

# RARE-EARTH INFORMATION CENTER NEWS

ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE  
IOWA STATE UNIVERSITY / AMES, IOWA

Volume XV

March 1, 1980

No. 1



Front row from left: A. V. Golubkov, T. I. Volkonskaja, L. S. Parfen'eva, G. A. Marchenko, S. G. Shul'man, Back row from left: L. N. Vasil'ev, V. M. Sergeeva, V. V. Kaminskii, V. V. Tichonov, A. I.

Shelich, I. A. Smirnov, I. N. Kulikova, N. N. Stephanov, T. T. Dedegkaev.

## A. F. Ioffe Physico-Technical Institute— Rare Earth Semiconductor Research

In 1973 at the A. F. Ioffe Physico-Technical Institute, a rare earth research group headed by Prof. I. A. Smirnov was organized. The main research directions of the group are the search for, preparation and study of rare earth semiconductors, which have possible application in microelectronics, lasers and devices for recording, storage and processing of optical information.

An up-to-date technology for the synthesis and preparation of single crystals and thin films of many rare earth semiconductors has been developed. The single crystals are grown by Bridgman's method using an induction furnace. Several methods are employed for the thin film preparation: evaporation from three independent sources, flash

evaporation and RF-sputtering. In recent years, single crystals and thin films have been obtained from the following rare earth compounds:  $RX$ ,  $R_2X_3$ ,  $R_3X_4$ ,  $RB_6$  and solid solutions:  $R_2X_3-R_3X_4$ ,  $Sm_{1-x}R_x^{+3}X$  ( $R$  = rare earth metal,  $X$  = S, Se, Te). Single crystals of several compounds were produced for the first time.

The physico-chemical, structural, electrical, thermoelectrical, galvanomagnetic, magnetic, thermal and optical properties of the above-mentioned materials have been studied. The measurements were made in a wide range of temperatures and magnetic and electric fields. Some investigations are carried out at hydrostatic pressure. There is a small theoretical group to interpret the results.

Special interest in recent years has been paid to the investigation of the semiconductor-metal and metal-semiconductor phase transitions in SmS. It is known that at the hydrostatic pressure of 6.5 kbar ( $T = 300$  K) SmS undergoes an isostructural (NaCl-NaCl) first order semiconductor-metal phase transition. With the removal of pressure there is a reverse (metal-semiconductor) transition. Thin films of the metallic phase of SmS which are stable at atmospheric pressure have been prepared. The reverse metal-semiconductor transitions in SmS metallic films occur only after heating up to 200-400°C. This property has been used for information recording by a laser beam. The minimum energy necessary to induce the phase transition and the threshold recording energy density were measured (the latter was found to be  $\sim 0.046$  J/cm<sup>2</sup>), the phase

(continued on page 4)

## ISOTOPES

If isotopes are what interest you, then Books B5 and B6 of the *Gmelin Handbuch der Anorganischen Chemie, System 39, Rare Earth Elements* should definitely be on your list. The preparation, separation, enrichment and decontamination of both stable and unstable isotopes of the rare earth elements plus yttrium and scandium are detailed. Additional topics presented include applications, detection and determination, chemical reactions with various elements, organic and inorganic compounds, and catalytic actions. Volume B5 contains information on the isotopes of Sc, Y and La-Sm and volume B6 treats the isotopes of Eu through Lu. Information on over 350 nuclides of the 17 rare earth elements was gathered from the literature up to the end of 1976.

Published in 1978 by Springer-Verlag, Book B5 is 152 pages long and costs \$217.70 and Book B6 is 184 pages long and costs \$267.30. Both volumes contain an English table of contents, preface, margin notes and a brief review at the beginning of each chapter.

## Two Rare Earthers Die

RIC has been informed of the deaths of two well known rare earthers, Dr. C. E. Lundin and Dr. W. H. Zachariassen, during September and December, respectively, last year. Dr. Lundin received his M.S. in metallurgy from the Illinois Institute of Technology in 1952. In 1955, he joined the Denver Research Institute and in 1970 he received his Ph.D. from the University of Denver. At the time of his death, he was head of the Metallurgy and Materials Science Division of the Denver Research Institute and Senior Research Metallurgist. He is best known as an authority on rare earth metals and metal hydrides.

Dr. W. H. Zachariassen died last December after a short illness at the age of 73. Zachariassen, a professor emeritus from the University of Chicago, originally came to the U.S. from Norway. One of the senior physicists on the Manhattan Project, he is best known to the rare earth community for his crystal chemistry study of various rare earth compounds and most recently on the various polymorphs of cerium.

## REers on the Move

L. A. Luyckx, recently named as an executive vice president of REMACOR, has left that company to form his own consulting firm under the name Metserve, Inc. which is located in Newcastle, PA.

Ronson has announced the promotions of three of its staff. They are E. Klein to the position of vice president-manufacturing, W. A. Otis to vice president-marketing and S. R. Poch to the position of controller of Ronson Metals Corporation. All promotions will be in effect January 1, 1980.

## RE Handbook

*Volume 3: Nonmetallic Compounds I* and *Volume 4: Nonmetallic Compounds II* of the *Handbook on the Physics and Chemistry of the Rare Earths*, K. A. Gschneidner, Jr. and L. Eyring, eds., have been published by North-Holland Publishing Co., Amsterdam in 1979. Volume 3 is 664 pages in length and costs \$97.75 (Dfl. 220). Volume 4 contains 590 pages and costs \$86.75 (Dfl. 195). Subscription price for 3 and 4 are \$83.00 (Dfl. 187) and \$73.75 (Dfl. 166), respectively. It is anticipated that this will become an open ended series with supplements being issued on a regular basis to keep the Handbook up-to-date. Chapters and authors are listed below.

Volume 3:  
 "Geochemistry and mineralogy of the rare earths" L. A. Haskin and T. P. Paster  
 "Separation chemistry" J. E. Powell  
 "Theoretical chemistry of rare earths" C. K. Jørgensen  
 "The absorption and fluorescence spectra of rare earth ions in solution" W. T. Carnall  
 "Complexes" L. C. Thompson  
 "Hydrides" G. G. Libowitz and A. J. Maeland  
 "The binary rare earth oxides" L. Eyring  
 "Mixed rare earth oxides" D. J. M. Bevan and E. Summerville  
 "Perovskites and garnets" C. P. Khatkhat and F. F. Y. Wang  
 "Rare earth molybdates" L. H. Brixner, J. R. Barkley and W. Jeitschko  
 Volume 4:  
 "Sulfides, selenides and tellurides" J. Flahaut  
 "Halides" J. M. Haschke  
 "Rare earth pnictides" F. Hulliger

## REs Indentured

Rare earthers have been known to get together at conferences and meetings and "chew the fat" about this or that rare earth application. Well, there finally is a rare earth application with which anyone can literally chew the fat. M. Smyth and J. Lee-You have patented a process in which small percentages (in the molar range) of cerium and terbium oxides are incorporated into dentures (U.S. Patent 4,170,823). Apparently natural teeth fluoresce under ultraviolet light while false teeth do not. Smyth's and Lee-You's patent corrects this oversight. Large-scale production of the fluorescing false teeth has not begun yet so producers do not foresee any cavities forming in the cerium or terbium oxide supplies.

"Chemistry and physics of R-activated phosphors" G. Blasse  
 "Rare earth lasers" M. J. Weber  
 "Nonradiative processes of rare earth ions in crystals" F. K. Fong  
 "Chemical spectrophotometric and polarographic methods" J. W. O'Laughlin  
 "Trace element analysis of rare earth elements by spark source mass spectrometry" S. R. Taylor  
 "Analysis of rare earth matrices by spark source mass spectrometry" R. J. Conzemius  
 "Optical atomic emission and absorption methods" E. L. DeKalb and V. A. Fassel  
 "X-ray excited optical luminescence of the rare earths" A. P. D'Silva and V. A. Fassel  
 "Neutron activation analysis" W. V. Boynton  
 "Mass-spectrometric stable-isotope dilution and analysis for lanthanides in geochemical materials" S. Schuhmann and J. A. Philpotts  
 "Shift reagents and NMR of paramagnetic lanthanide complexes" J. Reuben and G. A. Elgavish  
 "Bioinorganic chemistry: lanthanides as probes in systems of biological interest" J. Reuben  
 "Toxicity" T. J. Haley  
 All four volumes are available from Elsevier's Science Division, P.O. Box 211, 1000 AE Amsterdam, The Netherlands.

## Steel Applications

The theory and practice of rare earth additions to steel have been reviewed by P. E. Waudby (*Intern. Metals Rev.* 1978, [2] 74-98). The occurrence, physical properties and affinity of the rare earth metals for O, S, C and N and the free energy of formation of various rare earth compounds are reviewed along with theories for the prediction of rare earth activities in steel. The effects of rare earth additions including deoxidation, desulfurization, inclusion formation, cleanliness and modification of mechanical properties are discussed. Finally various aspects of commercial application are presented. These include the type of rare earth alloys used, addition rates, optimum conditions and several different methods of adding the rare earths in the ladle and the mold. Possible future areas of study of rare earth addition to steel are mentioned.

## Industrial Applications

A two day American Chemical Society Symposium on the Industrial Applications of Rare Earth Elements has been scheduled for August 24-29, 1980 in San Francisco, California. Organized by K. A. Gschneidner, Jr., the symposium will consist of invited talks in four areas: metallurgical applications, ceramics and catalysts, electronics and phosphors, and miscellaneous applications. Additional information will appear in the *RIC News* as soon as it becomes available.

RIC News  
(USPS 464-960)  
Vol. XV No. 1 March 1, 1980

published  
March, June, September and  
December

by  
Rare-Earth Information Center  
...

Second-Class postage  
paid at Ames, Iowa 50011  
...

Postmaster: send address changes to:  
RIC News, Rare-Earth Information Center,  
Energy and Mineral Resources Research  
Institute,  
Iowa State University, Ames, Iowa 50011

Telephone: Area Code 515-294-2272  
FTS...865-2272

K. A. Gschneidner, Jr. ...Editor  
Bernie Evans...Staff Writer

## Address Change

The Goldschmidt Chemical Corporation (formerly Th. Goldschmidt Products Corporation) has moved to Route 2, Box 101, Hopewell, Virginia 23860. Their new telephone number is (804) 541-8658.

