

RARE-EARTH INFORMATION CENTER NEWS



ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE
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No. 2

\$\$ NEW RECORD \$\$

As we said in the last issue, we needed a strong fourth quarter and we very definitely got it. You came through in record numbers, allowing us to come from behind and beat, with a total of 47 donors, not only the number of benefactors (45) of the past two fiscal years, but to also break the all time record of 46 sponsors. Four new family members were added, while we lost two old friends. Let's hope we continue to merit your support, add some new sponsors, and set another new record for fiscal year 1984. Our thanks and deepest appreciation goes to all 47 companies who supported us this year.

The seventeen companies, including one new family member, who sent in their donations this quarter are listed below. The number in parentheses denotes the number of years the company has given support.

- Allied Chemical Corporation, U.S.A. (11)
- Bose Corporation, U.S.A. (6)
- Cometals, Inc., U.S.A. (6)
- Denison Mines Limited, Canada (11)
- General Electric Company, U.S.A. (8)
- GTE Products Corporation, U.S.A. (11)
- Hitachi Magnetics Corporation, U.S.A. (9)
- Inland Motor Division, Kollmorgen Corporation, U.S.A. (7)
- Kolon Trading Company, Inc., U.S.A. (10)
- Middlewest Investment Company (5)
- Rare Earth Products Limited, England (11)
- Reactive Metals and Alloys Corporation, U.S.A. (7)
- Santoku Metal Industry Company, Limited, Japan (13)
- Sterling Manufacturing Company, U.S.A. (1)
- Trans-Tech, Inc., U.S.A. (2)
- V/O Techsnabexport, U.S.A. (6)
- Wako Bussan Company, Limited, Japan (14)

FRANK H. SPEDDING AWARD WINNERS



Sam Legvold



Wally Koehler

Two pioneers, Sam Legvold and Wallace C. Koehler, were named co-recipients of the 3rd Frank H. Spedding Award by The Rare Earth Research Conference for their studies of the magnetic properties of rare earth metals, alloys and compounds. They received this award during opening ceremonies of the 16th Conference, held April 18-23, 1983 in Tallahassee, Florida. Rhone-Poulenc was the sponsor for the award this year and has agreed to sponsor it the next five times the award is given. The award is presented to person(s) whose research and leadership in the rare earth field comes closest to the model set by Spedding during his career of 50 plus years. Dr. Spedding was on hand to offer the two winners his congratulations.

Professor Emeritus Dr. Sam Legvold, Ames Laboratory and Physics Department, Iowa State University, is a Fellow of the American Physical Society and a Distinguished Fellow of the Iowa Academy of Sciences. He was named a Distinguished Professor of Sciences and Humanities at Iowa State University in 1976. Dr. Legvold and his many co-workers used magnetic susceptibility, resistivity, thermoelectric power, thermal conductivity and magnetostriction to study the magnetic behavior of the rare

earth metals and alloys. In his plenary lecture he used some magic liquids, which of course were drinkable, to demonstrate the ferromagnetic-paramagnetic transition of gadolinium. Gadolinium, retrieved from one beaker with a bar magnet, quickly lets go and drops to the bottom when placed in the other beaker. The magic solutions are of course water below and above the Curie temperature (20°C) of gadolinium. Dr. Legvold has authored or co-authored over a hundred papers. He is now retired from teaching but not from his research. He is doing collaborative work on double ferromagnetism with Dr. T. Ito of Japan and on neutron diffrac-

(Continued on page 3)

GMELIN HANDBOOKS

The RIC library was the appreciative recipient recently of eight additional volumes of *Gmelin Handbooks*. We now have all 23 volumes that have been published on scandium, yttrium and the lanthanides (Gmelin's System 39). We will review these eight newly acquired volumes in this and succeeding issues of the *RIC News*.

