Rare-earth Information Center NEWS

Ames Laboratory
Institute for Physical Research and Technology
Iowa State University / Ames, Iowa 50011-3020 / U.S.A.

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THE CAPELLEN YEARS

Jennings "Cap" Capellen will be retiring from RIC and Iowa State University on June 30, 1990 Most of our readers know of Cap since he is responsible for the writing of most of the material that is published in the *RIC News*. In addition, many of you have had personal interactions with Cap when you visited RIC, or have met him at the North American Rare Earth Research Conferences, or have talked to him on the phone or corresponded with him by letter or FAX.

Jennings Capellen joined the Ames Laboratory on January 15, 1951, and on March 1, 1982, transferred from the Ames Laboratory to RIC when Mr. Bernie Evans left. Over the years Cap has left his mark on the rare earth community including approximately 150,000 words as published in the *RIC News* and answering more than 1,600 information inquiries—nearly one for every day he has worked for RIC. During this period RIC has grown considerably, as measured by several standards: from publishing 18 pages per year to 32 pages of the *RIC News*, from 45 sponsors in 1982 to 149 this year, and from 180 information inquiries in 1982 to 269 in 1989. A good part of this growth has come about as a result of the efforts of Cap.

His greatest strength is his personal interactions with those of you requesting information about various aspects of the rare earths. He spends a great deal of time and effort getting his customers the best answers we can supply from our resources.

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These sentiments were well expressed in a recent letter sent to Cap by Mr. Katsuhisa Itoh, general manager of the New Metal Products Development Department of Sumitomo Light Metal Industries Ltd.: "The news in the latest issue of the *RIC News* surprised me very very much. Now you are retiring! I believe rare earthers in Japan greatly appreciate your contribution to the field. I also thank you for your cooperation with us over the past several years. I sincerely and personally hope you will enjoy your fruitful post-retirement life."

We will miss Cap and his constant joyful personality and his efforts to help his fellow human beings. We wish him well in his retirement.

Reactor Experiments Incorporated

Rhône-Poulenc Chimie Mineral Fine

Santoku Metal Industry Company, Limited

Shin-Etsu Chemical Company, Limited

This year we have four companies we wish to honor for their 20 years of support. Reactor Experiments Incorporated, Rhône-Poulenc Chimie Mineral Fine, Santoku Metal Industry Company, Limited, and Shin-Etsu Chemical Company, Limited, join the previous six companies on our growing list of long time sponsors. We wish to express our appreciation for their long and faithful support.

NOMINATIONS OPEN FOR 6TH SPEDDING AWARD

The 6th Frank H. Spedding Award will be presented at the 19th Rare Earth Research Conference in July 1991 in Lexington, Kentucky. This prestigious award is given in recognition of distinguished contributions in the field of rare earth science and/or technology. It is presented by the Rare Earth Research Conference Corporation with financial support of Rhône-Poulenc Indstries..

Nominations are being sought from the rare earth community, worldwide. An individual can nominate more than one person for the award, or can propose a joint award for leaders in a particular field. Seconding letters are encouraged, particularly if they present significant information not covered by the nominator.

Nomination forms can be obtained from: W. T. Carnall, chair, Frank H. Spedding Award Committee, Chemistry Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439, U.S.A. The deadline for submission of the nominations is December 1, 1990.

* * THANKS * *

A/T Products Corporation

Rhône-Poulenc Incorporated

Two more companies, A/T Products Corporation and Rhône-Poulenc Incorporated (USA) have reached the 10 year plateau of support. They became the 34th and 35th sponsors who reached or surpassed this level of support and we wish to extend them special thanks for their support.

CONFERENCE CALENDAR

6th International Conference on Valence Fluctuations (VI-ICVF)
Rio de Janeiro, Brazil
July 9-13, 1990
RIC News, **XXIV**, [4] 2 (1989)

1st International Conference on *f*-Elements (ICFE)
Leuven, Belgium
September 3-7, 1990
RIC News, **XXIII**, [4] 4 (1988) and **XXIV**, [2] 2 (1989)

REE in Processes of Petrogenesis
Tashkent, USSR
September 1990
RIC News, **XXIV**, [2] 2 (1989)

5th International Conference on Physics of Magnetic Materials (5ICPMM)
Madralin, Poland
October 9-12, 1990
RIC News, **XXIV**, [4] 2 (1989) and *RIC News*, **XXV**, [1] 2 (1990)

11th International Workshop on Rare-Earth Magnets and Their Applications and 6th International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth-Transition Metal Alloys
Pittsburgh, Pennsylvania, U.S.A.
October 21-25, 1990
RIC News, **XXIV**, [4] 2 (1989)