## Sintering Symposium

The Proceedings of the International Symposium on Factors in Densification and Sintering of Oxide and Non-Oxide Ceramics, held October 3-5, 1978, at Hakone, Japan, and edited by S. Sōmiya and S. Saito, have been published by Gakujutsu Bunken Fukyu-Kai in 1979. Eight of the 50+ articles deal with rare earth-stabilized zirconia, rare earth-containing multicomponent oxides,  $Y_2O_3$  ceramics,  $Y_2O_3-Si_3N_4$  composites, gas turbine rotors and PLZT applications. The book is 677 pages long and costs \$40.00. Copies may be obtained from Bunken Fukyu-Kai c/o Tokyo Institute of Technology, Ookayama, Meguro, Tokyo 152, Japan.

## About Garnets—

"Everything you always wanted to know about garnets but were afraid to ask" could be an alternative title for a new release in the *Landolt-Bornstein Numerical Data and Functional Relationships in Science and Technology Series, Group III, Volume 12, Part a: Magnetic and Other Properties of Oxides and Related Compounds*, K.-H. Hellwege and A. M. Hellwege, eds., Springer-Verlag (1978). The cloth-bound volume costs \$225.00 (DM 510) and contains 520 pages. Group III, Volume 12, Part a is a supplement to Group III, Volume 4, Part a which carries the same title and was published in 1970. Taken together these books constitute a comprehensive critical evaluation of the information available up to 1976/1977 concerned with the crystallographic, magnetic, electric, optical, thermodynamic and elastic properties of garnets, perovskites and perovskite-related compounds.

For more information contact Springer-Verlag New York, Inc., 175 Fifth Avenue, New York, NY 10010 or Springer-Verlag KG, Postfach, Heidelberger Platz 3, D-1000 Berlin 33, West Germany.

## BENEFACTORS

Contributions were received from nine companies during the third quarter of FY 1980. Eight of the companies listed below renewed their support of RIC and one new member was added to our family. The number in parentheses is the number of years of support for the Center.

Aldrich Chemical Co., Inc., USA (1)  
British Flint & Cerium Manufacturers, England (8)  
Colt Industries—Crucible, Inc., USA (6)  
Comphania Industrial Fluminense, Brazil (8)  
General Electric Company, USA (5)  
GTE Laboratories, Inc., USA (8)  
Middlewest Investment Co., USA (2)  
Mischmetal & Flints Private, Ltd., India (4)  
Pokmen Company, Hong Kong (2)

## REs in the News

### Ce Solar Energy

Cerium oxide is under consideration in a process which uses solar energy to release hydrogen from  $H_2O$  according to scientists at the Oak Ridge National Laboratory. The cerium oxide is reacted with sodium hydrogen phosphates yielding sodium cerium phosphate. Sodium carbonate is added to this and heated in the presence of steam to produce  $CO_2$  and hydrogen.

### Fast Crystal Structures

A neodymium-doped glass laser has been used to take single-pulse extended x-ray absorption fine structure spectra of atoms having a molecular weight of 40 or less according to researchers at Battelle's Columbus Laboratories. The laser focus time is measured in nanoseconds. Several advantages would be time savings, x-ray data for light weight molecules and for molecules whose lifetime is measured in parts of a second.

### Bubble Memories Online

The first commercially available megabit memory device has been introduced by Intel Magnetics of Palo Alto, CA. Intel's support circuits and components for a megabyte memory

(Continued on page 4)

## Ce Senses REs

A new rare earth ion selective electrode which uses a cerium (IV) oxide membrane has been developed by Y. Takasaka and Y. Suzuki [*Bull. Chem. Soc. Japan* **52**, 3455-6 (1979)]. A cerium concentration of 55% oxide/45% adhesive gave the closest response to the Nernst theory. The electrode's response behavior to trivalent lanthanum, praseodymium, dysprosium, lutetium and yttrium in solution plotted versus activity resulted in slopes of around 58 mV. Optimum pH range was from 3 to 5.5. Barium and zirconium did not interfere with the electrode, however alkali metals showed appreciable interference.

## 18th InterMag

A program of more than 29 invited and 252 contributed papers has been set for the 18th International Magnetism Conference to be held April 21-24, 1980 at the Sheraton Boston Hotel, Boston, MA, USA. Forty sessions will cover the newest developments in applied magnetism, related magnetic phenomena information storage technology and superconductivity. There will also be an exhibit of equipment, component materials, services and technical literature from prominent commercial firms. For registration information contact R. M. Josephs, Sperry-Univac, P. O. Box 500, Blue Bell, PA 19424.

## New Catalyst Bibliography

Molycorp, Inc. has announced the completion of a new bibliography on catalysis with the rare earths covering the years 1971-1976. 801 abstracts are included covering rare earth catalyst application in cracking, hydrocracking, alkylation and dealkylation, isomerization, hydrogenation, dehydrogenation, dehydration, reforming, hydrolysis and hydration, disproportionation, hydrocarbon conversion, halogenation, desulfurization, polymerization, oxidation, exhaust gas treatment and miscellaneous. This edition supplements the original bibliography which covered the period 1964-1970. Both are available free of charge by writing to Molycorp at 6 Corporate Park Drive, White Plains, NY 10604.

## RE Semiconductor

(Continued from page 1)

transition rate was estimated to be  $\sim 10^{-8}$  sec. The influence of various factors on the threshold recording energy density was assessed (time and wavelength of the recording pulse, film thickness, presence of the atmosphere). A recording was made with the density of  $3 \times 10^7$  bit/cm<sup>2</sup>.

The complex investigation of the metallic and semiconductor phases of SmS has contributed to the understanding of the band structure which has allowed the refinement of the theoretical model of the semiconductor-metal phase transition in this compound.

The Information Center on the Rare Earth Semiconductors of the Academy of Science USSR is also located at the A. F. Ioffe Physico-Technical Institute. This Information Center regularly publishes review books and a bibliography on rare earth semiconductors.

## 26th MMM

The twenty-sixth annual Conference on Magnetism and Magnetic Materials will be held November 11-14, 1980 at the Dallas Hilton, Dallas, Texas. The conference traditionally emphasizes both experimental and theoretical research on magnetism, the properties and synthesis of new magnetic materials and advances in magnetic technology. Those wishing to contribute a paper must meet an abstract submission deadline of July 25, 1980. For more information contact Dr. H. C. Wolfe, American Institute of Physics, 335 East 45th Street, New York, NY 10017.

## RE News

(Continued from page 3)

device can be constructed on 90 square inches of board space.

## Lasers and Bubbles

Lasers and magnetic bubble devices, two up and coming rare earth applications, have finally gotten together thanks to International Business Machine's (IBM) scientists. In europium-yttrium and lanthanum-yttrium gallium iron garnets the magnetic properties can be controlled by the gallium-iron distribution in various crystal locations. To tilt the distribution towards randomness lasers heat the garnet films almost to the melting point and then the films are rapidly cooled to affect the desired distribution/magnetic properties.

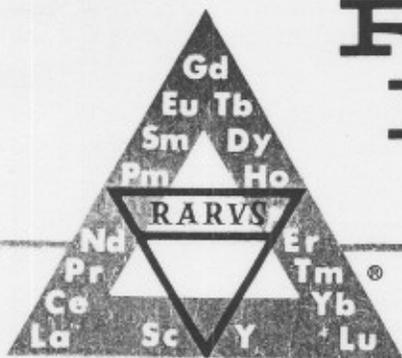
## Up- and Down-graded Lasers

With the addition of two neodymium glass amplifiers and other equipment the Australian National Laboratory in Canberra has upgraded its laser system to provide peak power of up to 250 GW. Studies to obtain very high spatial resolution x-ray images of plasma are continuing.

Shiva, the world's largest laser complex, was unexpectedly downgraded by the earthquake that rocked Northern California January 25, 1980. The 132-foot-long laser was knocked off its support pins when one inch diameter bolts, which held it to a metal frame, were broken. Scientists expect Shiva to be out of commission for at least a month for cleaning, repair and realignment.

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Energy and Mineral Resources Research Institute  
Iowa State University  
Ames, Iowa 50011



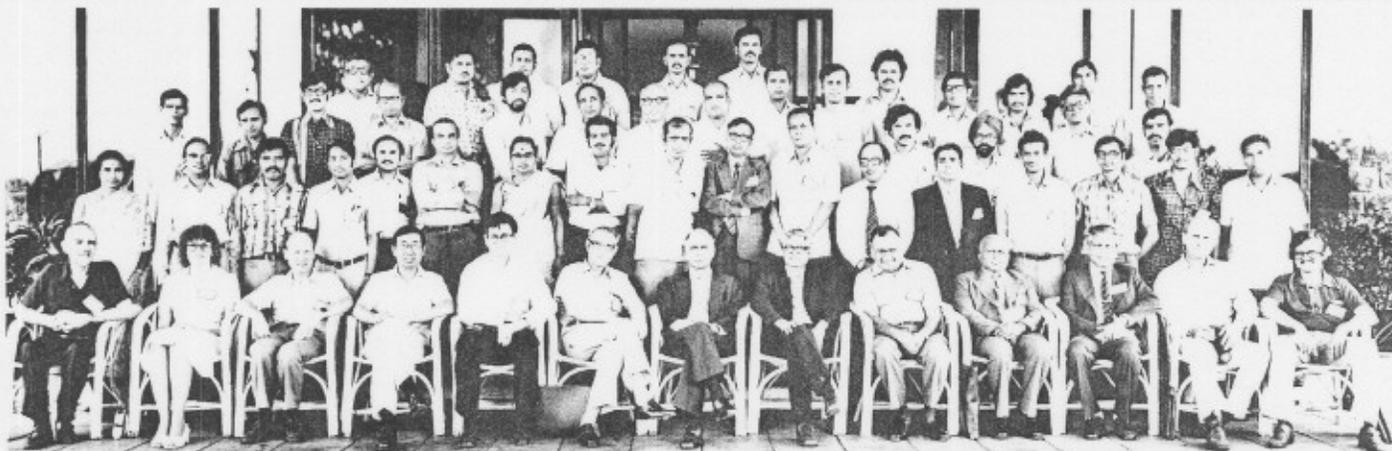
# RARE-EARTH INFORMATION CENTER NEWS

ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE  
IOWA STATE UNIVERSITY / AMES, IOWA

