RARE-EARTH INFORMATION CENTER NEWS

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Materials Research Laboratory–

Rare Earth Research at Penn State

PENN STATE GROUP–In the back row from left are P. Provenzano, J. Blanks, E. Imperato, T. Besmann and Dr. L. Drafall. In the center row from left are Dr. K. E. Spear, D. Petsinger, Dr. W. B. White, Dr. G. J. McCarthy and N. Price. Kneeling in front from left to right are R. Johnston, S. Boldish, M. Davidson, T. Choy and C. Sipe.

Rare earth research at Pennsylvania State University's Materials Research Laboratory spans two decades. Early work, initiated by Prof. Rustum Roy, director of the Materials Research Laboratory, was concerned with crystal chemistry, phase relations and defects in oxide and halide systems. Current research is focused on rare earth oxides, borides and sulfides.

Dr. G. J. McCarthy directs a variety of projects on rare earth oxides. R-M-O systems are being studied for phase relations (M=Mo, W, Nb), applications to catalysis (M=Mn, Co), and systematic crystal chemistry and x-ray powder diffraction standards (M=1st row transition metals). He is collaborating with Prof. J. E. Greedan of McMaster University on synthesis, stability and magnetic properties of ternary and quaternary oxides containing Eu^{2+}. Another project is concerned with fixation of commercial power reactor radioactive wastes of which the rare earths are the most abundant cationic species. Group members include graduate students R. Johnston and T. Choy, and technical assistants M. Davidson, N. Price and C. Sipe.

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Scandium Handbook

A dramatic increase in the literature dealing with scandium and its differences in behavior and crystallochemical properties as compared with the rare earths are given as reasons for the compilation of *GMELINS Handbook of Inorganic Chemistry, System No. 39 Rare Earth Elements, Part A2, Scandium,* I. Kubach, W. Muller, eds. (GMELIN–Institute for Inorganic Chemistry, Max Planck Society for the Advancement of Science, Weinheim, Germany, 1973) 181 pp. The price is DM 254 (~ $94).

The handbook begins with a brief history. Scandium's abundance in stars, meteorites, and lunar rocks is covered in cosmochemistry. The geochemistry of scandium deals with its crystallochemistry and abundance in the earth, water and atmosphere. The scandium-bearing minerals are extensively reviewed and finally the recovery of scandium, location of mineral deposits, possible applications, and the costs involved are discussed.

The handbook, published in German, features both German and English tables of contents and English headings and subheadings in the margins.

RARE EARTH INDUSTRIES PROMOTES LEON LUYCKX

Leon Luyckx has been named manager of product and market development for Rare Earth Industries, Inc., West Pittsburg, Pa. Just prior to his appointment, Luyckx had been a metallurgical consultant to the firm.

Iowa State Honors Pioneer Rare Earther


F. H. Spedding

Iowa State University on May 6, 1974, honored one of its most distinguished scientists when in formal ceremonies it renamed one of the major Ames Laboratory buildings the Frank H. Spedding Hall. Spedding is the founder of Iowa State's Energy and Mineral Resources Research Institute and the Atomic Energy Commission's Ames Laboratory which is located on the ISU campus. Now professor emeritus, Spedding directed a World War II project at Iowa State which resulted in the production of more than 2 million pounds of uranium metal. He has won acclaim for his work on the chemistry and metallurgy of the rare earths which spans four decades.

RIC SUMMARY

The Center's activities were summarized at a recent U.S. Government sponsored meeting on Materials Information and Data Centers. A limited number of copies of the summary were produced and they are available free to *RIC News* subscribers while the supply lasts. Included is a list of all the Center's industrial contributors since 1968.

New Plant for Ronson

Ronson Metals Corp. has announced the start-up of its new mischmetal production plant at Newark, N.J. Vice President I. S. Hirschhorn says the added capacity of the new plant gives Ronson the largest capacity for mischmetal production in the United States. Incorporated in the new facility are electrolytic cells of the most modern design coupled with the latest material handling and ingot casting equipment.