Rare Metals '90
Kokura, Kitakyushu, Japan
November 14-16, 1990
RIC News, **XXIV**, [4] 2 (1989)

International Conference on Rare Earth Minerals and Minerals for Electronic Uses
Hat Yai, Thailand
January 23-25, 1991
**This Issue*

The Magnetic Bearings and Dry Gas Seals Conference and Exhibition (ROMAG '91)
Washington, D.C.,U.S.A.
March 13-15, 1991
**This Issue*

Journées des Actinides
Lagos, Algarve, Portugal
April 28-May 1, 1991
**This Issue*

Second International Conference on Rare Earth Development and Applications (2nd ICRE)
Beijing, China
May 27-31, 1991
**This Issue*

19th Rare Earth Research Conference (19th RERC)
Lexington, Kentucky, U.S.A.
July 14-19, 1991
RIC News, **XXV**, [1] 2 (1990)

**News Story This Issue*

ROMAG '91

The Magnetic Bearings and Dry Gas Seals Conference and Exhibition is scheduled for March 13-15, 1991, in Washington, D.C. Companies and researchers currently working on magnetic support systems that are useful for vibration isolation, noise reduction, energy conservation, and other applications may be interested in attending. Many of these systems use rare earths or rare earth materials. Those interested can contact Professor David Lewis, Center for Magnetic Bearings, Department of Mechanical and Aerospace Engineering, University of Virginia, Charlottesville, Virginia 22901, U.S.A.

Actinide Conference

An overview of the research activity in the chemistry and physics of the actinides will be held April 28 to May 1, 1991. "Journées des Actinides" will take place in Lagos, Algarve, Portugal. The presentation of results can be either oral or by posters and will be collected in an abstract booklet that will be available at the time of the conference. For more information contact A. Pires de Matos, Departmento de Quimica, ICEN, LNETI, Estrada Nacional 10, 2686 Sacavém Codex, Portugal.

2nd ICRE

The 2nd International Conference on Rare Earth Development and Applications (ICRE), sponsored by the Chinese Society of Rare Earth, will be held May 27-31, 1991, in Beijing, People's Republic of China. An exhibition of books, instruments, equipment, RE metals and compounds, and other products containing rare earths will be held at the same time. The official language will be English. The program will include plenary lectures, and invited and contributed papers. Contributed papers may be oral or poster presentations.

The 2nd ICRE will consist of three sections: RE chemistry, RE resources and RE metallurgy, and new materials and applications. Papers on coordination, solution, organometallic, molten salt, bioinorganic, analytical, structure, and quantum chemistry will be presented in the chemistry section. Bioinorganic chemistry will include the fields of agriculture and medicine.

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The topics covered in the resource and materials section will include RE separation processes, automatic control of equipment and processes, preparation of RE metals and alloys, preparation of high purity RE metals and compounds, and RE resources.

The third section, new materials and applications, will include papers on high T_c superconductivity, magnetic materials, hydrogen storage materials, luminescence, phosphors, lasers, cast iron, steel, nonferrous metals, etc. Included in magnetic materials are those with magnetostrictive properties and those used in magnetic refrigeration.

After the conference, participants may make arrangements to visit various factories, universities, and research institutes associated with rare earths. Visits also may be arranged to famous scenic spots.

For more information contact Liu Aisheng or Jin Jinghong, The Chinese Society of Rare Earth, 76 Xueyuan Nan Lu, Beijing 100081, People's Republic of China.

Minerals and Electronics

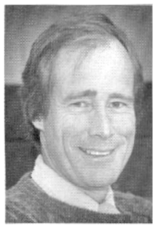
The International Conference on Rare Earth Minerals and Minerals for Electronic Uses will be held January 23-25, 1991, at Hat Yai, Thailand. The conference will take place at Prince of Songkla University and will follow the conference outline: world resources/reserves, world supply/demand—present and future, mineralization, extraction, applications, national management plan, information management system, technologies of the next decade that need rare earth minerals, and other related areas. The language will be English. Interested persons are requested to contact Assistant Professor Dr. Boonsom Siribumrungsukha, head, Department of Mining and Metallurgical Engineering, Prince of Songkla University, P.O. Box 2, Khohong, Hat Yai 90112, Thailand.

Czech REE Conference

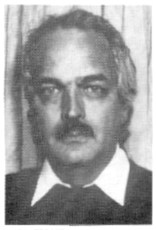
The Third Czechoslovakian Conference on Rare-Earth Elements was held September 25-28, 1989. The conference took place in Zemplinska Sirava where 38 papers were presented. The proceedings and abstracts from the conference may be obtained by contacting: Professor M. Matherny, CS-043 85 Kosice, Svermova 9/III, Czechoslovakia.

