RARE-EARTH INFORMATION CENTER NEWS

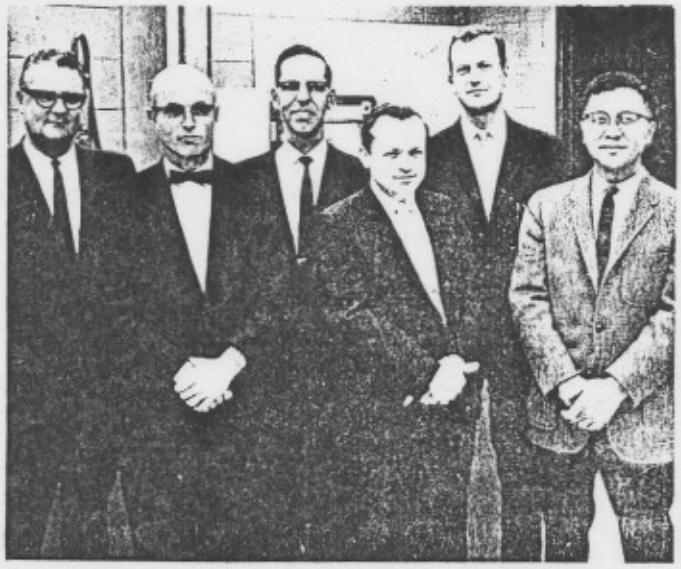
SUPPORTED BY INSTITUTE FOR ATOMIC RESEARCH
IOWA STATE UNIVERSITY / AMES, IOWA

Volume III | December 1, 1968 | No. 4

Metallurgy Division –

University of Denver Research Institute

The study of rare earths in the Metallurgy Division of the University of Denver's Research Institute has been an active and continuing program for the past 13 years. The program was activated by and has been under the general direction of Charles E. Lundin, Manager, Metal Studies. During this time the nature of the program has been varied. Both applied and basic studies have been carried out with the respective objectives being to develop commercial alloys and to further the basic understanding of the rare-earth metals and alloys.



Pictured from left are Charles B. Magee, Richard W. Sullivan, Charles E. Lundin, Gavin R. Mallett, Philip J. Spencer and Albert S. Yamamoto.

Phase equilibria and how it relates to alloying behavior and properties of the rare earths and their alloys has been the focus of the studies during these years. This previous work is as follows:

1. The determination of yttrium-base binary phase diagrams with Ti, Zr, Hf, V, Pb, Ta, Cr, Mo, W, Si, Al, Re, Ce, Be, O and N.

2. A study of the pressure-temperature-composition relationships in the Y-, Ce-, Er-, and Ho-H, Er-D and Er-H-D systems, and the calculation of the thermodynamic properties of these systems.

3. The scavenging of interstitials in Cr, Mo, and W by rare earth-metal additions to enhance ductility.

4. The effect of rare-earth additions on OFHC (oxygen free high conductivity) copper in an attempt to simultaneously increase electrical conductivity and dispersion harden the copper.

5. A study of the thermodynamic properties and alloying behavior of intra-rare-earth binary alloy systems.

6. A structural study of the samarium structure in binary rare-earth systems by alloying a light rare earth with a heavy rare earth.

7. A determination of the heats of solution of La, Pr, Nd, and Sm in liquid Sn and the heats of mixing of Pr-Nd alloys by drop calorimetry.

8. A study of the rate of perme-

(Continued on Page 2)

7th Rare Earth Conference

The 7th Rare-Earth Research Conference was a great success with over 200 persons attending the 12 half-day sessions. About 75 current research reports were presented at the conference in addition to 8 invited papers. (A list of the invited speakers and their papers were listed in the September 1 issue of *RIC News*, Vol. III, No. 3, p. 2.)

The papers dealt with a multitude of subjects including geochemistry; separation chemistry; metal preparation; inorganic chemistry; structural and crystal chemistry; spectral, luminescent and fluorescent properties; magnetic behaviors; solid state physics; and industrial processes and applications.

The highlight of the conference was the stimulating keynote address by Professor B. T. Matthias who spoke on "Melting and Magnetism of the Rare Earths." Many other interesting papers were also presented, but because of space limitations it is not possible to list them here.

Unfortunately, two of the invited speakers, Professors F. H. Laves and G. Brauer, were unable to attend because of illness. We all wish them a speedy recovery.

The 8th and 9th Rare-Earth Research Conferences are scheduled to be held in Reno, Nevada (Spring, 1970) and in Virginia (Fall, 1971), respectively. Tom Henrie, U. S. Bureau of Mines, is the 8th Conference Chairman and Alan Clifford, Virginia Polytechnic Institute, is the chairman for the 9th.

