developing countries and is financially supported by SIDA (Swedish International Development Authority)]. He allowed me to work on rare earth compounds and to purchase chemicals of my choice, which was my real entry into the field of rare earths.

I utilized one year of fellowship in studying the magnetic, dielectric, and electrical transport properties of rare earth sesquioxides and their tungstates. As I was returning home, INTSEM provided me the apparatus and the sesquioxide and tungstate samples. It was a surprise upon returning to India that I had to pay the custom duty on these chemicals and I did not have enough money to do so. Fortunately INTSEM intervened and I was able to bring the

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samples into India. Had this not been done, my activity in the field of rare earths would have been slowed down considerably.

In March, 1979, I joined Prof. S. Methfessel at Ruhr Universität, Bochum, Germany. Here I had the chance to go through the huge literature collection on rare earth materials. I carried out a lot of measurements particularly on rare earth-indium-silver alloys. I was much inspired by the publication of a photograph and a summary of my group's research activity in India in *RIC News*, **XVI**, No.4, 1 (1979). Prof. Methfessel and his colleagues were delighted to see it. Also, we have been greatly encouraged by Dr. J.B. Goodenough who gave us his valuable suggestions on many of our articles.

Today, the literature on the rare earths is so great that small universities, like ours, are unable to purchase it. In such a situation *RIC News* provides us with much information about new materials, literature, conferences, and active groups in the field. In fact, *RIC News* is of great service for the development of research activity on rare earths worldwide. ▲

RIC-SNTT Sharing Resources

The Rare-earth Information Center (RIC) and the Society of Non-Traditional Technology (SNTT) have reached an agreement to share their information data systems to help promote the development and advancement of the science and technology of rare metals, especially the rare earth elements. RIC's literature data base has over 53,000 references on rare earth materials, which can be accessed through key words (about 34,000) or authors (about 46,000). SNTT has a factual data base (over 80,000 entries) which contains physical and chemical properties of rare metal materials in the form of tabular and/or graphical data. The RIC-SNTT agreement will allow SNTT to search RIC's literature data base for literature citations on rare earth materials, while RIC will be able to search SNTT's factual data base for numerical and/or graphic information on the properties of rare earth and other materials. The Society for Non-Traditional Technology is located in Tokyo, Japan and is supported by Science and Technology Agency of Japan and Japanese industrial corporations.

In time we expect that other scientists, engineers and other professionals will be able to access RIC's literature data base electronically without interacting with RIC's staff. ▲

Order and Phase Stability in Alloys

A new book, *Order and Phase Stability in Alloys*, is Volume 3 of the Cohesion and Structure series from North-Holland. The main purpose of this book is to describe the modern tools of solid state physics (in particular, electronic structure calculations and statistical thermodynamics) that enable us to understand ordering effects in alloys and to determine phase diagrams. This approach is used more to gain insight on the most important physical mechanisms rather than to be able to make accurate predictions suitable for particular applications. However, more phenomenological, practically oriented approaches can expand the scope of these new theoretical insights. A second purpose of the book is to show that materials science can provide wonderful, and too often ignored, examples to test the most fundamental physical theories. For example, many real alloys which have a face-centered cubic lattice are marvelous examples of the Ising model on this lattice with many different ordered structures, which may or may not be commensurate. The text is definitely theoretical, with emphasis on the methods more than on the interpretation of experiments.

The book contains an introductory chapter followed by seven chapters in two parts. Part one discusses the application of the Ising model to ordering phenomena in alloys and discusses the principles of the techniques in detail. The second part is devoted to the electronic structure of alloys, its main purpose being to explain the principles of a recently developed method that enables the calculation of interatomic interactions and the justification of the use of an effective Ising model. It is in chapter six where the electronic structure and the coherent potential approximation is explained by the cohesive energy of the transition metals. Such transition metals as La, Sc and Y are used to illustrate the tight-binding approximation by showing the cohesive energy of these metals as a function of the numbers of d electrons.