RIC-DD Airmail Rate Change

Due to recent changes in postage rates, RIC has revised the airmail rate schedule for RIC-DD documents. The new schedule is as follows:

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Rate	A	B	C
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RIC-DD documents are priced to include the cost of first-class surface mail. Documents will be sent by airmail upon payment of the appropriate airmail schedule for each document in addition to its stated price.

The five additional documents listed below have been placed in the RIC Document Depository.

RIC-DD-8 State Functions for Many-Electron Atoms. Eigenfunctions of L^2 and S^2 for One- and Two-Open Shell Configurations by J. Karwowski and S. Fraga (1974) 71 pp. (U.S. $7.10)[Airmail Rate B]

RIC-DD-9 State Functions for Many-Electron Atoms. Eigenfunctions of J^2 and S^2 for p^N, d^N, and f^N Configurations, by J. Karwowski and S. Fraga (1974) 69 pp. (U.S. $6.90)[Airmail Rate B]

RIC-DD-10 State Functions for Many-Electron Atoms. Eigenfunctions of J^2 and S^2 for f^6 Configurations, by J. Karwowski and S. Fraga (1974) 92 pp. (U.S. $9.20)[Airmail Rate B]

RIC-DD-11 State Functions for Many-Electron Atoms. Eigenfunctions of J^2 and S^2 for f^7 Configurations, by J. Karwowski and S. Fraga (1974) 114 pp. (U.S. $11.40)[Airmail Rate C]

RIC-DD-12 Matrix Elements for Many-Electron Atoms. Spin-Orbit Interaction for One-Open Shell Configurations, by J. Karwowski and S. Fraga (1974) 107 pp. (U.S. $10.70)[Airmail Rate C]

THERMODYNAMIC BOOK

Termokhimiya Soedinenii Redkozemel'nykh i Aktinoidnykh Elementov (Thermochemistry of Compounds of Rare Earth and Actinide Elements) by G. A. Krestov (Atomizdat, Moscow, 1972) 253 pp., has been translated into English by the U.S. Joint Publications Research Service (AEC-tr-7505) and is available for $7.60 from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151.

The book emphasizes oxides, halides and aqueous solutions. In

(Continued on Page 3)

New Magnet Alloy

J. P. Heinrich, H. Garrett and R. P. Allen report a breakthrough in the synthesis of the first 2:17 alloy to exhibit useful permanent magnet properties, *J. Appl. Phys.* 45, 1873-4 (1974). It had been demonstrated earlier that $Sm_2(Co, Fe)_{17}$ alloys had potential permanent-magnet properties which were even better than those of $SmCo_5$. The difficulty involved in achieving that potential was that most 2:17 alloys prepared previously had low coercive forces. A method of preparing $Sm_2(Co_{0.7}Fe_{0.3})_{17}$ is described which results in values of 5600 Oe for $_mH_c$ and 12 MG Oe for $(BH)_{max}$. The authors believe that even though there is still a large gap between the theoretical and actual properties obtained, their alloy already competes favorably with several existing commercial permanent magnet materials in that it has a higher energy product and lower production cost.

MORE CAPTURED

More of the shifty Lanthanide gang have been captured in print by A. F. Cockerill, G. L. O. Davies, R. C. Hardin and D. M. Rackham in "Lanthanide Shift Reagents for Nuclear Magnetic Resonance Spectroscopy", *Chemical Reviews* 73, 553-88 (1973).

This review covers theory, experimental procedures, data evaluation, application of lanthanide shift reagents (LSR) to mono- and polyfunctional molecules, their limitations, and recommended procedures for the use of LSR.

Reprints are not available from the authors but can be purchased from the Journals Department, American Chemical Society, 1155 16th Street N.W., Washington, D.C. 20036. Price $4.00 each; send cash or check with order.

ERRATA

IS-RIC-6, Thermochemistry of the Rare Earths:

On page 26 the value for $-\Delta G_f^\circ$ for Praseodymium Sesquioxide (Pr_2O_3) at 1600°K which reads 331.076 SHOULD READ 326

RE in Cloud Nine

Recent research directed by S. Drapatz has finally put a rare earth in "Cloud Nine" as evidenced by a paper entitled "Experiments with Europium-Vapour Clouds in the Upper Atmosphere" presented at the 16th Plenary Meeting and Specialized Symposia of the Committee on Space Research, May 23-June 6, 1973 at Constance, W. Germany, *Space Research* XIV (Academie Verlag, Berlin, 1974) pp. 233-40.