Volume XV

June 1, 1980

No. 2



**Sitting:** (L to R) R. S. Craig, C. Zinsser, K. A. Gschneidner, Jr., S. H. Liu, J. J. Rhyne, W. E. Wallace, M. A. Hadi, E. C. Subbarao, K. J. Strnat, B. P. Nair, T. K. S. Murthy, L. Eyring, G. Shenoy; **Standing 1st Row:** T. A. Padmavathy Sankar, K. P. Gopinathan, C. S. Menon, V. Ramakrishna Rao, T. G. Ramesh, R. Vijayaraghavan, M. Bose, P. N. Mohan Das, V. S. Arunachalam, C. V. Sundaram, G. S. Rao, G. K. Kelkar, S. G. Patil, G. V. Subba Rao, E. M. T. Velu, N. R. Bonda, G. Venkateswaralu; **Standing 2nd Row:** R. A. Tewari, A. Jain, R. Narayan, L. C. Gupta, A. K. Singh, S. Ramachandran, K. P. Gupta, D. B. Sirdeshmukh, H. S. Maiti, P. Ganguly, D. Bahadur, S. Singh, J. Gopalakrishnan, V. Rajasekharan Nair; **Standing 3rd Row:** M. Multani, S. H. Ghude, C. K. Gupta, T. S. Radhakrishnan, J. Chacko, P. K. Radhakrishnan, Y. N. S. Pillai, S. K. Malik, R. D. Kambalkar, T. S. Krishnan, T. V. Swaminathan.

## RARE EARTHS IN INDIA

The editor was privileged to be a member of the nine man scientific delegation from the United States to attend and participate in the *Indo-U.S. Conference on Science and Technology of Rare Earth Materials* which was held in Cochin on March 3-8, 1980. Cochin is a sea port on the west coast near the southern tip of India. The fact that the main plant of Indian Rare Earths Ltd is located near Cochin in Udyogamandal was one of the reasons for the Conference being held in this local. Also the availability of a convention center—the Ambalamedu House of FACT (Fertilisers and Chemicals Trv.), located on an island amid the beautifully wooded hills a few kilometers outside of Cochin—was another important consideration. After the Conference many members of the U.S. delegation visited (separately) various universities, institutes of technology or science and research institutes throughout India.

The Indian delegation was 56 in

number and came from all parts of India. The twofold purpose of the Conference was to discuss the science and technology of rare earth materials and to identify possible areas of collaborative work between the scientists and engineers of the two countries. The first goal was easily realized with 20 review presentations (11 U.S. and 9 Indian) and 15 contributed talks and 11 poster presentations (all by the Indian scientists). The second goal was also achieved by laying the foundation in a few areas for cooperative joint research.

The contributed review papers were (listed in order of presentation): W. E. Wallace—surface chemistry and catalysis, C. K. Gupta and T. K. S. Murthy—extraction, K. A. Gschneidner, Jr.—preparation and purification of metals, J. J. Rhyne—amorphous alloys, R. Vijayaraghavan—nuclear magnetic resonance, E. C. Subbarao—superionic conductors and ferroelectrics, S. H. Liu—electron structure, L. C. Gupta—

valence fluctuations, S. K. Malik—crystal fields, R. S. Craig—hydrides, G. K. Shenoy (U.S.)—Mossbauer effect, Rhyne—neutron scattering, M. B. Maple—superconductivity and ferromagnetism, C. N. R. Rao—photoelectron spectroscopy, L. Eyring—defect structures in oxides, V. S. Arunachalam and S. Ramachandran—steel technology, K. Strnat—permanent magnets, K. P. Gupta—phase equilibria in R-Co systems, Gschneidner—phase relationships and alloy theory, and T. G. Ramesh—high pressure studies. All of the review papers will appear in a volume edited by E. C. Subbarao and W. E. Wallace. The availability, price, etc. will be announced by RIC as soon as this volume is published.

Much of the success of this Conference was due to the efforts of Prof. E. C. Subbarao, Conference Chairman, and his committee. The local arrangements and assistance of the staff of Indian Rare Earths were deeply appreciated, especially by the American delegation.

After the Conference the editor vis-  
(continued on page 6)

## CONTRIBUTORS

Five companies renewed their support of RIC during the fourth quarter of fiscal year 1980. This brings the total number of companies that contributed to the support of the Center to 44, 43 of which are sustaining members and one new company. All things considered, it was a good year for RIC and for the rare earth industry. This quarter's companies are listed below. The number in parentheses is the number of years that company has supported the Center.

Atomergic Chemetals Corp., U.S.A. (8)

Bose Corporation, U.S.A. (3)

Companhia Industrial Fluminense, Brazil (8)

GTE Sylvania, U.S.A. (8)

Industrial Minera Mexico, S.A. (6).

### Working the bugs out. . .

or working out with the bugs is what R. S. Wilcox has been doing with the help of small samarium cobalt permanent magnets [*Science* 206, 1325-1327 (1979)]. Wilcox was studying the different modes in which the insect called the masked water strider (*Gerris remigis*) communicates. Apparently the male of the species can send both a high frequency (>90 waves per sec.) and a low frequency (3 to 10 waves per sec.) surface wave signal by vertical oscillations of its forelegs. The female of the species can only generate the low frequency signal. Wilcox was specifically studying whether or not the male masked strider can determine the sex of other water striders solely by the presence or absence of the high frequency signal. To accomplish this he glued a small samarium cobalt permanent magnet to the foreleg of a female water strider and then encircled the encounter area with a wire coil. Electromagnetic fluctuations from the wire coil caused vertical oscillation of the magnet to imitate the high frequency signal of the male. Wilcox found that when the magnet was activated the male water strider treated the female water strider as if it were another male thus confirming his hypothesis. Unfortunately this disproves the belief, held by many rare earthers, that samarium cobalt magnets can attract anything.

## Laser Glass Handbook Compiled

Neodymium-doped laser glass spectroscopic and physical properties have been compiled by S. E. Stokowski, R. A. Saroyan, and M. J. Weber [*Lawrence Livermore Laboratory (LLL) Report No. M-095* (November 1978)]. The compiled data have resulted from the ongoing research at LLL and other laboratories to determine the suitability of different neodymium-doped glasses for use in fusion lasers. The types of glass examined are silicate, phosphate, fluorophosphate, fluoroberyllate, borate, borosilicate, and miscellaneous. Data sheets for each glass consist of a composition diagram and table, a range of linear and nonlinear refractive indices and dispersion, and emission cross section and peak emission wavelength. The properties of a glass versus systematic composition variation are also illustrated if they have been studied.

The authors did not intend for this to be a comprehensive listing but instead have concentrated on the effects of different glass network-former and network-modifier ions on the optical properties of Nd<sup>3+</sup>; compositional series in which a single modifier ion, such as an alkali or alkaline earth, was varied; and specific compositional regions, to achieve a low nonlinear refractive index, a large or small stimulated emission cross section, and high energy storage.

Over 200 copies of the handbook have been distributed throughout the world to laboratories and researchers who are working with neodymium-doped laser glasses. The handbook will be updated semi-annually with additional and/or replacement pages as new data become available.

## Proceedings Published

The Proceedings of the International Conference on Neutron Scattering and Magnetism, August 29-31, 1979 Julich, Federal Republic of Germany has been published in the *Journal of Magnetism and Magnetic Materials*, 14, 105-350 (1979). The Proceedings contain 64 papers on the topics of band magnetism, low dimensional systems, magnetic phase

(continued on page 5)

## Dy Traces Pollution

W. D. Loveland has completed a study in which he has demonstrated several advantages of using a dysprosium diethylenetriamine pentaacetic acid (DTPA) complex as a river pollution tracer [Water Resources Research Institute-59 (July 1978)]. The Dy complex was introduced into the final effluent tank of a municipal sewage treatment plant which discharges directly into the river. Samples of river water at different locations in the river were then taken and analyzed for Dy tracer content. The use of Dy-DTPA complex circumvents two objections to methods currently being used, namely 1) the release of radionuclides into the environment and their long term (real or imagined) hazards and 2) the fact that there is no water discoloration as is the case when dyes are used. Other advantages include ease of analysis, detection sensitivity, non-interference of pollutants with analysis, low natural concentration of Dy in sediment and water, minimal adsorption on sediments, and the ability to "fingerprint" each source with a fixed ratio of tracer elements. Furthermore, Dy-DTPA is cost competitive. Loveland's results could indicate an increased involvement of the rare earths in the fight against water pollution.

## Crystal Field Meeting

The Polish Academy of Sciences is sponsoring the IV International Conference on Crystal Field and Structural Effects in *f*-electron Systems, to be held September 22-25, 1981 in Wroclaw, Poland. The program will consist of invited and contributed talks concerned primarily with metallic and semimetallic materials. Papers dealing with nonmetallic materials will be considered for presentation. English is the recommended language and the program, abstracts, and proceedings will be printed in English. For more information contact the Institute for Low Temperature and Structure Research, Polish Academy of Sciences, 50-950 Wroclaw, P.O. Box 937, Poland, preferably by August 1, 1980.

## 15th Rare Earth Research Conference

The 15th Rare Earth Research Conference will be held at the Rolla campus of the University of Missouri on June 15-18, 1981. Rolla (gateway to the beautiful Ozarks) is located 100 miles southwest of St. Louis on Interstate 44. Public transportation is available from St. Louis to Rolla.

The program will include the following major topics: General and Analytical Chemistry, Solutions and Solvation, Biochemistry, Geochemistry, Spectroscopy, Metallurgy, Crystal Growth, Intermetallic Compounds, Phase Studies and Diagrams, Solid State Physics, X-ray Diffraction, Neutron Scattering, Magnetism, Thermal and Transport Properties, Surface and Interface Phenomena, Rare Earth Technology, Industrial Processes, Uses and Applications.