The 1991 book has 511 pages and can be obtained for $151.50 US (295 Dfl) from Elsevier Science Publishers, P.O. Box 211, 1000 AE Amsterdam, The Netherlands Tel:(31-20)5862911 Fax:(31-20)5862623 Telex:10704. In the U.S.A. and Canada contact: Elsevier Science Publishing Co., Inc., P.O. Box 882, Madison Square Station, New York, NY 10159. ▲

Luminescence and the Solid State

Luminescence and the Solid State by R.C. Ropp is a text that has been written to address the need for more literature in the field of solid state chemistry. The concepts contained in the book regarding luminescence and phosphors are unique and have been covered extensively providing a useful reference source for anyone requiring such knowledge as a basis for further study. The discussion on the defect state, which is handled in chapter two, can be applied to many other systems such as superconductors.

Chapter nine, Lanthanides and Lasers, begins with a short summary of occurrence of lanthanides, and their abundance in the earth's crust, methods of processing of ores and then the spectroscopic properties of Ln^{3+}. The electron configurations of the rare earth elements are reviewed which precedes a section on the methods of calculating rare earth energy levels. The author advocates the use of "Free-ion Energy Levels" as the best alternative to display lanthanide energy levels. The final sections of the chapter deal with lasers and "up-conversion" phosphors. The compositions of these phosphors as well as the activators and host lattices and resulting emission wavelengths are included. The author also compares the relative efficiencies of Anti-Stokes phosphors.

Chapter ten contains a section on the preparation of rare earth phosphors utilizing solid state reactions and techniques. The spectral properties and relative efficiencies of YVO_4, Y_2O_3, YPO_4, $YNbO_4$, $GdVO_4$ hosts activated by Eu^{3+}, Dy^{3+}, Tb^{3+}, Sm^{3+} ions are also examined.

This comprehensive text can be used for self-study and should also prove to be invaluable in graduate study as an introduction to the solid state and luminescence. The book has extensive, useful equations and figures, the derivations of which are simple and easy to follow. *Luminescence and the Solid State* by R.C. Ropp was published in 1991 by Elsevier Science Publishers and contains 453 pages. It costs US $185.50 (325 Dfl) and can be ordered from Elsevier Science Publishers, P.O. Box 211, 1000 AE Amsterdam, The Netherlands; or in the U.S.A. and Canada from Elsevier Science Publishing Company, P.O. Box 882, Madison Square Station, New York, NY 10159, U.S.A. ▲

CERIUM was named after the newly sighted asteroid Ceres in 1803.

Superbearing

A magnetic bearing built from high-temperature superconducting materials has demonstrated the lowest frictional loss achieved so far in laboratory tests. The near-frictionless bearing was built and tested by scientists at United Technologies Research Center (UTRC) and Argonne National Laboratory.

The results of this work could lead to the development of flywheels which are highly efficient energy storage devices for possible utilization in space, electric utilities, and other commercial and government applications.

UTRC and Argonne researchers said their experiments show that a superconducting magnetic bearing can have about 25 times less friction than the best existing magnetic bearings and about 1,000 times less friction than bearings found in today's cars and trucks.

"If perfected for commercial use, the UTRC-Argonne superconducting bearing could lead to flywheel devices about half the size of a typical desk and capable of storing 50 to 500 megajoules of energy," said Argonne scientist John Hull. "That is enough to provide a typical house with electricity for one to ten days."

Today's flywheels are not very efficient energy storage devices because of high energy losses which are caused by bearing friction. However, a flywheel fitted with this type of superconducting magnetic bearing would lose less than one-tenth of one percent of its stored energy per hour, allowing it to be used in long duration energy storage.

In the flywheel system, a permanent magnetic rotor attached to the flywheel sits above the bearing's disk-shaped superconductor. Cooling the superconductor to 90K produces an equal but opposite magnetic field that causes the magnet to float above the disk. The result is a nearly frictionless bearing.

The superconductor is a YBaCuO compound that was melted and solidified slowly. The magnetic rotor is a Sm-Co alloy. When tested in a vacuum at 77K, the bearing achieved rotor speeds of 200,000 rpm and a 0.000004 drag-to-lift ratio. According to Hull, "That is about 25 times less friction than the highest reported drag-to-lift ratios (0.0001) for both conventional and superconducting magnetic bearings." ▲

Hole Drilling Laser

Scientists at the GE Research and Development Center at Schenectady, New York have announced a new high-water mark for average output from a single laser head. This achievement opens the door for development of laser systems that can cut and drill space age metals with unprecedented speed and precision.