The volume *Rare Earth Elements A3* (1980) treats the cosmochemistry of yttrium and the lanthanides and covers their occurrence in stellar spectra, the solar atmosphere, meteorites and tektites, and on the moon. Specific references, where these data can be found, are compiled and average abundances given for the solar system and the moon. Ranges of abundance and distribution patterns of these elements in individual meteorites and lunar samples are discussed. The theories on cosmochemical and geochemical evolution that have been developed to account for deviations and anomalies in the distribution patterns are reviewed. Abundances of the lanthanide isotopes and their ratios on the sun, in meteorites, and on the moon are listed. The ages of the meteorites and lunar samples, as determined from Nd and Sm isotope ratios, are included.

Rare Earth Elements A4 (1979) has two chapters. The first describes minerals in which the rare earth elements are an integral part of their chemical formulas while the second describes minerals, with a variable rare earth content, which do not have a rare earth as part of their chemical formulas. Tabulated in the first chapter are 127 minerals containing Y and/or lanthanides. Absolute compositions as well as relative compositions are listed. A general description of factors influencing the rare earth content and composition in minerals is followed by examples that demonstrate the rules relating various formation conditions and the resulting distributions of the rare earth elements in the minerals. The theory that relates rare earth distribution, in particular the partition coefficients, in coexisting minerals is reviewed and applied to the paragenesis of rare earth minerals with minerals of lower rare earth content.

(Continued on page 3)

MEETINGS

Academia De Ciencias Quimien Das Terras Raras

The 2nd Rare-Earth Chemistry Symposium will be held October 10-15, 1983 at the University of São Paulo, Brazil as part of the 8th Annual National Meeting of the São Paulo Academy of Science. The program will consist of plenary lectures and contributed papers in several fields of rare earth chemistry. Portuguese or English will be used for presentations. The deadline for abstract receipt is June 30 and for papers, October 15. For more information contact L. B. Zinner or G. Vicentini, University of São Paulo, C.P. 20780, 01498 São Paulo, SP, Brazil. (See separate news item for availability of first symposium.)

(page 4, column 3)

REACIM-84

Organized by the Austrian Physical Society, an EPS topical conference on *Electron Structure and Properties of Rare Earth and Actinide Intermetallics* (REACIM-84) will be held September 3-6, 1984 in St. Pölten near Vienna, Austria. The Conference will be held at the Wirtschaftsförderungsinstitut which will also provide accommodations. The proceedings will be published by *Physica B*. Deadlines are March 1, 1984 for abstracts and May 1, 1984 for papers. The scientific program will include papers on electronic structure, phase transitions, magnetic properties, magnetovolume effects, Mössbauer effect, ground state properties and crystal structure, anisotropy and coercivity, properties of R-3d permanent magnets, spectroscopy, transport properties, superconductivity vs. magnetism, mixed valency compounds, pnictides and chalcogenides, and other related topics dealing with intermetallics. Registration is SFr 200 (~U.S.\$100) for EPS members and SFr 250 (~U.S.\$120) for nonmembers. For more information contact Dr. G. Hilscher, Secretary of the REACIM 84, % Institute for Experimental Physics, Technical University Vienna,

HANS-GUNTER DOMAZER

RIC has received word of the death of H.-G. Domazer who died on January 31, 1983 at the age of 48. Domazer studied non-ferrous extractive metallurgy at the mining schools and institutes of technology in Freiberg, Saxonia, East Germany and in Clausthal, West Germany. He worked for DEGUSSA in Hanau and for Gebr. Böhler and Co. AG in Dueseldorf before going to work for Th. Goldschmidt AG of Essen, West Germany in 1972. He was responsible for research and development of rare earth-cobalt permanent magnet alloys and within two years had invented and established a calcium reduction process for their production. The scientific and technological community has lost an extraordinarily talented and skillful research metallurgist and engineer.

Karlsplatz 13, A-1040 Vienna, Austria. A copy of the first announcement is also available from the Rare-Earth Information Center.