The purpose of the study was to determine the feasibility of using europium-vapor clouds to measure the magnitude and direction of electric fields in the upper atmosphere. Eu is theoretically applicable because of its low ionization potential, low evaporation temperature, short photoionization time scale, resonance lines of both atom and ion in the visible spectral range, and low abundance in the solar photosphere.

An artificial cloud is made by detonating an explosive charge in the upper atmosphere. Europium in the charge lining is vaporized, some in the ground state and some in an ionized state. The original cloud is soon divided into two clouds as the neutral cloud drifts along with the wind while the charged (ionized) cloud aligns itself with the electric fields.

Fluorescence spectra obtained in these studies have illuminated various atomic and molecular properties of europium, some of which could not be detected in laboratory situations. These observations include transition probabilities, photoionization cross sections, comparison of chemical reactivity of atoms in the ground and excited states, and the lifetimes, radiative transitions and oxidation processes of metastable states.

Thermodynamic Book

(Continued from Page 2)

addition to experimental data the author presents methods of estimating thermodynamic properties from interionic distances and crystal chemical radii.

Get the Lead Out

Rare earths may soon be taking the hard knocks – in gasoline, that is. The U.S. Environmental Protection Agency's imperative to "get the lead out" (of gasoline) has prompted researchers to investigate lanthanide anti-knock compounds, according to a report in *Chem. & Eng. News* 52, 27-8 (Mar. 25, 1974). A group led by Dr. R. E. Sievers demonstrated encouraging results in simulated tests using supercharged and conventional engines. Data from road tests being conducted are not yet available, but preliminary indications are favorable.

Cerium compounds – particularly cerium (2, 2, 6, 6- tetramethyl -3, 5-heptane-dionate)$_4$ or Ce (thd)$_4$ – appear to be the most promising. The cerium chelate not only raises the octane rating of the fuel, but the CeO_2 combustion product may also serve to reduce smog-forming hydrocarbon emissions by catalysis. Further enhancement of the already favorable cost picture of these compounds is likely through the substitution of mischmetal for pure cerium.

CONTRIBUTORS

Contributions received from six more rare earth firms during the last three months bring the total number of Center supporters to 37 for FY 1974. Additional financial support came from:

British Flint and Cerium Manufacturers, United Kingdom (2),*

Companhia Industrial Fluminense, Brazil (2),

Hitachi Magnetics Corp., (formerly General Electric Co., Magnetic Materials Product Section), U.S.A. (2),

Lim Fong Seng Sdn. Bhd., Malaysia (3),

Shinetsu Chemical Industry Co., Ltd., Japan (5), and

Westinghouse Electric Corp., U.S.A. (2).

*Indicates years in support of RIC including present fiscal year.

It's Pm Time

Promethium, the mercurial recluse of the 4*f* family which until 1945 eluded scientific sleuths, has at last emerged from its obscure shadows. Researchers, primarily at Hanford and Battelle-Northwest Laboratories, though hampered as recently as 1965 by inadequate supplies of the relatively short-lived radioactive material, have uncovered a substantial portion of the element's characteristic habits. Because many of these results have not been published or are available only in U.S. Atomic Energy Commission documents, E. J. Wheelwright has published a comprehensive review, *Promethium Technology* (American Nuclear Society, Hinsdale, Il., 1973) 395 pp., $20.25 for ANS members, $22.50 for non-members.

Scientists and engineers will find extensive information on a range of subjects including historical perspectives, recovery techniques, and purification schemes. Six of the 15 chapters are devoted to promethium's unique radiochemical properties and their biological implications. Analytical chemistry, preparation and properties of the sesquioxide and the metal, and a review of current applications complete the discussion. The brief outline and summary preceding each chapter is especially helpful as well as the author index which indicates both those cited in the text and those included in the list of references after each chapter.