New Materials Prize

F. Steglich



Z. Fisk



H. Ott

J. Smith

The 1990 American Physical Society International Prize for New Materials, sponsored by International Business Machines Corporation, was shared by four scientists—Frank Steglich, Zachary Fisk, Hans R. Ott, and James L. Smith. The award was for "the discovery of heavy fermion materials" and for "pioneering research on the exotic and remarkable physical behavior of such systems." With his discovery of superconductivity in $CeCu_2Si_2$ in 1979, Steglich initiated a new subdiscipline of solid-state physics, the study of heavy-fermion systems. Four years later, Fisk, Ott, and Smith identified a second heavy fermion material, UBe_{13}, proving that Steglich's compound was not unique, but one of a whole class of materials. The award ceremony was held March 12, 1990, in Anaheim, California, at the APS spring meeting.

Steglich received his doctoral degree from the University of Göttingen in 1969, and his habilitation in physics from the University of Köln in 1976. He was a research assistant at the University of Köln from 1969 to 1976 and has been a professor of physics at the Polytechnic University of Darmstadt since 1978.

Fisk earned his Ph.D. in physics from the University of California, San Diego, in 1969. He was a researcher at the University of California, San Diego, from 1971 to 1981, when he became a member of the

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Molecular Analogue

C.-S. Neumann and P. Fulde pose the question, "Is there a molecular analogue of a Kondo singlet state?" in an article with the same title published in *Z. Phys. B*, **74**, 277-8 (1989).

Acting on suggestions that molecules containing cerium ions with a formal valency of +4 may form a ground state resembling a Kondo state they made some calculations on cerocene or bis(pi-[8]annulene) cerium ($Ce(C_8H_8)_2$). Cerocene was selected because of the high D_{8h} symmetry that guarantees a sufficient *lf*-hybridization. Using a computer program and literature values for physical properties, they demonstrate that the formation of a Kondo singlet is indeed likely, which should lead to drastic changes in the physical properties of the substance at low temperatures. They are rather confident that cerocene shows characteristic features of the singlet-triplet splitting. They also suggest that Ce^{4+} in other compounds might exhibit this phenomena and that perhaps Yb^{2+} might also. In the Yb^{2+} case the 4*f* electron is replaced by a 4*f* hole.

The authors are awaiting experimental investigations for the answer. If true, it would open up a new field in Kondo behavior experiments.

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staff at Los Alamos National Laboratory.

Ott finished his doctoral work at the Federal Institute of Technology in Zürich in 1973. He has done research and taught at the same institute since 1974, becoming a full professor of physics in 1987. In 1988 he also became head of the research department for solid-state physics and materials sciences at the Paul-Scherrer Institute in Villigen, Switzerland.

Smith earned his Ph.D. in physics from Brown University in 1974. He joined the staff of Los Alamos National Laboratory in 1973 and is now chief scientist of the exploratory research and development center there.

All four scientists have made low temperature studies on a large variety of rare earth and actinide materials, especially cerium and uranium intermetallic compounds, and now more recently on the high temperature ceramic oxide superconductors.

The Rare Earths 25 *and I* 25

As our 25th year is well under way, personal, rare earth related stories continue to arrive at RIC. We are hoping that more readers will send us stories so that we might publish a booklet containing all those received.

This brief history was sent by Dr. Ervin Colton, chair and chief chemist, CERAC, Incorporated.

My "Romance" with Lanthanum Hexaboride
by Dr. Ervin Colton

Coincidentally, just as the Rare-earth Information Center and RIC News celebrate their 25th anniversary, so does CERAC celebrate 25 years of specialty inorganic manufacturing during 1989-1990.

CERAC (an acronym for *Cer*amic *A*llis *C*halmers) was born in 1964 as an outgrowth of my work on high temperature materials in the Research Division of A-C. I had always been fascinated with rare-earth chemistry and nosed around Dr. Moeller's laboratory at the University of Illinois even though my Ph.D. work was with Audrieth on nitrogen chemistry.

One of our first orders as a new and private company at CERAC was to supply LaB_6 powder. There were numerous merchants offering LaB_6, supposedly, but careful investigation revealed some unknown source thought they could produce it, and the merchants were all quoting the same unknown supplier! We wisely decided we should synthesize our own material in order to control the quality, to ensure a continuing supply, and to establish a lower selling price. We selected the classical, very high temperature, vacuum reaction between lanthanum oxide and boron carbide:

$$La_2O_3 + 3B_4C \rightarrow 2LaB_6 + 3CO$$

Very few chemists were aware then (or are today) that boron carbide is an excellent "boriding" agent at elevated temperatures in vacuum. Properly executed, the reaction yields nearly the theoretical quantity of beautiful blue-purple LaB_6 as a sintered mass. Subsequent ball-milling provided us with powder of various particle sizes.