Tuesday, October 29 was kept

(Continued on Page 3)

MEETING

SET ABSTRACT DEADLINE FOR FRENCH RE CONFERENCE

The organization committee of the International Colloquium on Rare-Earth Elements has issued a call for abstracts from those who wish to have papers considered for presentation at the colloquium. The colloquium, sponsored by the French National Center for Scientific Research, will be held in Paris and Grenoble, France from May 5-10, 1969.

Abstracts must include the title, authors' names and affiliation, and must not exceed two typewritten pages. *The deadline for submitting abstracts is January 15, 1969.*

Abstracts of papers dealing with chemistry, crystallography and metallurgy should be submitted to P. E. Caro, Laboratoire des Terres Rares du C.N.R.S., 1, place Aristide-Briand, 92 Bellevue, France. For papers dealing with solid state physics and magnetism, abstracts should be sent to E. F. Bertaut and R. Pauthenet, Laboratoire d'Electrostatique et de Physique du Métal du C.N.R.S., B.P. 319, 38 Grenoble, France.

(Continued from Page 1)

ation and diffusion of hydrogen through erbium.

9. The determination of the work function of erbium and various Er-H alloys.

Currently, investigations involving rare-earth systems are continuing in several areas. As in the past, the emphasis is on the nature of rare-earth metal hydrides. A complete structural investigation by x-ray diffraction analysis is being conducted on Sc and Er hydrides, deuterides, and tritides. Samples of both bulk and evaporated thin films are being employed.

In conjunction with these studies, the effect of tritium decay to He^3 and its strain in the lattice of tritided Er and Sc as a function of time are being determined. Finally, the phase diagrams of the Sc-O and Sc-N systems are being delineated.

Nuclear-Electronic Interactions

A book which may be beneficial to many rare-earthers especially those working in the nuclear physics, and solid state physics and chemistry areas is *Hyperfine Interactions* edited by A. J. Freeman and R. B. Frankel, Academic Press, New York, 758 pp., $16.00. Hyperfine interactions deal with the influence of an electronic quantity on a nuclear quantity and thus in effect the nucleus serves as a microscopic tool for examining the interior of the solid.

The first 13 chapters in this book (more than 80% of the text) were written in a textbook style by eminent scientists in the various fields. The remaining 12 chapters were written by specialists and are more of a research and tutorial nature.

Of the 13 primary chapters the following should be of special interest to our readers: "Hyperfine Structure and Electron Paramagnetic Resonance" by Bleaney; "Hartree-Fock Theory" by Watson and Freeman; "Atomic Beam Resonance" by Sanders and Dodsworth; "Optical Hyperfine Measurements" by Steudel; "Special Topics in Electron Paramagnetic Resonance" by Geschwind; "Nuclear Magnetic Resonance" by Narath; "Conduction Electron Effects" by Watson; "Nuclear Specific Heats" by Lounasmaa; "Recoilless Absorption of γ-Rays" by Mössbauer and Clauser; and "Angular Correlations" by Cohen.

Of the 12 secondary chapters, those by Murnick, Walker, Lubbers, Budnick and Skalski, and Shaltiel contain information on the rare-earth metals, alloys and compounds.

NEW BOOKS

RE REFERENCE

For those who want both an attractive and convenient reference to the rare-earth oxides, metals and their applications (including yttrium), a new booklet issued by Michigan Chemical Corp. should be useful. The booklet also contains physical descriptions of rare-earth oxides and metals.

Copies are available free from Michigan Chemical Corp., Rare Earths Div., 2 North Riverside Plaza, Chicago, Ill. 60606.

Cerium Pneumoconiosis

A recent book by R. Hoschek, M. D., discusses and describes a hitherto unknown occupational disease due to the inhalation of minute mineral particles of the rare earths. This book, *Die "Cer-Pneumokoniose" nach Einstmung von Natürlichen Seltenen Erden,* 152 pp, was published by A. W. Gentner Verlag, Stuttgart, Germany (1968) and is volume 18 of a series on Industrial and Social Medicine and Industrial Hygiene.

Dr. Hoschek briefly discusses the chemistry, mineralogy, properties, technology, industrial production, pharmacology and toxicology of the rare-earths. The remainder of the book (75%) is concerned with the many ramifications of cerium pneumoconiosis: the exposure, detection, symptoms, effects, treatment, etc. of the disease. It is a well documented book. This volume should be of vital interest to the rare-earth industry and those who are involved in continuous exposure to these materials.

Metatungstates

The Sylvania Chemical and Metallurgical Division has introduced a line of rare-earth metatungstates. Y, La, Ce, Nd and Er metatungstates are available now in purities greater than 99.9% and other rare-earth metatungstates can be prepared, Sylvania says.

A technical bulletin describing the chemical and physical properties, availability, toxicity, typical analyses and suggested applications of the metatungstates is available free from Sylvania Metals and Chemicals, Towanda, Pa., USA.

Solid State Physics, 21, 393 (1968).