The second Frank H. Spedding Award for excellence in research and leadership in rare earth science and technology will be bestowed at this meeting. For more information see the article entitled "2nd Frank H. Spedding Award" on page 6.

We hope to have in attendance the leading experts in rare earth science and technology from around the world. We hope to maintain the strong interdisciplinary character of the previous conferences and to have substantial representations from government, academic, and industrial institutions.

To assist the Program Committee in detail planning, please complete and return before September 1, 1980, the preliminary information form provided below.

(DETACH)

### 15th Rare Earth Research Conference

University of Missouri-Rolla, Rolla, Missouri

June 15-18, 1981

Please complete the following and send before September 1, 1980 to:

Prof. W. J. James  
Materials Research  
University of Missouri-Rolla  
Rolla, MO 65401 U.S.A.  
Phone: (314) 364-4352

This form is for information only and carries no final commitment.

PLAN TO ATTEND  Yes  No

PLAN TO PRESENT PAPER  Yes  No

SPOUSE ATTENDING?  Yes  No

TOTAL NO. IN YOUR PARTY \_\_\_\_\_

Special interest area(s) \_\_\_\_\_

\_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

## Previous RE Conference Proceedings†

French International Rare Earth Conference, May 5-10, 1969, Paris and Grenoble, France

*Les Éléments des Terres Rares*, Tome I and Tome II, Bureau 3A-Service de Presse, Centre National de la Recherche Scientifique, 15 Quai Anatole France, Paris 7<sup>e</sup>, France. Tome I—price unknown, Tome II—107.50 F.

*Proceedings of the 8th Rare Earth Research Conference, Reno, Nevada, April 19-22, 1970*, available free from Reno Metallurgy Research Center, U.S. Bureau of Mines, Reno, NV, 89505, USA.

Conference on Rare Earths and Actinides, University of Durham, Durham City, England, July 5-7, 1971.

*Conference Digest No. 3, Rare Earths and Actinides, Durham 1971*, Institute of Physics, London, England (1971). Available from the Institute of Physics, Distribution Center, Blackhorse Road, Letchworth, Herts SG6 1HN, England. £7.50 (except £3.75 for members of the Institute of Physics).

*Proceedings of the 9th Rare Earth Research Conference, Blacksburg, Virginia, October 10-14, 1971*, available from Dr. Larry Taylor, Department of Chemistry, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA. \$20.00

NATO Advanced Study Institute on Analysis and Application of Rare Earth Materials, Kjeller, Norway, August 23-29, 1972.

*Analysis and Application of Rare Earth Materials*, O. B. Michelsen, ed., Universitetsforlaget, Oslo, Norway (1973), available from Universitetsforlaget, P.O. Box 307, Blindern, Oslo 3, Norway or from Universitetsforlaget, P.O. Box 142, Boston, MA 02113. \$28.00.

*Proceedings of the 10th Rare Earth Research Conference, Carefree, Arizona, April 30-May 3, 1973*. CONF-730402-(P 1-2). Available from the National Technical Information Service, Springfield, VA 22151, USA. \$27.20.

Seventh Russian Conference on Rare Earth Metals, Moscow, USSR. Sept. 12-17 (1972). *Rare Earth Metals, Alloys and Compounds* [*Redkozemelnye Metally Splavy i Soedineniya*] (Izdatel'stvo Nauk, Moscow, 1973) 355 pp. Cost is 1R, 81K (~\$2.00 U.S.) [14 papers in English, 5 in French and 67 in Russian]. Suggest contacting a book store dealing with Soviet publications.

*Proceedings of the 11th Rare Earth Research Conference, Traverse City, Michigan, Oct. 7-10, 1974*, available from Harry A. Eick, Department of Chemistry, Michigan State University, East Lansing, MI 48824, U.S.A., \$25.00

*Proceedings of the 12th Rare Earth Research Conference, Vail, Colorado, July 18-22, 1976*, available from University Microfilm, 300 N. Zeeb Rd., Ann Arbor, MI 48106. LD-000328, \$83.00.

Thirteenth Rare Earth Research Conference, Oglebay Park, West Virginia, October, 1977. *The Rare Earths in Modern Science and Technology*, G. J. McCarthy and J. J. Rhyne, eds., Plenum Publishing Corp., New York (1978), \$49.50.

Conference on Rare Earths and Actinides, University of Durham, Durham City, England, July 4-6, 1977. *Institute of Physics Conference Series Number 37*, W. D. Corner and B. K. Tanner, eds., Institute of Physics, London (1978). £ 22.00.

French International Rare Earth Conference, September 4-7, 1978, St. Pierre-de-Chartreuse, France. *Physics of Metallic Rare Earths, J. Phys. (Paris) Colloque C-5 40*, C5-1-404 (1979), 245 F.

Fourteenth Rare Earth Research Conference, Fargo, North Dakota, June 25-28, 1979. *The Rare Earths in Modern Science and Technology, Vol. 2*, G. J. McCarthy, J. J. Rhyne and H. B. Silber, eds., Plenum Publishing Corp., New York (to be published in 1980)

†Published since 1970. For information on earlier conferences see *RIC News* XIII [2], 4 (1978) or contact RIC.

lanthanides under reductive conditions [pages 941-952 in *Fundamental Research in Homogeneous Catalysis*, Vol. 3, M. Tsutsui, ed., Plenum Press Corp., (1979)]. Cost of the entire volume is \$75.00.

The major thrust of their study was to discover a new type of chemistry for the lanthanides with possible potential for catalytic applications. In focusing on the synthesis and isolation of complexes in which the lanthanide metal is in the +1 or 0 oxidation state, they were successful in preparing five new compounds which represent the first isolable organometallic species obtained from alkyne-metal atomization reactions. Furthermore, all five were successful as hydrogenation catalysts at room temperature under one atmosphere of hydrogen in converting 3-hexyne to hexane. The authors claim this to be the first example of homogeneous catalytic activation of hydrogen by a complex of an *f* orbital element. Further studies are in progress.

### Proceedings

(continued from page 2)

transitions, disordered magnetic systems including spin glasses, crystal field effects and magnetic structures, and new techniques including polarized neutrons. This volume costs \$75.90.

their topics is given below. In case of two authors, the individual whose name is italicized will present the paper.

"Overview—RE Markets Today, History of Application" E. Greinacher

"The Rare Earths in Ductile Iron" *H. F. Linebarger*, T. K. McCluhan

"The Rare Earth Metals in Steels" L. A. Luyckx

"Rare Earths in Oxide Dispersion Strengthened Superalloys" J. S. Benjamin

"Industrial Applications of Pure Rare Earth Metals and Related Alloys" K. E. Davies

"The Use of Rare Earths in Glass Compositions" L. W. Riker

"Polishing Compounds" R. V. Horigan

"The Use of Rare Earth Elements in Zeolite Cracking Catalysts" *E. W. Albers*, J. S. Magee

"Rare Earths in Non-cracking Catalysis" G. Kim, *A. W. Peters*

"Nuclear Applications of Rare Earths" R. L. Crowther

"Availability and Commercial Preparation of Rare Earths" J. Kaczmarek

"Use of Rare Earths in TV and Cathode Ray Phosphors" *J. R. McColl*, F. C. Palilla

"Lamp Phosphors" W. A. Thornton

"Rare Earth X-ray Phosphors for Medical Radiography" J. G. Rabatin

"Bubble Domain Memory Materials" J. W. Nielsen

"Yttrium Iron Garnets for Microwave Applications" *L. P. Domingues*, A. L. Hunt

"High Energy Permanent Magnets and Their Use" R. Parker

"Applications for Rechargeable Metal Hydrides" *E. L. Huston*, J. J. Sheridan, III

"Oxygen Sensors" F. L. Kennard

"PLZT Electrooptic Ceramics and Devices" G. H. Haertling

"Rare Earths—Future Applications" J. G. Cannon

Copies of abstracts of these talks are available from the Rare-Earth In-

formation Center. Anyone interested in attending the Symposium should also contact RIC for additional information.

formation Center. Anyone interested in attending the Symposium should also contact RIC for additional information.

### 1979 IR-100

Competition was apparently pretty tough as only one rare earth product was able to make it into the top 100 list of significant new technical products in 1979 as determined by *Industrial Research/Development* (20, No. 10 (1979)). This year's place winner is a neodymium-doped fluorophosphate laser glass developed at the Lawrence Livermore Laboratory (LLL) by M. J. Weber, S. E. Stokowski, and E. P. Wallerstein, LLL; T. Izumitani, Hoya; P. Vergano and C. Rapp, Owens-Illinois; K. Mader and N. Neuroth, Schott; and W. Haller, National Bureau of Standards. A small nonlinear refractive index allows high intensity laser beams to be propagated through the glass with little spatial distortion. The planned use of this glass in the large Nova Laser system will achieve almost twice the performance per unit cost. The Nova system is attempting to determine the feasibility of producing thermonuclear energy by implosion of fuel with laser light.

formation Center. Anyone interested in attending the Symposium should also contact RIC for additional information.



A. Blandin

RIC News  
(USPS 464-960)  
Vol. XV No. 2 June 1, 1980

published  
March, June, September and  
December  
by  
Rare-Earth Information Center  
...

Second-Class postage  
paid at Ames, Iowa 50011  
...

Postmaster: send address changes to:  
RIC News, Rare-Earth Information Center,  
Energy and Mineral Resources Research  
Institute,  
Iowa State University, Ames, Iowa 50011

Telephone: Area Code 515-294-2272  
FTS...865-2272

K. A. Gschneidner, Jr. ...Editor  
Bernie Evans...Staff Writer

## 2nd Frank H. Spedding Award

The Frank H. Spedding Award, first presented at the Fourteenth Rare Earth Research Conference in 1979, is given in recognition of distinguished contributions in the field of rare earth science and/or technology. Nominations are now being sought from the worldwide community of scientists and engineers for the 1981 Award to be made at the Fifteenth Rare Earth Research Conference, June 15-18, 1981. An individual can present more than one candidate for consideration. Seconding letters are encouraged, particularly if they present significant information not covered by the nominator.