Ac/Ln Separations

An International Symposium on Actinide/Lanthanide Separations will be held December 16-22, 1984 in Honolulu, Hawaii as part of the International Congress of Pacific Basin Societies. The symposium is being cosponsored by the American Chemical Society Divisions of Industrial and Engineering Chemistry and of Nuclear Chemistry and Technology. Papers will be presented covering all areas of actinides and lanthanides relating to: extractive metallurgy; recovery from solid and liquid wastes; separation and purification of individual elements; separation of lanthanides from actinides; reactor fuel reprocessing; and any new developments in separation science or technology. For details contact either James D. Navratil, Rockwell International, Rocky Flats Plant, P.O. Box 464, Golden, Colorado 80401 or Wallace W. Schulz, Rockwell Hanford Operations, P.O. Box 800, 2704S 200W, Richland, Washington 99352.

16th Rare Earth Research Conference

General Conference Chairman Gregory Choppin, the Program Committee chaired by John Greedan, the representatives of Florida State University, and everyone else involved in conducting the 16th RERC deserve a round of applause. Held in the Florida State University Conference Center, April 18-21, 1983, the conference carried on the tradition of combining stimulating technical sessions with a variety of social activities for relaxed interaction among the conferees. Of



Photo courtesy of G. J. McCarthy

course Mother Nature had to get in the act with some "liquid sunshine" and record low temperatures for the Tallahassee area. One outstanding characteristic of the conference was, as is usual, the cosmopolitan nature of the participants. Those attending gave 15 foreign countries and 30 states as their residences. Adding to the cosmopolitan flavor of the conference was the fact that of the 179 attendees, 41 were from industry, 40 from government laboratories or departments, and 98 from institutions of higher learning—a real cross section of people involved in the use and study of the rare earths.

About 200 papers were presented in both oral and poster sessions under the general topics of organo-



Photo courtesy of G. J. McCarthy

metallic, bioinorganic, inorganic, structural and solution chemistry; intermetallic, hydride, mixed-valency and metallic-glass compounds and alloys; surface, luminescence, fluorescence, surface, and crystal field spectroscopy; comparative chemistry and physics of the actinides and lanthanides; technology and applications; catalytic and magnetic properties; and co-existence of magnetic ordering and superconductivity. A copy of the program or program with abstracts can be obtained from the Rare-Earth Information Center.

The proceedings of the conference will be edited by G. J. McCarthy, J. J. Rhyne and H. E. Silber and published in a special issue of *The Journal of Less-Common Metals* by Elsevier Sequoia in a hard cover edition. Information on the availability of the proceedings will be announced in the *RIC News* as soon as this information becomes available.

It was a definite pleasure to have Dr. Frank H. Spedding and his wife at the conference. His presence added extra meaning to the awarding of the Frank H. Spedding award to co-winners Sam Legvold and Wallace Koehler.



Photo courtesy of J. M. Capellen

The 17th Rare Earth Research Conference will be held in August of 1985 at McMaster University, Hamilton, Ontario, Canada. Professor John E. Greedan is the General Conference Chairman and Dr. William T. Carnall will be the Program Chairman. Here's to a bigger and better 17th and we will see you all there, we hope. Further details will be printed in the *RIC News* as they become known.

Spedding Award

(Continued from page 1)

tion with co-winner, Dr. Koehler.

Dr. Koehler, Director of the National Center for Small-Angle Scattering Research, is also a Fellow of the American Physical Society. He was appointed a Corporate Research Fellow by the Union Carbide Corporation in 1979 in recognition of his long and fruitful 30-year association with the Oak Ridge National Laboratory. Dr. Koehler's area of expertise is neutron scattering. He participated in the early work on fundamentals of scattering from ferromagnetic materials, and he has since made significant contributions to the magnetic structures and properties of many elements and compounds. Among these were the rare earth elements as well as their alloys with each other or other elements and their nitrides, oxides, hydrides, etc. Dr. Koehler has authored or co-authored more than 150 publications and is still active in the National Center for Small-Angle Scattering. It seems very fitting that the two scientists most responsible for our understanding of the magnetic properties of the rare earths should be honored together and should now be collaborators and hopefully co-authors of many more papers.