This power output was achieved with a neodymium-doped yttrium-aluminum-garnet (ND:YAG) face-pumped laser. A crystal slab of this material is precision-machined to about an inch in width by a quarter inch in height by eight inches in length. Light is pumped into the faces of the crystal by a pair of ultra high-intensity flashlamps energized by a 17,000-watt power supply. High beam quality is maintained by directing the laser beam through the slab along a zigzag path that eliminates thermal distortion.

According to Joseph P. Chernoch, the GE scientist who invented the face-pumped laser, this type of laser generates light with a wavelength that is well absorbed by metals. Its wavelength is one micron, just beyond the visible in the near-frared end of the spectrum. The carbon-dioxide laser, widely used to cut thin sheet metal in factories, can put out kilowatts of power in a good quality beam, but its wavelength is ten times greater than that of the face-pumped laser, limiting how small a spot of light it can deliver and how well the light can be absorbed by metals. The solid-state rod laser can deliver light with excellent beam quality at low power, but above about 50 watts the beam quality deteriorates. Michael H. McLaughlin, manager of the GE R&D Center's process Automation Project, states "With its combination of high power, good beam quality and short wavelength, the face-pumped laser delivers awesome cutting and drilling power. The device can cut or drill through more than two inches of tough nickel-based superalloys, a feat far beyond the reach of other known lasers". This laser is not currently on the market but its commercialization is being explored. ▲

Meldform Metals

Meldform Metals has expanded its warehouse and processing facilities. Contact: Tony Bayley, York Way, Royston, Herts, SG8 5HJ, England, Tel:44(0)763 248915; Fax:44(0)763 249312; Telex:817446 MELDFM G. ▲

Cool Alloys, Big YAG's, and Record Current Density

Japan New Materials Report VI, No. 2, 8-11 (1991) reports on three important developments in the materials science industry. These developments have applications in various industries worldwide.

Erbium-Nickel Alloy for Cryocooling

Toshiba Corporation has begun sample shipment of an Er-Ni alloy for use as a cryocooler material in superconducting cooling equipment. A rapid growth in demand is expected for small sized cooling apparatus for use with superconducting magnets in magnetic resonance imaging (MRI) devices and magnetic levitation trains. Toshiba has used this alloy to attain a temperature of 2.5K in small cooling equipment. The previous low temperatures using lead was 10K. The new Er_3Ni alloy has a uniform grain size and a smooth surface. This results in high-efficiency heat exchange with helium gas. Long term cycling studies reveal that there is no damage to the grains from repeated compression and expansion cycles. Another application for the alloy includes the use as a cryopump for semiconductor manufacturing.

Largest YAG Single Crystals

Sumitomo Metal Mining Company Ltd. has developed an improved process for producing YAG single crystals with a maximum length of 250mm and a diameter of 125mm. This exceeds the dimensions of previous crystals by 50mm in length and 60mm in diameter. These large crystals were produced through the use of a newly developed computer program that controls temperature gradients and other variables during crystal growth. The crystals are doped with about one percent neodymium and can be formed into both rods and slabs. This increased size makes possible YAG lasers with greatly increased outputs in the 1 GW to several GW range. These lasers are expected to be used in place of carbon dioxide gas lasers for metal processing.

Record Current Density

The Superconductivity Industrial Research Laboratory has announced attainment of a critical current density of 222,000 A/cm² in an ultra-strong magnetic field of 35 Tesla at a temperature of 31K. Even at the increased temperature of 77K and in a magnetic field of 10 Tesla, the current density of the rare earth ceramic superconductor was 24,000 A/cm². The previous record current density in a strong magnetic field was 210,000 A/cm² at 30 T and 4.2K, however, the current density dropped rapidly to 400 A/cm² at 77K. The new record is attributed to the use of a proprietary process in which the materials are partially sintered, then pulverized, after which it is shaped and sintered at a high temperature. ▲