Forms for use in making nominations can be obtained from Dean J. B. Gruber, Executive Secretary of the Frank H. Spedding Award Committee, North Dakota State University, Fargo, North Dakota 58108 U.S.A. (701) 237-7411. Nomination forms, including seconding letters and other supporting documents, must be in the hands of the Executive Secretary by January 31, 1981.

## 5th RE-Co Workshop

The Fifth International Workshop on Rare Earth-Cobalt Permanent Magnets and Their Applications will be held June 7-10, 1981 at the Hotel Roanoke, Roanoke, Virginia. Organized by the University of Dayton, the Magnetic Materials Producer's Association and the Inland Motor Division of the Kollmorgen Corporation, this workshop will follow much the same format as the earlier workshops. The June date was chosen so that interested parties could attend both the Workshop and the 15th Rare Earth Research Conference (see page 3 for details) during the same trip. This could be the last opportunity for local scientists to attend for several years since the next two workshops are tentatively planned for late August 1982 near Vienna, Austria and September 1983 in Peking, The People's Republic of China. For more information write to K. J. Strnat, Magnetics Laboratory, KL-365, University of Dayton, Dayton, Ohio 45469.

## RE's in India

(continued from page 1)

ited three institutions before returning to America. The first was the Indian Institute of Technology—Madras, where Prof. G. Aravamudan and Dr. G. V. Subba Rao and their co-workers served as hosts. Their research efforts involving rare earths are concerned with 1) preparation and magnetic and electrical conductivity measurements on mixed rare earth oxides such as perovskites and pyrochlores, and 2) the preparation and properties of the superconducting Chevrel phases.

The next visit was with Prof. R. Vijayaraghavan, Dr. S. K. Malik and their co-workers at the Tata Institute of Fundamental Research in Bombay. Their research efforts are primarily concerned with nuclear magnetic resonance and magnetic susceptibility studies of a variety of rare earth intermetallic compounds and alloys, especially Ce mixed valence systems and intermetallic hydrides.

The final visit was with Dr. C. V. Sundaram, head of the Metallurgy Division, and his staff at the Bhabha Atomic Research Center in Bombay. Dr. Sundaram's staff is involved in a large variety of problems in all areas of metallurgy and ceramics. Their main interests in the rare earths are the preparation and purification of the metals, and they are planning to expand their efforts in this area in the next few years.

It was a memorable and interesting two weeks—the exposure to a new culture, the variety of different flora, the face-to-face meeting with

## BUSINESS NEWS

### New Company Formed

Union Minerals, a wholly owned subsidiary of Union Oil of California, is participating in a joint venture with four Norwegian companies to investigate a large carbonatite deposit in the Fen area in eastern Norway. The mineral deposit contains rare earths, niobium and other elements of potential economical interest. The new company is named K/S A/S Fenco and is a limited partnership.

### New Address and Expansion

Molycorp, Inc. has relocated to 709 Westchester Avenue, White Plains, NY 10604. Their telephone number is (914) 997-8880. Additionally, Union Oil of California, of which Molycorp is a wholly owned subsidiary, has announced a multimillion dollar program to increase Molycorp's production of separated rare earths. The program will include the installation of several new solvent extraction circuits at the Mountain Pass, California location, a new samarium metal production plant in Washington, Pennsylvania and modifications at their rare earth processing plant in York, Pennsylvania to increase capacity for high purity chemical compound preparation.

scientists whose scientific works previously were known only from the journals, and the renewal of old friendships.

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Iowa State University  
109 Office & Lab

# RARE-EARTH INFORMATION CENTER NEWS



ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE  
IOWA STATE UNIVERSITY / AMES, IOWA

Volume XV

September 1, 1980

No. 3

## Ferromagnetism

Citing the need for an up-to-date comprehensive reference source on the subject of ferromagnetism, E. P. Wohlfarth has undertaken the task of editing a four volume series entitled *Ferromagnetic Materials, A Handbook on the Properties of Magnetically Ordered Substances*. The series will consist of around 32 review articles by the leading experts involved in research and technology. New information, as well as previously compiled data, on the physics, chemistry, metallurgy, structure and engineering aspects of these materials will be presented in both graphical and tabular form.

Published in 1980 by North-Holland Publishing Company, Amsterdam and New York, Volume 1 is 630 pages long and costs \$102.50 (Dfl. 210). Approximately one half of Volume 1 is devoted to 3 review articles that deal with rare earth materials. In the first rare earth review S. Legvold presents the magnetic properties of the individual rare earth metals and intra-rare earth alloys. Magnetic anisotropy and magnetostriction are also discussed. 243 references are cited. K. H. J. Buschow has undertaken the monumental task of reviewing the magnetic properties of the rare earth binary and ternary intermetallic compounds and hydrides. Much of the data appears at the end of the review in easily accessible tabular form. Over 700 references are cited. The final rare earth review was written by A. E. Clark on the magnetostrictive rare earth-Fe<sub>2</sub> compounds. Magnetostriction, magnetization, magnetic anisotropy, elastic properties, and magnetomechanical coupling of binary, pseudobinary and amorphous R-Fe<sub>2</sub> alloys are among the topics covered. Over 90 references are cited.

## 14th RERCP

The Proceedings of the 14th Rare Earth Research Conference, held at Fargo, North Dakota, June 25-28, 1979 are now available as a single volume entitled *The Rare Earths in Modern Science and Technology Vol. 2*. The 118 papers detail the current state of research and application in the areas of materials preparation, coordination chemistry, structural and solid state chemistry, valence instabilities, superconductivity, physical properties of elements and alloys, intermetallics, semiconducting and insulating compounds, spectroscopy, sources and applications, physical and chemical properties of hydrides, and lasers.

Edited by G. J. McCarthy, J. J. Rhyne and H. B. Silber and published in 1980 by Plenum Press, the book is 647 pages long. The cost is \$59.50. Copies may be obtained by writing to Customer Service, c/o Ms. Helen Connors, Plenum Press, 227 West 17th Street, New York, NY 10011.

## Applied Pressure

J. S. Schilling has reviewed the use of pressure as a parameter in the study of dilute magnetic alloys [Advances in Physics 28, 657-715 (1979)]. The experimental methods of generation of high pressure and subsequent measurements are briefly discussed. Experimental and theoretical results for very dilute magnetic alloys under both external and lattice (from substituted impurities) pressure are examined with particular reference to effects on exchange interaction. The results from experiment and theoretical study of more concentrated alloys under pressure are then presented. The volume dependence of magnetic interaction is detailed. 183 references are cited.

## \$\$ 1981 \$\$

Yes, believe it or not, a new fiscal year is upon us! It looks like another good year for the rare earth industry judging from the quality of the response to date. This is certainly understandable as more and more rare earth applications come on line. If we keep working at it one day soon praseodymium will be a household word—well, at least cerium! At any rate, fourteen companies have contributed to the support of RIC during the first quarter of fiscal year 1981 and they are listed below. Of the fourteen companies, thirteen renewed their support of the Center and there was one new addition to our family of benefactors. The number in parentheses is the number of years the company has supported the Center.

Cerac, Inc., U.S.A. (5)  
Ferro Corp., Transelco Div., U.S.A. (5)  
Foote Mineral Company, U.S.A. (9)  
Inland Motor Div., Kollmorgen Corp., U.S.A. (5)  
Kolon Trading Co., U.S.A. (8)  
Lunex Company, U.S.A. (11)  
Molycorp, Inc., U.S.A. (13)  
Reactive Metals & Alloys Corporation, U.S.A. (5)  
Reactor Experiments, U.S.A. (11)  
Ronson Metals Corp., U.S.A. (13)  
Santoku Metal Industry Co., Ltd., Japan (11)  
V/O Techsnabexport, U.S.S.R. (4)  
Wako Bussan Co., Ltd., Japan (12)  
Yao Lung Chemical Plant, Shanghai (1)

## Superalloy Hot Workability

S. Yamaguchi, H. Kobayashi, T. Matsumiya and S. Hayami have studied the effects of five minor elements (S, Ca, Mg, Y and Zr) on the hot workability of nickel-base superalloys [Metals Technology 1979, 170-5 (May 1979)]. Citing the need

(continued on page 3)

# Gd

1880

31980 is the 100th anniversary of the discovery of gadolinium by J.-C.-G. de Marignac in 1880. Gadolinium is a fourth generation rare earth by way of didymia from lanthana from ceria. In 1880 Marignac separated a compound from samarskite and gave it the notational name "Ya". Gadolinium's name actually came about through the work of L. de Boisbaudran. Marignac and others, including Boisbaudran, suspected as early as 1853 that didymium was not a pure substance. In 1879 Boisbaudran devised a method for separating samaria from didymium and then in 1886 separated yet another compound from didymium. This other compound was identical to Marignac's "Ya" and so, with Marignac's approval, Boisbaudran named the new compound gadolinia. Various gadolinium compounds find application today in microwave frequency control, circulators, isolators, bandpass filters, substrates, phosphors, X-ray screens and magnetic heat pump devices.

## 1981 INTERMAG

The 19th International Magnetism Conference (INTERMAG) has been scheduled for May 12-15, 1981 at the Alpes Congrès Conference Center in Grenoble, France. The Conference is open to all persons subject to payment of a registration fee and will consist of both invited and contributed papers, technology assessment sessions, workshops, and an exhibit of equipment, components, materials and technical information from commercial firms. Examples of anticipated topics include applied magnetism and related magnetic phenomena, magnetic recording, memory technologies, control and power conversion, magnetometry and transducers, magnetic printing, magnetism in life sciences, magnetic separation, magnet field calculations, magnetic materials properties and

## RE Pneumoconiosis

More information has come to light concerning the effects on humans of the inhalation of rare earth particles as a result of a study by M. Hamid Husain, J. A. Dick and Y. S. Kaplan [*J. Soc. Occup. Med.* 30, 15-9, (1980)]. They examined an individual who showed radiological evidence of pneumoconiosis and whose only known occupational exposure was to rare earths. The individual worked for a company that produced glass rubbing polish from rare earth ore concentrate. A routine chest X-ray showed nodular shadowing throughout the lung fields typical of occupational dust exposure. The individual's respiratory functions (i.e. tidal volume, residual volume, total lung capacity, etc.) were examined at the time and again eleven months later and no pulmonary impairment was discovered. In fact, the person's overall state of health was excellent. Other persons from the company in similar or identical jobs were examined and found to have normal chest X-rays. Questioning revealed these other individuals to be more conscious of the need to wear the protective masks provided by the company.