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RE Proceedings

The proceedings of the Seventh Russian Conference on Rare Earth Metals, Moscow, Sept. 12-17, 1972, E. M. Savitskii, ed., has been published as *Rare Earth Metals, Alloys and Compounds [Redkozemelnye Metally Splavy i Soedineniya]* (Izdatel'stvo Nauk, Moscow, 1973) 355 pp. The cost is 1R, 81K (approximately $2.00 U.S.)

The total of 86 papers, written in Russian (67), English (14) or French (5), cover general properties, magnetic materials, alloys, refractory compounds and miscellaneous applications. RIC will provide free a copy of the table of contents in English (except for the papers published in French). The proceedings may be purchased through a commercial firm dealing with Russian publications.

LETTER

To the Editor:

With reference to the news item "Explain Enigma" which appeared on page 2 of the March 1974 *RIC News* we wish to point out that the anomalous *behaviour* of the Knight shift in $SmSn_3$ and $SmAl_2$ arises due to the admixture of excited (J=7/2) state into ground (J=5/2) state of Sm^{3+} by crystal fields as shown by Malik and Vijayaraghavan [*J. Phys. (Paris)* 32, Cl-1028 (1971) and *Phys. Letters* 34A, 67 (1971)]. The inclusion of sixth degree terms in the crystal potential is only necessary for fitting the experimental results and does not change the features first shown by us. To date the only noncubic Sm compound in which Knight shift behaviour has been found to be anomalous is SmF_3 [Malik, Vijayaraghavan and Bernier, *J. Mag. Resonance* 8, 161 (1972)] and this has also been explained on the basis of mixing of levels by crystal fields of lower symmetry.

Yours sincerely,

R. Vijayaraghavan

Rare Earth Research at Penn State

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Phase equilibria, crystal chemistry, property correlations, and chemical vapor deposition synthesis studies on rare earth-boride systems are being conducted by the research group directed by K. E. Spear. A major goal of this program is to help develop an understanding of the chemical bonding and properties of these borides through empirical correlations of carefully measured properties, and to relate these observations to the fundamental properties of the elements. An extensive review and analysis of R-B systems has been carried out and is to be published as a book chapter.

Experimental research is directed toward filling in the gaps in phase equilibria and related synthesis data for R-B systems. Three graduate students are conducting their Ph.D. research on projects within this program. T. M. Besmann is studying the chemical vapor deposition of metal borides, an extremely complex kinetic and thermodynamic problem. E. G. Imperato is completing a detailed phase equilibria study of the Er-B system, which includes examining the homogeneity ranges and defect structures of the phases. J. H. Blanks has begun his research on a phase equilibria study of the Gd-B system. Other recently accomplished research includes phase equilibria studies of the Sm-B and Dy-B systems and studies of the fascinating RB_{66} phases. D. W. Petsinger, an undergraduate technician, assists in all of the experimental studies.

Prof. W. B. White heads up research in rare earth-containing chalcogenides including the synthesis and crystal growth of compounds suitable for use in high power laser windows, and infrared and Raman spectra of these compounds. He also has worked on the luminescence of rare earth-activated phosphors in a number of studies over the last ten years. His group consists of Dr. L. Drafall, who is completing a post doctoral project on ternary sulfides, and doctoral candidates P. L. Provenzano and S. I. Boldish.

MEETING

PERMANENT MAGNET WORKSHOP

A workshop on Rare Earth-Cobalt Permanent Magnets will be held Oct. 13-16, 1974, at the University of Dayton. The meeting was set for the week after the 11th Rare Earth Research Conference (Oct. 7-10, 1974) to make it convenient for foreign visitors to attend both.

Topics to be covered, in addition to the Introduction and Preview, are Raw Materials, Magnet Alloys, Magnet Manufacture, Special Topics in Magnet Production, Magnet Properties and Magnetic Processing, and Device Applications. A "satellite" symposium on the general topic Magnetic Crystal Anisotropy and Coercivity of Rare Earth-Transition Metal Intermetallics will be held the day following the close of the formal workshop.

Prospective conferees may obtain additional information from Prof. K. J. Strnat, Magnetics Laboratory, KL-365, School of Engineering, University of Dayton, 300 College Park, Dayton, Ohio 45469, U.S.A.

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