A new research and development company will contribute to the advancement of new energy technologies, especially hydrogen energy. SunaTech, Inc., was founded by Dr. Gary Sandrock and will initially concentrate on developing rechargeable rare earth metal hydrides. SunaTech offers R&D and consulting support to individuals and corporations interested in the technology and applications of metal hydrides and hydrogen-related technology in general. Dr. Sandrock previously served as Vice President of Ergenics, Inc. and has authored about 75 papers and patents in the fields of alloy metallurgy and metal hydrides. He can be reached at the offices of SunaTech, Inc. at 113 Kraft Pl., Ringwood, New Jersey 07456 USA Tel/Fax:(201)962-1158. ▲

Al-Y Thin Films

The use of Al-Y alloys for interconnections in silicon integrated circuits has been proposed by Y. K. Lee and fellow scientists in *Mater. Lett.*, **10**, 344-47 (1991). They found that bulk Al-Y metal alloy systems, particularly the Al-Y alloy system, possess very small grains and show high heat and corrosion resistance. Al-Y alloy films within the composition range of 0-8.6 wt% were deposited directly onto (100) Si substrates by use of a co-evaporation method. They found 0.7 wt% (0.2 at 0%) Y to be enough yttrium to get the desired effect. The grain size of these films was significantly less than with pure Al film. Electrical resistivity of the Al-Y films, which increases with increasing Y-content in the as-desposited state, tends to decrease to the level of pure Al by annealing at 500°C for one hour. No results were reported on electro-migration; however, since the solid solubility of Y in Al after annealing at 500°C is very low, the major portion of the Y in their alloy is expected to be precipitated as intermetallic compounds with Al, at Al matrix and grain boundaries, thus acting as an impediment to movement of Al atoms through grain boundaries. Thus the Al-Y thin films may suppress both the electro-migration and stress migration of Al in the thin films used as interconnections in silicon interconnections in silicon integrated circuits. ▲

Surface, Interface, and Thin-film Magnetism

A materials report entitled "Surface, Interface, and Thin-film Magnetism", written by L. M. Falicov and 11 additional authors, appeared in the *J. of Mater. Res.* **5**, 1299-1340 (1990). This report is the product of a panel convened in June, 1989, to assess the state of the art, identify major issues, and estimate prospects for future research. The twelve member panel was chaired by Falicov and Daniel T. Pierce.

The theoretical background including electronic structure, phenomenology and model systems, critical phenomena theories, transport properties in magnetic systems, and micromagnetic theory are discussed. Next a section on materials includes consideration of growth techniques, growth modes, systems highlights and physical properties. The next section covers modern research techniques available to the materials science community: magnetometry-spectroscopy, polarized electron techniques, electron microscopy, diffraction, and photon sources. A section on applications includes magnetic recording, magnetoelastic devices, integrated optical and elctronic devices, and permanent magnets. The last section is an attempt to highlight what the author consider important issues and what they believe are the prospects for future research opportunities in surface, interface, and thin-film magnetism. This report includes 213 references, 3 tables and 4 figures.

20th RERC

The 20th Rare Earth Research Conference will take place September 12-17, 1993 in Monterey, California, U.S.A. The General Chair is Dr. Herbert B. Silber, San Jose State University, San Jose, California 95192 Tel:(408)924-4954; Program Chair is Dr. Frederick S. Richardson, Department of Chemistry, University of Virginia, Charlottesville, Virginia 22901 U.S.A.

This conference will be followed by Actinides-93, in Santa Fe, New Mexico, U.S.A. from September 19-24, 1993. For more information about Actinides-93, contact Dr. D.E. Hobart, Los Alamos National Laboratory, Los Alamos, NM 87545 U.S.A. ▲

Address Change

Metal Extractor Group of Norway (MEGON) has moved to a new location. Their new address is: MEGON AS, Forskningsparken, Gaustadalléen 21, N-0371 Oslo, Norway, Tel:+472 95 88 91; Fax:+472 60 44 27. ▲

Review of Ce-Cu- and Yb-Cu-Based Compounds

A critical review of the experimental results for Ce-Cu- and Yb-Cu-based compounds by E. Bauer, appeared in *Adv. Phys.*, **40**, No.4, 417-534 (1991). He reports that most of these compounds exhibit unusual physical properties as a consequence of various competing mechanisms. These include: a magnetic interaction of the Ruderman-Kittel-Kasuya-Yoshida type, Kondo interaction and crystal-field splitting. The ground-state properties are then dominated by whichever process surpasses the others.