Although in the present case the effects of the inhalation of rare earth dust particles appear to have been benign, the authors urge everyone in positions of possible exposure to inhalation of rare earth dust particles to take every precaution to avoid such inhalation until more is known about the short and long term effects.

processing.

Information about abstract submission may be obtained by writing to Conference Chairman J. M. Lommel, General Electric Corporate Research and Development, P.O. Box 8, Schenectady, NY 12301. Abstracts must be submitted by December 15, 1980 to the Program Co-Chairman J. P. Lazzari, Centre de Recherche, CII Honeywell Bull, Rue Jean Jaures, 78340 Les Clayes S/Bois, France. Commercial firms that would like to present an exhibit should contact the Local Arrangements Chairman D. Randet, LETI, Centre d'Études Nucléaires, B. P. No. 85, 38041 Grenoble CEDEX, France.

## 'Let there be rare earths'

Evidence has been uncovered by W. V. Boynton, R. M. Frazier and J. D. Macdougall to suggest that this article's title might have been the next statement after 'Let there be light' [pp. 103-5 in *Lunar and Planetary Science XI*, the Lunar and Planetary Institute, Houston, Texas (1980)]. The authors have been studying inclusions in the Murchison meteorite which fell in Australia in 1969 and comparing these results to those from the Allende meteorite. Based on the findings from the Allende meteorite, a theory was presented in which the ultra-refractory elements (including the rare earths and especially the heavy rare earths) were the first elements to precipitate from the primordial gaseous cloud. Unfortunately, this enriched heavy rare earth fraction was never found in the Allende meteorite. However, an inclusion in the Murchison meteorite has been found to have the characteristic rare earth concentrations of the missing ultra-refractory component. Dysprosium, holmium, lutetium and scandium are enriched to 100 times the normal value. Other rare earths are also enriched but not to this extent. These anomalies suggest that the Murchison inclusions were among the first entities to condense from the gas cloud. *Editor's note: A logical (for us) extension of this theory would indicate that everyone can trace their roots back to the rare earths!*

## Ce Aids Competition

One of the leading competitors of  $\text{LaNi}_5$  in the race for commercial application of the metallic storage of hydrogen,  $\epsilon\text{-FeTi}$ , has been aided by the addition of small amounts of cerium according to C. M. Stander [*Metal Science* 1979, 322-3 (May 1979)]. One of the drawbacks of  $\epsilon\text{-FeTi}$  is that oxygen impurity causes the formation of  $\text{Fe}_7\text{Ti}_{10}\text{O}_3$  which in turn leads to the formation of  $\text{Fe}_2\text{Ti}$ ; neither of which absorb hydrogen. The addition of 6% cerium was sufficient to get most of the oxygen from the FeTi samples, thus suppressing the formation of  $\text{Fe}_7\text{Ti}_{10}\text{O}_3$  and  $\text{Fe}_2\text{Ti}$  and resulting in hydrogen absorption of up to 99% of the theoretical hydrogen capacity for those samples.

## CEF Conference

*Crystalline Electric Field and Structural Effects in f-Electron Systems* is the title of the Proceedings for the conference of the same name held November 12-15, 1979 in Philadelphia, Pennsylvania. Edited by J. E. Crow, R. P. Guertin and T. W. Mihalisin and published by Plenum Press, New York, the Proceedings contain 638 pages and cost \$69.50. In the title the editors have emphasized the newer developments in the field of study by including structural effects and the actinides (f-electron systems). Topics covered include crystal field and structural effects, lattice effects, actinides, Kondo and intermediate valence properties, transport and thermodynamic properties, superconductivity, lifetime effects, singlet ground state and other properties. Twenty-five of the sixty-three published papers were invited and approximate comprehensive reviews. Portions of the discussions which followed the presentation of the papers are included and illustrate well the interaction and communication between the experimentalists and theorists. A subject index is also included.

## REers ON THE MOVE

D. A. Hackett has been promoted to the position of Manager of Metallurgical Product Sales for MolyCorp, Inc., a wholly owned subsidiary of Union Oil Company of California. Hackett has been with MolyCorp since 1967 and most recently was regional manager of ferroalloy sales to U.S. and Canadian accounts.

## Patent Information

If you have been (desparately or otherwise) looking for an easy way to find out what has been patented recently with respect to rare earth materials, then F. Villani has come to your rescue. He has edited *Rare Earth Technology and Applications* which was published this year by Noyes Data Corporation, Park Ridge, New Jersey. This book contains information on the 270 United States patents issued since January 1973 that describe rare earth technology and applications. The table of contents also serves as a subject index in breaking the entries down into subject categories. There are 23 patents for separation methods, 50 patents for specific rare earths used in the chemical industry, 52 patents for uses in various chemical processes, 74 patents for pollution control catalysts, 37 electronic application patents, 21 for single crystal preparation and 13 for phosphors and other luminescent materials. Other features include a patent number index, an inventor index and a company index. The clothbound book, also listed as *Chemical Technology Review No. 154*, is 367 pages long and costs \$48.00.

### Superalloy . . .

(continued from page 1)

to know either to what level the sulfur concentration should be reduced or what quantity of desulfurizing element(s) should be added, the authors defined the formula  $\Delta S = \%S - 0.8 \times \%Ca - 0.3 \times \%Mg - 0.5 \times \%Y - 0.1 \times \%Zr$  where "%" means wt. %. By systematically varying the additions of the various elements it was observed that for  $0.003 > \Delta S > -0.004$  excellent hot ductility was achieved. For  $\Delta S > 0.003$  segregation of sulfur in the grain boundaries reduced the hot ductility and for  $\Delta S < -0.004$  the hot ductility was adversely affected by precipitation of intermetallic compounds in the grain boundaries. On the basis of these findings the authors successfully processed a newly developed Ni-Cr-W type superalloy by the controlled addition of Ca, Mg, Y and Zr. The anticipated application for this superalloy is in heat-exchanger pipes in a high-temperature gas reactor.

## Organometallics

In order to get a clear picture of what was going on in the fast emerging field of rare earth and actinide organometallic chemistry, a NATO Advanced Study Institute was held at Sogesta, Urbino, Italy in September 1978. The Proceedings of that conference are now available as a volume entitled *Organometallics of the f-elements*. Edited by T. J. Marks and D. Fischer and published by D. Reidel Publishing Company in 1979, the Proceedings are 517 pages in length and cost \$57.50 (Dfl. 110). In publishing the main body of lectures, the editors hope to present a comprehensive and meaningful description of the knowledge currently available on the chemical and physical properties of organo-f-element compounds. Papers of interest to rare earthers discuss the electronic structure of f-block compounds, organometallic compounds with lanthanide-carbon sigma bonds, kinetically stable lanthanide alkyls and bridging methyls, lability and stability in f-transition metal organocompounds, structure and bonding of 4f and 5f series organometallic compounds, optical spectroscopy of f-element compounds, theory and practical applications of nuclear magnetic resonance for rare earth complexes, and catalysis and other applications of f-element organometallics. An appendix lists other contributed papers that were not published.

## RES IN THE NEWS

### Let There be (Cheap) Light!

Rare earth fluorescent powders have struck again in the form of a new light bulb developed by North American Philips Lighting Corporation that will replace the conventional incandescent bulb. The new lamp lasts over seven times longer and uses 70% less energy. A 100 watt incandescent lamp can be replaced by a 25 watt rare earth lamp. Rare earth powders coat the interior wall of the bulb and convert ultraviolet radiation into visible light. The new bulbs cost more initially but reduced electricity consumption over the life of the bulb will result in upwards from several dollars savings depending on the cost per watt of electricity.

RIC News  
(USPS 464-960)  
Vol. XV No. 3 September 1, 1980  
published  
March, June, September and  
December  
by  
Rare-Earth Information Center  
...  
Second-Class postage  
paid at Ames, Iowa 50011  
...  
Postmaster: send address changes to:  
RIC News, Rare-Earth Information Center,  
Energy and Mineral Resources Research  
Institute,  
Iowa State University, Ames, Iowa 50011

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Bernie Evans...Staff Writer

## THIN FILMS

In an effort to clear up the confusion surrounding thin films of the rare earth metals, M. Gasnier has published a critical review of the rare earth metals, rare earth hydrides and rare earth oxides as thin films [*Phys. Stat. Solidi (a)* 57, 11-57 (1980)]. Various preparation methods are examined with respect to the introduction of impurities. The extreme reactivity of the rare earths with hydrogen, water vapor and oxygen has resulted in the preparation of thin film rare earth hydrides and oxides when the metal was desired. Other identified impurities include hydroxides, oxihydroxides, oxinitrides and carbides. The structural, electrical, magnetic and optical properties of rare earth metals are then examined and compared to the corresponding properties of bulk samples.

As a result of the many investigations, much interest was directed towards the thin film oxides of the rare earths. Corresponding to this interest, the last section of the review is devoted to the preparation, crystallographic and structural studies of the rare earth sesquioxide thin films. Over 200 references are cited.

## Didymium Calibration

Several didymium glass filters have been specified by the National Bureau of Standards as standard reference materials for calibrating the wavelength scale of spectrophotometers [*NBS Special Publication* 260-66 (October 1979)]. The filters may also be used to calibrate reflectance spectrophotometers and densitometers. Transmittance data for the filters are included but it is emphasized that the filters should not be used as standards of transmittance. Explicit instructions are given for making a wavelength calibration curve including making corrections from transmittance minima and inflection points. Calibration uncertainties in the NBS calibration and those that may be introduced by the user are discussed. Additional background information and terminology are detailed in an appendix.