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25 *Highlights From Past RIC News* 25

In the second of a series of selected articles from past issues of the *RIC News*, we include a short note to rare earthers on how the Rare-earth Information Center received its call letters. This issue appeared in Volume 1, No. 2, June 1, 1966, and included a sketch in order to remind readers to use our correct title.

A number of our subscribers and users have referred to us as REIC. Please! Our call letters are RIC. REIC are the call letters for our sister information center, Radiation Effects Information Center, located at the Battelle Memorial Institute in Columbus, Ohio.

Rare-Earth-Bismuth Phase Diagrams

We have received copies of the Bonus Issue of *Bulletin of Alloy Phase Diagrams*, 10, No. 4a, September 1989. It contains evaluations of all the rare earth-bismuth systems (except promethium-bismuth) and six actinide systems (Ac-Pt, Al-Pu, Al-Th, Ca-Pu, Pt-Pu, Sn-Th). The Rare-earth Information Center will send a complimentary copy to interested readers. Please send your request to the address on the next to the last page of your *RIC News* or the masthead on page one.

Biochemistry

The rare earths (lanthanides plus yttrium and scandium) occur biologically only in trace quantities but they have been the focus of many biochemical studies. C. H. Evans, in an attempt to collate and present in reasonable detail the existing knowledge of lanthanide biochemistry before the literature becomes unmanageable, has authored the book *Biochemistry of the Lanthanides*. The informative book should be valuable to graduate and post-graduate investigators. The 444-page book was published in 1990 by Plenum Press, 233 Spring Street, New York, N.Y. 10013-1578, U.S.A. The cost of the book is U.S.$79.50 in the United States and Canada and U.S.$95.40 elsewhere.

The titles of the nine chapters give a clue to the extent of the coverage given in this book. Each chapter is well referenced and the book ends with an appendix listing all the review articles that the author could find. To illustrate the growth rate of articles in this field, a note added in proof states that well over a thousand publications on lanthanide biochemistry come to the author's attention between the time the book was completed and the time it went to press. Some of this information was incorporated into the text in the proofing stage. The author states that none of the recent data alters any of the underlying concepts of lanthanide biochemistry described in the book.

The titles of the nine chapters with the number of references in parentheses are: Historical Introduction (19); Chemical Properties of Biochemical Relevance (87); Biochemical Techniques Which Employ Lanthanides (159); the Interaction of Lanthanides with Amino Acids and Proteins (278); Interactions of Lanthanides with Other Molecules of Biochemical Interest (90); Interactions of Lanthanides with Tissue, Cells, and Cellular Organelles (328); The Occurrence and Metabolism of Lanthanides (168); Toxicology and Pharmacology of the Lanthanides (192); and Past, Present, and Possible Future Clinical Applications of the Lanthanides (148).

This book should be a welcome ad-

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dition to any biochemical or medical library. It gives a solid foundation on which to build future studies of the relationships of the rare earths with living organisms including plants.

Dust Explosions

Does your work involve cutting or milling Nd-Fe-B materials? Did you know that the residue from such activity can be hazardous? Although the intensity of the explosive power of Nd-Fe-B powders are quite low, they have been found to be readily explosible. A paper by M. J. Talvitie, et al. *J. Less-Com Met.*, **157**, 245-54 (1990)] describes the explosion properties: the lower explosible limit, the greatest explosion pressure, the rate of pressure rise, and the dust explosion class of this material. Using a mean particle size of between 3.0 and 3.5 μm, the authors conducted the experiments in a 20 liter water-cooled reaction chamber. The Nd-Fe-B powder was blown into the chamber using compressed nitrogen gas in an atmosphere of 40 percent oxygen and 60 percent nitrogen. It was found that the explosion pressure rises rapidly when the dust concentration increases from 50 to 1900 g/m^3, reaching the maximum overpressure of 6 bar in dust concentrations between 1900 to 2700 g/m^3. This compares with an explosion pressure between 10 and 20 bar with light metal dusts.

From this study, it was determined that the minimum explosible concentration of Nd-Fe-B powders appears to be between 15 and 100 g/m^3. It is important to note that the tested samples were stored in an argon atmosphere in order to inhibit reaction with oxygen. In air, the powder reacts to form a relatively inert oxide coating over the dust particle, leaving a large portion of the particle unreacted, and potentially hazardous if an ignition source is present. The minimum ignition energy for concentrations around 900 g/m^3 is smaller than 10 mJ. In the open atmosphere, this is sufficient for explosions to take place caused by discharge from static electricity. As the rare earth concentration of the powder increases, so does the potential for explosion. Fine-milled eutectic Nd-Fe alloys, for example, should be considered extremely hazardous.