PRODUCT NEWS

La-YIG Films

Allied Corporation, Morristown, New Jersey has developed single crystal La-YIG films on gadolinium gallium garnet (GGG) substrates. They currently offer the films on 2 inch substrates. La-YIG is used primarily in advanced magnetostatic signal processing technology.

Rare Earth Paints

ZYP Coating, Inc., Oak Ridge, Tennessee has announced the commercial availability of two new crucible/mold paints and a neutron absorbing paint. The two high temperature paints have been used for 10 years in the uranium industry to coat furnace components, crucibles and molds. Anticipated new usages are for melting and transport operations with pure metals, alloys, glasses or slags which may or may not be reactive. ZYP type "Y" and ZYP type "Z"

(Continued on page 6)

LETTER TO THE EDITOR

Dear Editor:

I read your last RIC with interest as usual. However, I am somewhat surprised by your technical comments on Date's facility. I am quite certain that the 70T coil does not operate with a 500 ms pulse length—the time must be about 500 μ s. They would need an increase in energy of 10^3 at least in addition to some new materials! At the time I visited in September they had not operated the 70T magnet. Do you know if they did actually operate it and for how many pulses?

Simon Foner, Chief Scientist
Head Research Division
Francis Bitter National Magnet
Laboratory
Massachusetts Institute of
Technology
Cambridge, Massachusetts 02139

Editor's Comment:

The time of 500 μ s is correct. The high field 70T magnet was put into operation between September and mid-November.

FERROMAGNETISM

Volume 3 of the four volume set, *Ferromagnetic Materials, A Handbook on the Properties of Magnetically Ordered Substances*, was published in 1982 by North-Holland Publishing Company, Amsterdam and New York. [For reviews of the previous two volumes see *RIC News*, XV, [3] 1 and [4] 2 (1980).] Volume 3, also edited by E. P. Wohlfarth, contains 852 pages and costs U.S.\$159.50 (Dfl. 375). The set is a comprehensive, well referenced review as well as a text book dealing with the physics, chemistry, metallurgy, structure and engineering aspects of the various materials.

In Chapter 1, U. Enz gives a historical perspective to the discovery and application of the magnetic properties of various classes of magnetic materials while H. Zijlstra, in Chapter 2, presents a treatise on the theory of permanent magnets. The remaining seven chapters deal with the magnetic properties of alloys, ferrites, and chalcogenide spinels. While these seven chapters do not contain an abundance of material on rare earths, they furnish a good base of data on which to build if rare earths were to be added to modify the properties of these magnetic substances.

Tale Of Two Eras

The West Chicago factory, where Kerr-McGee Chemical Corporation produced thorium and rare earth products for 40 years, is to be dismantled and the site restored and landscaped. One of the consultants for the Chicago project is Dr. Howard E. Kremers, who retired from Kerr-McGee, at Oklahoma City, at the end of September 1982. He stated in a letter, "This is where I started my professional career, and it is rather satisfying to be able to help in putting the old rare earth operation to bed."

According to a brochure prepared by Kerr-McKee, the restoration requires the dismantling of the 20 deteriorated structures, elimination of five settling ponds, and disposition of 5×10^6 cubic feet of waste material. The contaminated building rubble and process waste must be contained and enclosed on a landscaped and fenced portion of the site. This must all be done in strict compliance with rules and regulations established by the Nuclear Regulatory Commission for handling low-level radioactive material to ensure public environmental health and safety.