## ICM Proceedings

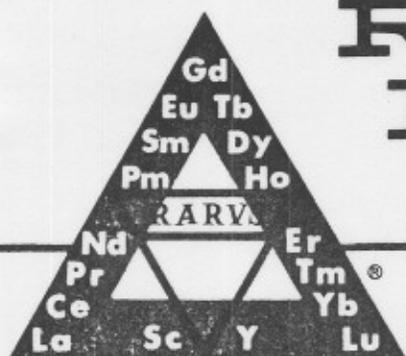
The Proceedings of the International Conference on Magnetism held September 3-7, 1979, Munich, Federal Republic of Germany, has been published as a three volume set in the *Journal of Magnetism and Magnetic Materials* Vol. 15-18, 1-1608 (1980). Over 30% of the 710 articles deal with rare earth materials and their properties. Among the subjects covered are crystal field effects, local magnetic moments in metals, spin glasses, disordered spin systems, itinerant magnetism, magnetic interactions, magnetic excitations of spin systems, phase transitions and critical phenomena, magnetic structures and neutron diffraction, anisotropies, magnetoelastic phenomena, Mössbauer effect, nuclear magnetic resonance, electron spin resonance, optical and magneto-optical phenomena, electronic structure, transport phenomena, mixed valence, low-dimensional systems, surface magnetism, thin films and small particles, lanthanide and actinide metals, alloys and compounds, magnetic metal-hydrogen systems, magnetic semiconductors and isolators, amorphous magnetic materials, soft and hard magnetic materials, domains, micromagnetics, memories, and general and interdisciplinary topics. The cost for this three volume set is \$417.44.

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## Hyperfine Fields Tabled

G. N. Rao has extended similar compilations by D. A. Shirley *et al.*, T. A. Koster *et al.*, and himself with the publication of a table of hyperfine fields for impurities in Fe, Co, Ni and Gd [*Hyperfine Interactions* 7, 141-99 (1979)]. The table contains data from all applicable references which appeared in Physics Abstracts up to the end of December 1978. The tabular data include the charge, element, and mass number of the solute, electronic configuration of the impurity, temperature at which the measurement was taken, atomic percentage of the impurity, hyperfine field at the impurity nucleus, reference, method of measurement, and remarks including sample preparation, details of analysis, etc. There are eighty-one entries for gadolinium. The impurities are fluorine, scandium, vanadium, chromium, manganese, iron, cobalt, arsenic, selenium, yttrium, zirconium, niobium, molybdenum, technetium, ruthenium, rhodium, palladium, silver, cadmium, indium, tin, antimony, tellurium, iodine, lanthanum, neodymium, samarium, europium, gadolinium, terbium, dysprosium, erbium, thulium, ytterbium, lutetium, hafnium, tantalum, rhenium, osmium, iridium, platinum, gold and mercury.



# RARE-EARTH INFORMATION CENTER NEWS

ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE  
IOWA STATE UNIVERSITY / AMES, IOWA

Volume XV

December 1, 1980

No. 4

## Two Giants Die

Within about 24 hours, two scientists who had major impacts on science over the last forty years died. Prof. B. T. Matthias died on Monday, October 27, and Prof. J. H. Van Vleck passed away the following day.

Matthias died of a massive heart attack at the age of 62. He had received his doctorate from the Eidgenössische Technische Hochschule in Zürich in 1943, where he worked on ferroelectric materials. He was associated with the Bell Laboratories since 1948 and held a joint appointment since 1961 with the Bell Laboratories and the University of California-San Diego. He was also closely associated with the Los Alamos Scientific Laboratory for about 30 years where he served as a Laboratory Fellow and consultant. His main research efforts were concerned with superconducting materials, and materials which have exotic and/or novel properties. A year ago he was one of three co-recipients of the American Physical Society's International Prize for New Materials.

Matthias was a personal friend of the editor and his passing away is a great loss to his relatives and to those of use who knew him, and his death will be deeply felt by the scientific and technological community.

Prof. J. H. Van Vleck died on Tuesday, October 28, after a short illness at the age of 81. Van Vleck received his doctorate from Harvard University in 1922. From there he went to the University of Minnesota until 1928, then to the University of Wisconsin until 1934, and finally back to Harvard where he was named Emeritus Professor of Mathematics and Natural Philosophy in 1969.

(Continued on Page 3)

## 1980 IR 100

Rare earth materials are building blocks in five of *Industrial Research's* 1980 list of the top 100 significant new technological developments [21, No. 10 (1980)]. The diversity of the applications described below is notable.

An yttria-stabilized zirconia membrane is the key to a zirconia pH sensor developed by L. W. Niedrach of the General Electric Co. The sensor works for extended periods of time under both high temperatures and pressures. Possible applications are direct pH measurement in nuclear reactor primary water systems, geothermal brines, and in high temperature corrosive processes.

A direct-writing recorder developed at the Bell & Howell Co. by N. E. Samek uses a PLZT (lead lanthanum zirconium titanate) ceramic material as a light gate. When a voltage is applied to the PLZT, its ferroelectric domains rotate the polarization vector 90° allowing light to reach the light-sensitive recording paper. The light gate is controlled by input data signals.

Yttrium hexaboride and erbium dodecaboride have gotten into the solar energy game thanks to J. Schreyer, C. Schmidt, and L. Abbatello of Union Carbide Corp., Nuclear Division. The fine particle boride powders form a plasma-sprayed coating which traps incoming solar radiation. The coating combines high temperature stability with a 71 to 97% heat recovery efficiency. Applications include solar power stations and furnaces.

R. Holsinger of the New England Nuclear Corp. has used samarium cobalt permanent magnets to produce a permanent magnet quadrupole for economically focussing charged particle beams. Advantages over electromagnet focussing in-

## 15th RARE EARTH RESEARCH CONFERENCE UPDATE

Several deadlines for the 15th Rare Earth Research Conference are fast approaching. The most immediate deadline is for nominations for the recipient of the second Frank H. Spedding Award. Nominations with supporting biographical data and a cover letter citing specific achievements should be sent to Chairman, Selection Committee, Professor W. E. Wallace, Department of Chemistry, University of Pittsburgh, Pittsburgh, PA 15261, U.S.A. by January 15, 1981.

The deadline for the submission of abstracts is also January 15, 1981. The abstract and two copies should be mailed to Professor G. R. Chopin, Program Chairman, Department of Chemistry, Florida State University, Tallahassee, FL 32306 U.S.A. General category, preference for mode of presentation, and desired form of publication should be noted. All papers submitted for publication will be refereed.

The final registration and abstract forms may be obtained by writing to Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401, U.S.A.

clude no power consumption, no cooling requirement, and smaller magnet volume per unit of field gradient.

Borides strike again in the form of a high purity single crystal lanthanum hexaboride gun for an analytical electron microscopy. Developed at Hitachi, Ltd. by M. Kubozoe, the electron microscope can be used for microelemental analysis in metallurgy, mineralogy, biology, and medicine. A triple lens system in conjunction with the lanthanum boride gun allows for a wide variety of illumination.

## William F. Meggers Award

J. G. Conway has been selected by the Optical Society of America to receive the 1980 William F. Meggers Award for outstanding work in spectroscopy. Conway's accomplishments in measurement and analysis of actinide crystal and atomic spectroscopy are cited. He has been a member of the Los Alamos Scientific Laboratory, a research associate at the University of Pittsburgh, and is presently on the senior staff of the Lawrence Radiation Laboratory. Current research interests include laser excitation determinations of energy levels and ionization energies of lanthanides and actinides.



## FERROMAGNETISM

Volume 2 of the projected 4 volume series entitled *Ferromagnetic Materials, A Handbook on the Properties of Magnetically Ordered Substances* has been published in 1980 by North-Holland Publishing Company, Amsterdam and New York. Edited by E. P. Wohlfarth, Volume 2 is 592 pages long and costs \$102.50 (DF1. 210.00). Subscription price for the entire series is \$87.00 (DF1. 178.50) each for Volumes 1 and 2.

Six of the eight review articles contain information on the rare earths. In chapter one M. A. Gilleo reviews rare earth garnets as ferromagnetic insulators. Crystalline and magnetic structures of the garnets, in particular yttrium iron garnet, are covered along with substitutional efforts on the magneto crystalline anisotropy and the magnetoelastic effect. In chapter three, P. I. Slick briefly touches on the effect of  $\text{La}_2\text{O}_3$  on the permeability of  $\text{MnZn}$  ferrites. J. Nicolas' review of microwave ferrites in chapter four contains a section on various polycrystalline garnets. The different types of garnets covered include conventional, high magnetization, low linewidth and high peak power parents. Yttrium iron garnet is emphasized. A. H. Eschenfelder

## Valence Instability

An International Conference on Valence Instabilities is being planned for September 28 to October 1, 1981 at the Physics Department of the Swiss Federal Institute of Technology (ETHZ) in Zürich-Hönggerberg, Switzerland. The Conference is open to anyone and will consist of invited and contributed papers on the general topics of electronic structure and associated properties, bulk magnetic properties, lattice properties, and microscopic magnetic measurements. Specific topics would include transport phenomena, photon spectroscopies, thermal properties, magnetization, change of magnetic state, elastic constants, compressibility, phonons, pressure effects, x-ray measurements of lattice symmetry, Mössbauer, NMR and EPR studies, and both elastic and inelastic neutron scattering. The proceedings of the conference will be published. English is the recommended language. For more information contact P. Wachter, Swiss Federal Institute of Technology (ETHZ), Lab. für Festkörperphysik, CH-8093 Zürich, Switzerland.

contributed both chapter five, crystalline films for bubbles, and chapter six, amorphous films for bubbles. In chapter five, elementary bubble concepts and the relationship between practical bubble parameters and fundamental magnetic and non-magnetic parameters are discussed. Garnet film fabrication, lattice mismatch, magnetization, anisotropy, static and dynamic bubble properties, and composition for applications are also covered. The review also touches on rare earth orthoferrites. In chapter six the various binary and ternary alloy amorphous films are presented with emphasis on the Gd-Co-Fe and Gd-Co-Mo alloys. Specific topics include film fabrication, magnetization, anisotropy, range of properties, and practical application. In chapter eight, S. W. Charles and J. Poplewell review the preparation, stability criterion, magnetic properties, ferro-hydrodynamics, and applications of ferromagnetic liquids. Finely divided gadolinium particles suspended in liquid approximate a ferromagnetic liquid.