Magnetic Cooling

A review entitled "Magnetocaloric Effects in Rare-earth Magnetic Materials" appeared in *Usp. Fiz. Nauk.* **158,** 553-79 (1989) [*Sov. Phys. Usp.* **32,** 649-64]. Written by A. Andreenko, K. Belov, S. Nikitin, and A. Tishin, the review discusses experimental investigations of the magnetocaloric effect (MCE) in rare-earth magnetic materials. The rare earth magnetic materials in the report were of different classes: heavy rare earth metals and their alloys, iron garnets, and intermetallic compounds. The authors report the results of measurements of the MCE near phase transitions for the vicinity of the Curie and Néel temperatures, and also near magnetic compensation points in the case of ferromagnetic-helicoidal antiferromagnetic and helicoidal ferromagnetic-paramagnetic transitions. The various magnetic sublattices in rare-earth ferromagnets that contribute to the magnetocaloric effect are also identified. The authors report that these refrigerators have high thermodynamic efficiency, compact size, a wide range of operating temperatures, and are reliable.

Optimistic forecasts on the use of the rare-earth paramagnetic compounds in magnetic refrigerators that operate between 15 K and 1 K are made. For example, the compound $Gd_2(SO_4)_3 \cdot 8H_2O$ is suitable for cooling from 4.2 K to 1.8 K, whereas gadolinium gallium garnet ($Gd_3Ga_5O_{12}$) and dysprosium aluminum garnet ($Dy_3Al_5O_{12}$) are best suited for cooling from 16 to 4.2 K.

For room temperature operation, gadolinium is used in a Stirling thermodynamic cycle. In this application, a column containing a recoverable heat-transfer liquid is set in reciprocating motion while the refrigerant interacts in a static magnetic field with the heat-transfer liquid. After 50 cycles, this refrigerator produced a temperature gradient from -1°C to 46°C along a column which was initially at room temperature.

In the area of the rare-earth intermetallic compounds, RNi_2 can be used in temperatures below 35 K whereas RAl_2 alloys are suitable for use at temperatures above 20 K.

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In the operation of magnetic refrigerators, temperature is increased or decreased as a result of the production or absorption of heat by reversibly changing the internal magnetic energy of the substance. This is accomplished by rapidly switching a strong magnetic field on and off under adiabatic conditions, or by rotating the refrigerant through a constant magnetic field at about 5 rpm.

The large magnetic fields (~5T or 50 kOe) necessary for magnetic refrigeration are generally produced by superconducting magnets, but for miniature devices the Sm-Co and Nd-Fe-B permanent magnets can be used.

Superconducting Bearings

Cylindrical rare-earth magnets levitated by yttrium-barium-copper-oxide (YBCO) superconducting bearings have reached rotational speeds of 120,000 rpm. These small rotors are kept in their equilibrium positions by what researchers refer to as "magnetic stiffness,"which is thought to be caused by flux pinning. Cornell University scientists F. Moon and P. Chang report in *Appl. Phys. Lett.* **56,** 397-9 (1990) that the measured decay of the free rotation rate of the rotor in a vacuum indicates that the flux drag torgues are constant and independent of speed. The experiment was carried out at 78 K. The results demonstrate that the drag may be related to small asymmetries in the magnetic flux densities around the axis of the spinning rare-earth magnet. The rotor was driven by air-core coils acting on a magnet inside the body of the rotor. When the rotor reached speed, power was turned off and the time recorded until there was no rotation. This took between 10 seconds and 20 seconds at 1 atm to over 25 seconds in partial vacuum. The tests in nitrogen gas at one atm showed evidence of exponential decay rates. One remarkable discovery was that even with an unbalanced rotor, vibration is virtually eliminated and the rotor appears motionless at speeds above 1800 rpm. In a partial vacuum, rotational speeds are limited solely by the ability of the rotor material to withstand centripetal stresses.

Sm-Fe-M (M = V or Ti) Magnets

Sm-Fe-V

High coercivity in mechanically alloyed Sm-Fe-V magnets with the $ThMn_{12}$ crystal structure are described by L. Schultz, K. Schnitzke, and J. Wecker in *Appl. Phys. Lett.* **56,** 868-70 (1990). The new hard magnetic alloys with the 1:12 structure have coercivities common to Nd-Fe-B magnets. Magnetically anisotropic Sm-Fe-V magnets have a remanence of 4.9 kG, not far below Nd-Fe-B. High coercivities are obtained in rapidly quenched 1:12 magnets by increasing the transition metal content to 16 at percent (9.1 kOe for $SmFe_{10}VTi$) or by adding boron (7.7 kOe for $Sm_{10}Fe_{80}Ti_{7.5}B_{2.5}$). The authors report coercivities up to 11.7 kOe for mechanically alloyed $Sm_{15}Fe_{70}V_{15}$ samples prepared by ball-milling much the same way as Nd-Fe-B materials.