The restoration project will require more than five years to complete, after approval of the plan by the NRC. For an interesting 16 page brochure describing the site, the required operation, the proposed disposal cell, and the final disposition of the entire plant site, contact:

Dr. Howard E. Kremers,
Consultant
Kerr-McGee Chemical
Corporation
Building 5, Unit 36
245 Roosevelt Road
West Chicago, IL 60185

Service Charges

(Continued from page 5)

tempted to keep the service charges as low as possible and to waive charges when imposing them would constitute a hardship.

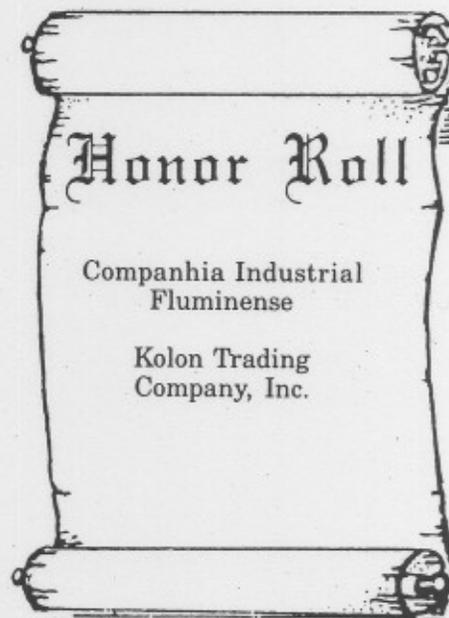
We have also instituted a charge for photocopying. Any publication that cannot be acquired by other means can be obtained from the Center. The charge is 25 cents per page for the first 10 pages (minimum \$2.00), 15 cents per page for the next 10 pages, and 10 cents for each page

Quimica Das Terras Raras

The proceedings of a special symposium entitled "Rare-Earth Chemistry," held in conjunction with the 6th Annual Convention of the São Paulo Academy of Science, is available from Academie de Ciencias do Estado de São Paulo, Caixa Postal 22.297, 01498 São Paulo, Brazil. The 316 page, soft-cover book costs U.S.\$10.00 and, except for the plenary lecture, "Some Spectroscopic Aspects of the Lanthanides" by Shyama P. Sinha, is written in Portuguese. Also included are the two plenary lectures and nine submitted communications that deal with research, application and production of rare earths in Brazil. The proceedings were edited by G. Vicentini and L. B. Zinner.

** THANKS **

Two companies joined our select list of 22 companies who have supported the Center for at least ten years. Our most sincere thanks to all on the list. The companies earning star billing and a place on the honor roll this year are:



thereafter. The charge is figured separately for each document photocopied. These charges do not apply, within reason, to services provided to our sponsors.

RIC To Increase Service Charges

Because of inflation over the past nine years (197%), the Rare-Earth Information Center (RIC) will be increasing the charges for services provided for our patrons who are not associated with one of our much appreciated sponsors. Beginning July 1, 1983, which is the start of our fiscal year, our minimum charge will be increased from \$25.00 to \$50.00. Additional charges for work above and beyond the minimum will be increased proportionately.

There are some exceptions to imposing the service charge: (1) No charges will be assessed to those companies that contribute to the support of RIC—at least up to the amount of their contribution. (2) Charges will be waived for those who certify they do not have resources available to pay for the service, e.g. students. (3) No charges will be made for (a) routine requests, such as information about a rare earth conference, (b) requests for information about the availability of commercial rare earth products, or (c) requests for additional information on articles or material presented in the *RIC News*.

We believe that one of our important functions is to make information available to anyone who needs it. It is for this reason that we have at-

(Continued on page 4)

McLean Twice Honored

Dr. Alexander McLean has been elected to the grade of Distinguished Member of the Iron and Steel Society, the highest honor awarded by the Society. The rank of Distinguished Member is conferred upon members of the Society who have made significant, long-term contributions to the iron and steel industry and/or to the Society.