## Application Prize

The second American Institute of Physics Prize for Industrial Application of Physics has been awarded to A. H. Bobeck of Bell Laboratories. The prize emphasizes industrial applications of physics, publicizes and encourages physics research in industry, and enhances awareness of the role of physics in industrial research. Bobeck is being cited for his leading role in the invention and development of single-walled magnetic bubble memory devices which has stimulated new discoveries and understanding in the field of magnetism. His contributions include the bubble propagation techniques of conductors, rotating field and oscillating bias field, the chevron expander detector, and the concept of growth-induced uniaxial anisotropy in epitaxial garnet films. Bobeck initially worked with rare earth orthoferrites before switching to rare earth garnets. Current interests include the development of high density bubble devices.



## Chemistry & Spectroscopy

N. M. Edelstein has edited a book entitled *Lanthanide and Actinide Chemistry and Spectroscopy*, ACS Symposium Series 131. Published by the American Chemical Society (ACS) in 1980, the book is based on a symposium sponsored by the Division of Inorganic Chemistry of the ACS and held in Washington, D.C. on September 10-13, 1979. As a result, this collection of papers serves as an introduction to current trends, developments, and applications in lanthanide and actinide chemistry and spectroscopy. Over a third of the papers deal with the rare earths under three general headings. These are organoactinide and organolanthanide chemistry; complex chemistry, thermodynamic properties and transcurium chemistry; and electronic structure and spectroscopy. The clothbound volume contains 472 pages and costs \$40.00.

## LETTER

### TO THE EDITOR:

re: Patent Information

In your September 1, 1980 issue of the *RIC News* you report on a quite recently published compilation of only 270 U.S.A. patents (since 1973) on the subject of rare earth technology (metallurgy and chemistry) and applications by F. Villani.

We wish to acquaint you with the actual, rather formidable size of the international position regarding rare earth patents, which includes since 1973 well over 1000 U.S.A. patents, on all aspects of rare earth technology, etc.

Very truly yours,

R. I. Rosenfelder  
Patents Research  
and Documentation  
7, Alba Gardens  
London, NW11 9NS  
England

### TWO DIE

(Continued from Page 1)

Van Vleck is known primarily for his contributions to the theory of magnetism. He was one of the first to explain the temperature dependence of the magnetic susceptibility of rare earth compounds. His book *The Theory of Electric and Magnetic Susceptibilities*, published in 1931 and reprinted many times, is a classic. In 1977 he was one of three co-recipients of the Nobel Prize in Physics. Van Vleck was often called the father of rare earth magnetism. To his successors he leaves a rich heritage.

RIC News  
(USPS 464-960)

Vol. XV No. 4 December 1, 1980

published  
March, June, September and  
December  
by  
Rare-Earth Information Center  
...

Second-Class postage  
paid at Ames, Iowa 50011  
...

Postmaster: send address changes to:  
RIC News, Rare-Earth Information Center,  
Energy and Mineral Resources Research  
Institute,  
Iowa State University, Ames, Iowa 50011

Telephone: Area Code 515-294-2272  
FTS...865-2272

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## HALF TIME

That's right! We are half way through Fiscal Year 1981. The statistics of the second quarter very nearly matched those of the first quarter in that thirteen companies contributed, bringing the total number to 27 for the year. Twelve companies renewed their support and one company joined our family of benefactors for the first time. All of the companies are listed below. The number in parentheses is the number of years the company has supported the Center.

Allied Chemical Corporation, U.S.A. (9)

Atomergic Chemetals, Inc., U.S.A. (9)  
A/T Products Corporation, U.S.A. (1)  
BBC Brown, Boveri & Company,  
Switzerland (9)

Cometals, Inc., U.S.A. (4)  
Davison Specialty Chemical Co.,  
Subsidiary of W. R. Grace & Co.,  
U.S.A. (13)

Th. Goldschmidt AG, Germany (12)  
Indian Rare Earths Ltd., India (12)  
MCI-Megon A.S., Norway (10)  
Rare Earth Products, Ltd., England (9)

Shin-Etsu Chemical Co., Ltd., Japan (11)

Treibacher Chemische Werke AG,  
Austria (9)

United States Radium Corporation,  
U.S.A. (11)

Special recognition is accorded to MCI-Megon A.S., as this year marks their tenth year as a benefactor of the Rare-Earth Information Center which qualifies them for the RIC Honor Roll. It is not an overstatement to say that the success of RIC is a direct result of this type of loyalty and support. To all of the rare earth industry and MCI-Megon in particular this year: Thank you!



## Top Inventor

W. A. Thornton, Jr. has been named Inventor of the Year for 1979 by the Association for the Advancement of Invention and Innovation. The association's committee, which



consists of scientists, engineers, patent attorneys, and businessmen, chose Thornton for his invention of prime color lamps and for formulating the theory that resulted in their development. Thornton is a research engineering consultant for Westinghouse Electric's Lamp Division. His lamp is based on the fact that the human eye responds better to three specific wavelengths which correspond to the colors blue-violet, green, and orange-red. Different mixtures of these colors approximate white light. Two of the three phosphors used in the prime color lamps contain rare earths.

*Editor's Note: Incidentally, the Rare-Earth Information Center has been part of a test by the Ames Laboratory on the effectiveness of the prime color lamps for the better part of a year now. Needless to say, we think they work great!*

## RE's IN THE NEWS

### Improved Coating

Using a less expensive cobalt-chromium-aluminum-yttrium alloy and a special plasma spray technique, researchers at General Electric have developed a new coating for gas turbine buckets. The useful life of the buckets is expected to triple when compared to the higher cost platinum-containing alloy currently being used.

### New Stainless Steel

Scientists at Sandvik, Inc. have developed a rare earth-containing stainless steel to replace 18-25 Cr-8-20 Ni type steels. The rare earth addition improves oxidation and carburization resistance up to 1150°C. The new steel is being applied in gas preheaters, heat exchangers, burners, and thermocouple protection tubes.

## Russian Acquisitions

New Russian books received by RIC include *Redkozemel'nye Poluprovodniki. Tekushchaya Bibliograficheskaya Informatsiya 10* [*Rare Earth Semiconductors. Current Bibliographic Information, No. 10*], V. P. Zhuze, ed., Fiziko-Tekhnicheskii Institut im. A. F. Ioffe, Akmiu Nauk SSSR, Leningrad (1979). Also we have received Nos. 11 (1979) and 12 (1980) which carry the same title, editor, and publisher as No. 10. The tenth bibliography has 551 citations while the eleventh has 542 and the twelfth 570. References are printed in their original language and a brief subject index is included in each volume. No. 12 also has an author index. Other volumes are: *Fazovye Diagrammy Elementov pri Vysokom Davlenii* [*Phase Diagrams of the Elements at High Pressure*], E. Yu. Tonkov, Nauka, Moscow (1979); *Splavy Redkikh i Tugoplavkikh Metallov c Osobymi Fizicheskimi Svoistvami* [*Alloys of Rare and Refractory Metals with Specific Physical Properties*] N. Kh. Abrikosov, ed., Izdatel'stvo Nauka, Moscow (1979); and *Tugoplavkie Soedineniya Redkozemel'nykh Metallov* [*Refractory Compounds of Rare Earth Metals*], K. E. Mironov, ed., Izdatel'stvo Nauka, Novosibirsk (1979).

## REers ON THE MOVE

J. B. Gruber has accepted the position of Vice President for Academic Affairs at Portland State University, Portland, Oregon. The appointment also carries the rank of Professor of Physics and Chemistry. Gruber leaves the position of Dean of the College of Science and Mathematics at North Dakota State University.

## LIGHT READING

With the publication of his book entitled *Fluorescent Lamp Phosphors, Technology and Theory*, K. H. Butler sheds a little enlightenment on man-made light. After a brief introduction to the history of lamp requirements and development, the topics covered are current research and development techniques, halophosphate optimization, specialized phosphors, lamp processing methods, lumin maintenance, optics of phosphor coatings, color and color rendition, phosphor and lamp efficiency, phosphors for high-pressure mercury vapor lamps, and applications for phosphors. The second half of the book deals with basic phosphor theory, theoretical background,  $\text{Sn}^{+2}$ ,  $\text{Pb}^{+2}$ , and  $\text{Sb}^{+2}$  activators,  $\text{Mn}^{+2}$  and  $\text{Mn}^{+4}$  activators, lanthanide and  $d^{10}$  activators, complex ion activators and energy transfer. The essential character tables and other tables for subgroups, allowed transitions, direct products with spin representations, and splitting of angular momentum representations are all brought together for the first time. Phosphors of specific interest to rare earths include rare earth activated phosphates, orthophosphates, borates, gallates, silicates, aluminates, aluminosilicates, and yttrium vanadate.

Published by the Pennsylvania State University Press in 1980, the book is 351 pages in length and costs \$39.50.

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## Caught in the Act

Since the mid 1970's, yttrium-stabilized, cubic zirconium oxide has been widely accepted as a diamond substitute. This is very easy to understand when one compares the index of refraction, dispersion and hardness of each. For yttrium-doped zirconia they are 2.15-2.18, 0.060-0.063, and 7.5-8.5 (the range of values corresponds to different compositions) while for diamonds they are 2.42, 0.044, and 10, respectively. These values are so close that it has become very difficult for even some of the experts to tell the difference if the stone is small and mounted in jewelry. Science and Ceres Electronics Corporation have come to the rescue according to P. Read [*Canadian Jeweller*, (November 1979)]. The Ceres diamond probe distinguishes real diamonds from the imitations by comparing the thermal conductivity of the gems. Cubic zirconia is a poor heat conductor and so it shows up obviously in the imitation column.

An interesting side note is that different rare earths add striking color when added to the yttrium-doped zirconia. Praseodymium imparts a yellow hue, erbium gives a pink color, and adding neodymium results in the color blue. Dysprosium, thulium, holmium, and gadolinium additions result in little or no color at all.

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Season's  
Greetings  
From R.I.C.

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