The hard magnetic phase is formed during a short diffusion heat treatment at between 600 and 900°C and 10^{-6} mbar argon. Magnetic measurements were made on a sample embedded in an epoxy resin at 20°C in a vibrating sample magnetometer in a field of 7.5 T. The highest coercivity recorded for 1:12 magnets were the $Sm_{15}Fe_{70}V_{15}$ and $Sm_{12}Fe_{73}V_{15}$ samples with values as high as 11.7 kOe. A higher remanence (4.9 kG) but lower coercivity (10.6 kOe) was attained by the lower Sm content in the $Sm_{12}Fe_{73}V_{15}$ sample. The results of the study show that these magnets with the $ThMn_{12}$ crystal structure can be produced using low-cost, large-scale production techniques.

Sm-Fe-Ti

These same authors along with M. Katter [*Appl. Phys. Lett.* **56,** 587-9 (1990)] describe the preparation of a new $Sm_{20}Fe_{70}Ti_{10}$ bulk phase permanent magnet by mechanical alloying annealing. Crystallization was performed in an argon atmosphere at 800°C. Tests show that the bulk microcrystalline material can be generated while achieving hard magnetic phase coercivities above 50 kOe at room temperature. The composition and crystal structure of the phases are at present undetermined. The authors point out that a similar alloy was previously observed in sputtered films but the coercivity is somewhat smaller than that found in mechanically alloyed material.

Nd:YAG Lasers

Pulsed lasers are finding uses in dentists' offices around the world as they replace drills used in dental surgery. Two brothers, T. Myers and W. Myers have developed rare-earth lasers to perform duties traditionally reserved only for mechanical devices. Pulsed Nd:YAG lasers are currently being used on both hard and soft dental tissues. Dentin and decayed enamel (hard tissues) can be treated with little or no pain, W. Myers claims. The reason for this is that the nerves have no time to respond to stimuli that are pulsed in microseconds. Tooth decay can be vaporized or gum disease (soft tissues) treated by the new method. The laser that has been used in over 10,000 dental procedures has a wavelength of 1.06 micrometers, a maximum power output of 3 watts and an average energy output of 90 mjoules per pulse. W. Myers states that the wavelength of the YAG makes it a precise tool to work on the dentin, or the parts of the tooth beneath the enamel. A fiber of between 200 and 600 micrometers is used to deliver the beam. In cases where enamel needs to be removed, a dental drill is used and then the YAG takes over to work the dentin. More research has to be done in the area of diseased nerves and root canal therapy before the full potential of Nd:YAG laser use in dental surgery is fully realized.

The YAG laser is currently used in Canada and seven European countries. Use in the U.S. is pending.

Medal of Science

In October 1989, President Bush, in a White House ceremony, presented the 1989 National Medals of Science to 19 scientists and the 1989 National Medals of Technology to eight recipients. Among the winners in the science division was Harry G. Drickamer, professor of chemical engineering, chemistry, and physics at the University of Illinois, Urbana. He was honored "for his discovery of the 'pressure tuning' of electronic energy levels as a way to obtain new and unique information on the electronic structure of solids." Among the solids he studied were the rare earth metals and the effect of pressure and temperature on their resistivities. He also studied rare earth halides and organic chelates.

Professorship

Dr. William L. Johnson, a faculty member at the California Institute of Technology since 1977, has been named the first Ruben F. and Donna Mettler Professor of Engineering and Applied Science. Caltech is located in Pasadena, California, U.S.A. Professor Johnson has been active in the study of amorphous superconductors (La with Au, Cu, and Ga) and their microcrystalline structures. He is also interested in the structure, magnetic ordering, thermopower, and crystal-to-glass transformation of various metallic systems involving rare earths.

Neomet Expands Line

Neomet Corporation of West Pittsburg, Pennsylvania, has expanded its production of rare earth alloys by adding dysprosium and praseodymium alloys. The Dy and Pr metals are produced from separated rare earth compounds by metallothermic reduction and electrowinning techniques, and are purified by vacuum refining. They can be used in making eutectic alloys of iron or more complex alloys containing boron, copper, aluminum, etc., as well as iron. Neomet is a subsidiary of Mitsubishi Metal America Corporation of New York City.

Superconductive Powders

Rhône-Poulenc, the French chemical group, has opened a new multimillion dollar plant in New Brunswick, New Jersey, in order to produce superconductive powders. Currently, the Superconductor Development Laboratory can produce, by a wet-chemical process, several tons of yttrium-based powders per year to support the superconductor industry. According to Rhône-Poulenc, the capacity of the plant can be easily scaled up to produce as much as 10 tons per year.