Also, in 1982, Dr. McLean was one of the first two scientists ever awarded the title of AISI Distinguished Professor by the American Iron and Steel Institute. He has been with the Department of Metallurgical and Materials Science, University of Toronto, Canada since 1970. He was educated in Scotland (University of Glasgow) and previously worked in an industrial research laboratory as supervisor of the deoxidation and casting group. He has authored several papers on the use of rare earths in steel, among them the Iron and Steel Society publication entitled *Iron and Steel Desulfurization*.

f-Electron Magnetism

The Proceedings of the Fourth International Conference on Crystalline Electric Field and Structural Effects in *f*-Electron Systems, held September 22-25, 1981 in Wroclaw, Poland have been published in a hard bound volume by Plenum Press, New York. Published in 1982 and entitled *Crystalline Electric Field Effects in f-Electron Magnetism*, the book contains 21 invited and 43 other papers, has 586 pages, costs U.S.\$72.50, and was edited by R. P. Guertin, W. Suski and Z. Zolnierek. The conference was organized to commemorate the 75th birthday of Professor Włodzimierz Trzebiatowski, one of the pioneers in the field of *f*-electron materials. (The Rare-Earth Information Center has learned that Professor Trzebiatowski was killed in an automobile accident on November 13, 1982. For obituary see *Physics Today*, p. 82, May 1983.)

The conference consisted of sessions devoted to the investigation of crystalline electric fields and structural effects by spectroscopic techniques, neutron diffraction, and magnetic, thermodynamic and electrical measurements. The studies cover a broad range of temperatures, pressures and magnetic fields. Materials covered include rare earth intermetallics, hydrides, diluted systems and actinides. Experimental results, as well as theory, are presented. A materials index, as well as the usual subject index, and a list of attendees and their addresses are included.

Seven of the papers are on uranium compounds; the other 57 deal with the rare earths. The rare earth papers were divided into seven sections entitled (1) Singlet Ground State; (2) Resonance Spectroscopy, Neutron Scattering; (3) Theory; (4) Lattice Effects; (5) Tetragonal Materials; (6) Cerium Compounds; and (7) Rare Earth Metallic and Semi-Metallic Compounds.

Economist, Inorganic and Specialty Chemicals Department, Chemical Business Center, SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025. The Rare-Earth Information Center would appreciate it if anyone contacting them mentions that they obtained this information from the *RIC News*.

Chemical Economics Handbook

A Chemical Economics Handbook (CEH) on the rare earths has been prepared by F. Alan Ferguson of SRI International. CEH Market Research Reports are comprehensive studies prepared from information in the CEH Data Center and from extensive personal interviews with sources in the chemical industry under study. A distinctive feature of the reports is the analysis of future supply/demand relationships. The reports are prepared primarily for clients to SRI's Chemical Economics Handbook Program.

The CEH report on rare earths is 103 pages long and the price for this report is U.S. \$2,000. The address for more information on this report, or on other reports in the series, is F. Alan Ferguson, Senior Industrial

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K. A. Gschneider, Jr. . . . Editor
Jennings Capellen . . . Staff Writer

Gmelin Handbooks

(Continued from page 2)

The second chapter, which deals with minerals not containing rare earths in their formulas, begins with an explanation of how rare earth elements may enter foreign minerals. The diadochy (atomic substitution) of the lanthanides with yttrium and other elements and the diadochy of the lanthanides with each other are presented. As a result of the volume of literature only data on minerals with a rare earth content of more than one percent are given unless there is an important relationship between the content and the genesis of the mineral. Experiments on the partition of rare earths between solid and molten silicates complete the chapter.

The prices of volumes A3 (178 pages) and A4 (242 pages) are DM 421 (~U.S.\$200) and DM 551 (~U.S.\$260), respectively. Information about the *Gmelin Handbooks* and addresses of their dealers may be obtained from Springer-Verlag, 4005-Marketing Gmelin, Heidelberger Platz 3, D-1000 Berlin 33, West Germany.