The Ce-Cu and Yb-Cu rare earth intermetallic compounds are known for their particular variety of physical properties. This includes normal long-range magnetic order, as in $CeCu_2$ or $CeCu_5$, to paramagnetism down to mK temperatures, as found in $CeCu_6$.

After a brief but comprehensive survey of rare earth and rare earth-Cu compounds, the author covers the theoretical aspects of single-impurity and lattice systems, transport and thermodynamic properties, and neutron scattering. Most of the properties evaluated relate to a single temperature scale, the Kondo temperature T_K.

The second half of the paper deals with the experimental results of the presented theories and includes substituted compounds. Information on the specific heat, thermopower, magnetic properties and crystal structures of these compounds should be helpful to workers in the field.

The 117-page paper contains 105 figures, 11 tables, and 253 references. ▲

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Telephone: (515)294-2272
Telex: 269266
Facsimile: (515)294-3709
BITNET: RIC@ALISUVAX
K. A. Gschneidner, Jr ..... Editor
Joel Calhoun ..... Staff Writer

Rare Earth Magnetism

Rare Earth Magnetism Structures and Excitations, by J. Jensen and A.R. Mackintosh, is dedicated to the properties and mechanisms of lanthanide magnetism and was published in 1991. The study of the magnetic properties of the rare earth metals originated in the 1930's, when the ferromagnetism of gadolinium was discovered and the paramagnetism of the other heavy lanthanide elements was investigated. This monograph was produced to present a unified and coherent account of an important area of lanthanide magnetism: magnetic structures and excitations. It reflects the nature of fundamental magnetic interactions and determines the characteristic properties of the metals.

The 403-page book contains topics on elements of lanthanide magnetism, magnetic structures, linear response theory, magnetic scattering of neutrons, spin waves in the ferromagnetic heavy lanthanides and in periodic structures, crystal-field excitations in the light lanthanides, and perspectives for lanthanide research. The experimental section is essentially complete and up-to-date.

Rare Earth Magnetism Structures and Excitations can be yours for $75.00 by ordering from Oxford University Press, Inc., Business Office, 2001 Evans Road, Cary, North Carolina 27513 USA Tel:(800)451-7556; Fax:(919)677-1303. ▲

ASM Fellow

Lynn Boatner of the Oak Ridge National Laboratory's (ORNL) Solid State Division has been elected a fellow in ASM International, a worldwide materials society. At the organization's recent awards dinner in Cincinnati, Ohio, Boatner was recognized for his contributions in the field of materials science and materials engineering. He was specifically cited for the "successful application of solid state physics to the resolution of materials science problems in the fields of textured ceramics, welding, amorphous materials, superconductors, and nuclear waste disposal."

His latest works in the field of rare earths include coordination chemistry, structural determination, electronic Raman scattering of rare earth phosphates and the study of photon transitions in rare earth-doped materials. ▲

Isao Kobayashi

RIC is saddened by the untimely death of Mr. Isao Kobayashi. He passed away October 23, 1991 after an 8-month battle with lung cancer.

Mr. Kobayashi acted as General Manager of New Business Department, Engineering Business Division of Sumitomo Light Metal Industries., Ltd. (SLM). Mr. Kobayashi served SLM his entire working career, first as a buyer and then as a rare earth purchasing agent and sales manager. He was also a former manager of New Metal Products Sales Dept. at SLM. He was well known to rare earthers and was experienced in rare earth permanent magnets. Mr. Kobayashi was a holder of both single and doubles Japan Tennis Championships in 1969, and was a player in the Davis Cup tournaments from 1967 to 1970.

We send our condolences to the family of Mr. Kobayashi, and to his friends and coworkers at SLM. ▲

MRS Award

Professor Shigeyuki Somiya, Nishi Tokyo University, Japan, was honored "for pioneering research in hydrothermal synthesis of ceramic materials" at the Materials Research Society's Fall meeting held in Boston, Massachusetts, U.S.A. Somiya recognized and developed the unique possibilities for high temperature/high pressure hydrothermal reaction processes in ceramic synthesis.