The company designed the plant to primarily produce 1-2-3 powders but it is flexible enough to produce varying ratios of chemical constituents depending on customers' demand. In addition, the computer-controlled process can supply raw materials in an array of particle sizes, and degrees of purity. Highly reproducible results and guaranteed purity levels are ensured by in-house sourcing of the raw materials.

Monazite Project Cancelled

Rhône-Poulenc, the world's ninth largest chemical company has announced that it will drop plans for the mineral sands processing plant in Western Australia. The plant, designed to process monazite at Pinjarra, south of Perth, was expected to reach $100 million in sales annually. Plans for the $150 million mineral-processing plant were dropped because of the absence of well-established regulations, according to Mr. Dominique Namer, general manager of Rhône-Poulenc Chimie Australia. Development proposals for the plant could not be advanced because the Australian government has no overall environmental strategy. In countries with established environmental standards, industry presents a proposal and an environmental report and the government then determines if it is acceptable. Without an established environmental strategy, there would be opportunity for criticisms on an issue-by-issue basis, which is undesirable. With the plans on hold, opportunities on world rare earth markets closed before Rhône-Poulenc could take action. Mr. Namer said that the company would be delighted to follow strict environmental standards, providing the company knows what they are.

Sumikin Molycorp

Molycorp, Incorporated (MI), a Unocal Company, and Sumitomo Metal Industries, Limited (SMI), have established a joint venture company, Sumikin Molycorp, Incorporated, to develop and market lanthanide and yttrium products in Japan. According to R. Gene Dewey and Yasuo Shingu, presidents of MI and SMI, respectively, the joint venture will combine the expertise and resources of both companies to expand the rare earth business in Japan where a high growth rate is forecast, especially in high technology fields.

Sumikin Molycorp began business on January 24, 1990, capitalized at $2 million. SMI holds 67 percent of the company with MI holding the other 33 percent.

Heat Mirrors

Transparent conductive heat mirrors have optical properties that enable them to transmit most visible radiation and reflect most infrared radiation. Many dielectric/metal/dielectric multilayer films have a visible transmission of 80 percent. This is all right for cold or temperate climates but due to the heat in the tropics the transmission should be reduced to about 50 percent. M. A. Angadi and K. Nallamshetty report on such a heat mirror using CeO_2/Cu/CeO_2 multilayer film [*J. Mater. Sci. Lett.* **8**, 391-4 (1989)].

They found that this film has a reflectance at infrared frequencies (800-900 nm) of about 90 percent and a peak in transmission of radiation at 600 nm (visible region). The transmission falls off at lower frequencies and is negligible at UV frequencies (190-320 nm). The value at the peak transmission can be regulated by film thickness with multilayer CeO_2/Cu/CeO_2 (22nm,30nm,22nm) films having a 50 percent transmission. The optical properties of these films improved significantly when deposited at higher substrate temperature (473 K) or annealed at 473 K for 2 hours. These films are aesthetically appealing because of their pleasant pink color.

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Tomography Scintillator

H. Yamada, et. al. [*J. Electrochem. Soc.* **136**, 2713-6 (1989)] describe a Gd_2O_2S scintillator developed especially for x-ray computed tomography (CT). At present the whole body CT apparatus employs an array of Xe ionization chambers for x-ray detection. Because these ionization chambers have limited x-ray absorbance, a search for solid-state scintillator replacements have been widespread.

The Gd_2O_2S is normally doped with Pr and in this paper studies were made on additional doping with Ce, Cl, and F. It was found that Ce reduces afterglow caused by traps in the host Gd_2O_2S while halogen ions improved the emission efficiency.

Another drawback of phosphor scintillators is the scattering loss of the emission. In order to solve this problem the authors and others have developed translucent ceramics by using HIP (hot isostatic pressing). The authors found that Li_2GeF_6 was the best sintering aid.

Glowing Faces

The element promethium, which emits beta particles, is now used by most watch companies to make watch dials that glow in the dark. It has replaced radium that formerly was used and is now banned. The radiation striking a fluorescent material causes light to be given off. A wearer of the watch would receive about the same radiation over a year's time as 4 chest x-rays, but only if the face of the watch was worn against the skin without a glass cover.

High Purity Rare Earths

One of the world's leading producers of high purity yttrium oxide, Megon A/S of Norway, now offers its rare earth products in the U.S. Crystalox, Ltd. will make rare earth products available according to customer specifications. Using a patented process, the company can produce rare earth oxides from 4-nine to 6-nine purity. Megon has been producing selected rare earth oxides for more than 20 years. The company also offers technical services for purification of rare earth minerals and material recovery. For services or information contact: Megon A/S, P.O. Box 122, 2007 Kjeller, Norway. Phone: 47-6-806-450. Fax: 47-6-819-870.