Product News

(Continued from page 3)

paints are aqueous suspensions of yttrium oxide and zirconium oxide, respectively. They have an expected upper use limit of 2000°C on a non-reactive metal or ceramic substrate, about 1500°C on graphite.

ZYP type "G" paint is a suspension of gadolinium oxide in ethanol/di-glyme ether. Designed for room temperature use, it can be applied in several coats to get almost any thickness desired. The large neutron capture cross-section of Gd_2O_3 (about 90,000 barns) makes this paint, according to the manufacturer, one of the best means of providing neutron shielding for detection equipment and facilities.

Ceramic Oxide Fabricators

Ceramic Oxide Fabricators of Eaglehawk, Australia has developed a solid electrolyte oxygen sensor they call the SIRO₂. Based on a doped, high-purity zirconia sensor it can be used to measure, monitor, and/or control oxygen in gas mixtures and molten metals from 1000 to 2000 K. Several have been used by geological laboratories to determine the fugacity of both moon and earth rocks.

RE's In The News

High Efficiency Laser

The Russians, according to an article in *Kvant. Elektron.* 9, 2533 (Dec. 1982), have investigated a laser with over three and one-half times the efficiency of an equivalent Nd: YAG laser rod. The new crystal is a $Cr^{3+} - Nd^{3+}$ doped gadolinium-scandium-gallium garnet.

New Laser Record

The Japanese have, according to a news item in the *Mainichi Daily News* of November 18, 1982, set a new output record for a YAG laser. Developed by Nippon Electric Company, for the Agency of Industrial Science and Technology, the laser attained a maximum continuous output of 340 watts and an efficiency of 3.6 percent. The previous record was 300 watts and 2.3 percent, respectively.

That's Cold!

The Japanese have reached a new low (temperature, that is). Using a nuclear demagnetization refrigerator they succeeded in lowering the temperature of their sample chamber to 27 millionths of a degree above absolute zero (27 μ K). The record was achieved by a team of physicists at Tokyo University led by Professor Kazuo Ono. The previous record was 38 μ K obtained by the Jülich Nuclear Research Institute in West Germany. Both laboratories are using the intermetallic compound $PrNi_5$, as their first stage nuclear refrigerant and in both cases the $PrNi_5$ was prepared by the Materials Preparation Center of the DOE Ames Laboratory, Iowa State University, Ames, Iowa.

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RE HANDBOOK

What started as a four volume set has now become an open ended series to ensure, as the publisher put it, an evolving authoritative and comprehensive *Handbook on the Physics and Chemistry of Rare Earths*. Edited by K. A. Gschneidner, Jr. and L. Eyring, Volume 5, the first supplemental issue, was published by North-Holland Publishing Co., Amsterdam in 1982, contains 701 pages, and costs U.S.\$149.00 (Dfl. 350). Subscription price is U.S.\$127.75 (Dfl. 300). All five volumes are available from North-Holland Publishing Company, P.O. Box 211, 1000 AE Amsterdam, The Netherlands or from Elsevier Science Publishing Co., Inc., 52 Vanderbilt Ave., New York, NY 10017. Continuation orders for the series are being accepted. Chapters in Volume 5 and their author(s) are listed below:

- "Rare earth alloys and compounds as thin films" M. Gasgnier.
- "Transport properties (electrical resistivity, thermoelectric power and thermal conductivity) of rare earth intermetallic compounds" E. Gratz and M. J. Zuckermann.
- "Adsorption and catalysis on rare earth surfaces" F. P. Netzer and E. Bertel.
- "Defects and phase transformation near room temperature in rare earth sesquioxides" C. Boulesteix.
- "Rare earth fluorides" O. Greis and J. M. Haschke.
- "Spectroscopic properties of triply ionized lanthanides in transparent host crystals" C. A. Morrison and R. P. Leavitt.