His work has lead to extensive, productive research programs in this field. The new process has enabled Somiya to produce new critical phase diagram determinations, which has lead to new insights in the field of single crystal growth. His research includes studies on stress, electrical conductivity, stability, synthesis, and morphology and crystallography of yttria-stabilized zirconia ceramics. His latest studies deal with phase relationships, phase diagrams, and the lattice energy and polymorphism of rare earth oxides.

Most of the industrial applications of Somiya's work on hydrothermal processing have been realized in Japan. These include hydrothermal powders, light weight cements, ceramic knives, dies, bearings, insulators, biomaterials, coatings for engine parts, catalyst systems and electronic materials. ▲

Nitrogen Uptake

H. Nagata and H. Fujii of Hiroshima University, Japan, report that a study of the effect of nitrogen uptake in the R_2Fe_{17} and the $R_2Fe_{17}C_{0.5}$ systems indicates that the nitrogen atoms occupy interstitial sites in the crystal structure [*Jap. J. Appl. Phys.* **30**, L367-L370 (1991)]. The a and c lattice constants of these compounds increased about 1.3 to 3.0% after full uptake of nitrogen without change in the crystal structure. However, the Curie temperature, T_c, increased by 230 K to 480 K upon nitriding. The $Sm_2Fe_{17}N_x$ compounds, for example, experience an T_c increase from 390 K to 752 K when saturated with nitrogen. The authors determined Curie temperature by using thermomagnetic analysis (TMA) equipment under a magnetic field of 3 mT in the temperature range from room temperature to 800 K. In addition, it is shown that a very sharp peak in magnetization just below T_c in the magnetization-versus-temperature curve for fully nitrided $Sm_2Fe_{17}N_x$, suggests a strong enhancement of uniaxial magnetic anisotropy. They conclude that the main effect of nitrogen uptake is thought to be the direct expansion of the *a*-axis through occupation of the 9(e) site, making the Fe-Fe ferromagnetic interaction in the basal plane much stronger, leading to a remarkable rise in T_c. ▲

$T_c(x)$ of YBCO

H. F. Poulsen et al. have developed a satisfactory method for the prediction of T_c, the temperature at which superconductivity sets in, based on oxygen content of the high temperature superconductor $YBa_2Cu_3O_{6+x}$ (YBCO). Their method is reported in *Nature*, **341**, 594-6 (1991) and discussed by J. D. Jorgensen on pp. 565-6 of the same issue. Jorgensen stated that, aside from the remarkable agreement of Poulsen et al.'s calculation with experiment, the method is intriguing in its simplicity. Poulsen et al. showed that consideration of the abundance of only two particular oxygen-ordered phases is sufficient to calculate T_c. They present computer simulations of the formation of oxygen-ordered domains of orthorhombic structure in the basal CuO plane using a microscopic model of the oxygen ordering. Together with a minimal-model assumption for the charge transfer, their calculations suggest that it is these domains that are responsible for the characteristic variation of $T_c(x)$. They obtained a

Continued in next column ➪

theoretical prediction of $T_c(x)$ that was in close quantitative agreement with experimental values. ▲

Supporters

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Since the December issue of the RIC News went to press, RIC has received financial support from three new family members, and renewed support from 19 other organizations. The supporters from the third quarter 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 parentheses, are listed below.

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- University of New South Wales, Australia (3)

Bureau of Mines

The rare earth commodity experts of the Bureau of Mines, U.S. Department of the Interior, have moved to a new location: 810 7th Street NW, Washington, D.C. 20241. The contact person is still James B. Hedrick, who can be reached at Tel:(202)501-9385; Fax:(202)501-3751. ▲

Reference Correction

The review article "Summary of Magnet Development in the Past Two Years" by H.H. Stadelmaier, which appeared on page 4 of the September 1, 1991 issue of the *RIC News*, contained the wrong reference information. The article actually appeared in *J. Mater. Eng.* 12, 185-93 (1990). The article was presented during "ASM Materials Week," October 3, 1989. Indianapolis, Indiana, USA. ▲

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