Studies Series

The RIC has received Volume **3** of the 3-volume series: *Studies of High Temperature Superconductors, Advances in Research and Applications,* edited by A. Narlikar and published by Nova Science Publishers. The first two volumes were reviewed in the December 1, 1989 issue of the *RIC News*.

Each chapter is meant to give a detailed review or an extended paper on one or more of the aspects of research on or applications of high T_c superconductors. They include high temperature superconductivity; structural chemistry; superconducting and normal state properties; crystal structures and microstructural effects; experimental techniques; characterization of materials; processing, fabrication, and production of materials for superconducting magnets; and applications.

Volume **3** contains 413 pages with 15 chapters, costs U.S.$74.00, and may be ordered from Nova Science Publishers, 283 Commack Rd., Suite 300, Commack, NY 11725, U.S.A.

Electroluminescence

Electroluminescence is the title of a book containing the proceedings of the Fourth International Workshop held October 11-14, 1988, in Tottori, Japan. Edited by S. Shionoya and H. Kobayashi, the 396-page book with 360 figures was published in 1989 by Springer-Verlag.

The proceedings contain the 20 invited papers and 60 contributed papers presented at the conference. The contributions are arranged under the following headings: Basic Physics, Luminescence Characteristics and Materials, Color Electroluminescence, Processing Technology, Thin Film Electroluminescent Panels, Powder Electroluminescent Panels, and Light Emitting Diodes.

Although most of the hosts are Zn(S,Se), other hosts include CaS, SrS, Gd_2O_2S, etc. The dopants include many of the rare earths and about half of the 80 papers involve rare earths.

The book may be ordered from Springer-Verlag, 4123/Rezensionswesen, Tiergartenstrasse 17, D-6900 Heidelberg 1, West Germany or Springer-Verlag New York Incorporated, 175 Fifth Avenue, New York, NY 10010, U.S.A. List price in the U.S. is $53.00.

** RECORD YEAR **

With a month left in fiscal 1990, we have 149 members in our family of benefactors. This breaks last year's record by 13. Of the 37 contributors in the fourth quarter of our fiscal year, 7 are newcomers to our family. Our heartfelt thanks to each of our sponsors for their wonderful support. The sponsors are listed below, with the number of years they have been supporting RIC in parentheses.

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Yb-Doped InP

The growth and luminescent properties of Yb-doped InP prepared by metalorganic vapor phase epitaxy (MOVPE) is reported by D. Williams and B. Wessels in *Appl. Phys. Lett.* **56**, 566-68 (1990). The authors state that using a beta-diketonate precursor as a dopant source decreases the air and moisture sensitivity of rare earth doped semiconductors. The electrical properties of the layers are not significantly changed by the beta-diketonate ligands. Atmospheric MOVPE using trimethylindium and phosphine yielded Yb-doped InP when sublimated trisheptafluorodimethyloctanedionate ytterbium ($Yb(fod)_3$) was introduced into the reaction zone by a hydrogen carrier gas. These epitaxial layers were grown at 600°C on semi-insulating InP, and resulted in a smooth morphology in the doped film. A 35 mW He-Ne laser with 632.8 nm excitation was used to determine the photoluminescent properties at 20 K. Results showed the characteristic emission at 1.23 eV associated with Yb intra-4f shell transitions indicating that the precursor did not influence the net carrier concentration.

Stamp Contest

In celebrating our 25th year of serving rare earthers and promoting rare earths around the world, the Rare-earth Information Center (RIC) is reminding readers to find world-wide postage stamps that have a direct relationship to the rare earths. As mentioned in the December 1, 1989 issue of the *RIC News*, the person who identifies the most will be offered a choice of one of the books the editor has available at the close of the contest or a free subscription to *RIC Insight*.

The contest has been open since December 1, 1989, and closes September 17, 1990, (all entries must be postmarked by September 17 and received by October 1, 1990). The winner will be announced in the December 1, 1990, issue of the *RIC News*.

The Rare Earths and I

(Continued from page 3)

The same synthesis, by the way, works as well with most of the rare-earths, and we soon prepared and offered for sale CeB_6, NdB_6, SmB_6, EuB_6, GdB_6, YbB_6. Some rare-earth elements (Ho and Er, for example) want to preferentially form the tetraborides, but that's another story.

I should mention here that very soon after we started CERAC in 1964, customers began to request solid shapes of many of our products. We had built a simple hot-press at A-C, but various research groups prevented our including it in the CERAC purchase, so we had to construct another one. The refractory inorganics we were producing had relatively high melting points or would decompose on melting. Hot-pressing was the only practical way to consolidate such materials.

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