In this review Dr. Cooper discusses the equilibrium magnetic behaviors of the metals, including their magnetic structures and transitions, and the effect of magnetic fields; spin wave theory as applied to magnetic field and magnetoelastic effects; spin wave theory and the various periodic moment arrangements (cone and planar spiral and sinusoidal); and experimental manifestation of spin waves, including neutron scattering, magnetic resonance and other macroscopic properties.

This 100-page article will be very valuable to those who are engaged in the study of magnetic properties of the rare-earth metals and compounds. The 120 references contained therein should enable the reader to obtain more detailed information from the original literature whenever necessary.

Imperfect Gadolinium

In a recent issue of *Phil. Mag. (18,* 503, Sept. 1968) Srivastava and Silcox reported some unusual dislocation structures in gadolinium metal. As far as we are aware this is the first time dislocations have been observed in gadolinium, but not the first time in a rare-earth metal, see Marcinkowski and Hopkins, *Trans. Met. Soc. AIME 242,* 579 (April 1968), who observed dislocations in lanthanum.

Srivastava and Silcox found the dislocations in gadolinium are edge dislocations with the Burgers vector perpendicular to the foil. They believe these dislocations formed through a climb process which depends upon a large temperature gradient in the foil which in turn causes the thermal diffusion of vacancies necessary for climb to occur.

the busiest RIC News periodic table, *Overview* discards the ordering of the rare earths on the basis of atomic number, and confines its discussions of the rare earths to an ordering based on their behavior in use. This ordering, as *Overview* sees it, consists of stable, lasing, divalent and quadrivalent groups.

The editors of *Overview* hope readers will use the new publication as a forum for how this unique grouping relates to practical uses, actual or envisioned.

Issued infrequently in the form of 8 1/2 by 11in., 3-hole punched sheets, *Overview* can be obtained free from Molybdenum Corporation of America, 280 Park Avenue, New York, N. Y. 10017.

Imaging System

Research Chemicals has announced the development of an improved neutron radiographic imaging system which utilizes a gadolinia conversion screen. The gadolinia coating on the screen is claimed to be defect-free and uniform in thickness over its entire active area; up to 14 by 17 in.

Details of the imaging system are available from Research Chemicals, P. O. Box 14588, Phoenix, Ariz. 85031.

IR Glasses

New glass compositions containing a light lanthanide in a V_2O_5-P_2O_5 matrix have been prepared by V. Sadagopan and H. C. Gatos, Center for Materials Science and Engineering, MIT, Cambridge, Mass. They report in *Mater. Sci. Eng. 2,* 273 (1967/68) that only La_2O_3, CeO_2 and Nd_2O_3 form glasses with 1:1 V_2O_5-P_2O_5, while the oxides Sm to Yb, Y and Sc do not.

Although the lanthanide additior

(Continued on Page 4)

York, 1968, 849 pp. provides in one volume a reference to every known chemical element. Articles appear on subjects such as isotopes, the periodic table, noble gases, and origin of the elements.

The articles, which deal with the lanthanides as a group and individually with each rare earth including Sc, Y and Pm, describe their history, occurrence, sources, separation, derivation, chemical and physical properties, principal compounds, applications, and biological and biochemical natures.

(Continued from Page 1)

open for a tour of the Scripps Institute of Oceanography, Salk Institute for Biological Studies and Gulf General Atomic. In the evening, however, it was back to work, when 12 papers were presented at two sessions.

Joe Nachman and his committee co-workers are to be congratulated for their efforts which resulted in another successful Rare Earth Research Conference.

RIC NEWS is published quarterly by the Institute for Atomic Research, Iowa State University.
OWNER AND PUBLISHER: Iowa State University. Institute for Atomic Research.
EDITOR: K. A. Gschneidner, Jr.
ADDRESS: Iowa State University, Ames, Iowa 50010
There are no known bondholders, mortgagees or other security holders.

RIC News
Vol. III, No. 4 December 1, 1968

published in
March, June, September and December
by
Rare-Earth Information Center
Institute for Atomic Research
Iowa State University

* * *

Second-Class postage
paid at Ames, Iowa.

* * *

Telephone: Area Code 515 294-2272
K.A. Gschneidner, Jr. . . . . .Editor
Charla Bertrand and W.H. Smith
Staff Writers

Rare Earths In the News

Ce IN MAGNETO–OPTICS

The magneto-optic effect is employed by General Electric Co. Ltd., Wembley, England to view directly the motion of magnetic flux in superconducting specimens. A 1mm disk of Ce glass is the magneto-optic element. It has the property of rotating the plane of polarization of transmitted polarized light relative to the strength and direction of the magnetic field in glass.

INFRARED TELEPHONE

An infrared telephone system is being developed by Associated Semiconductor Manufacturers Ltd. The system is being developed around a YIG modulator in the form of a 5 mm disk surrounded by a 12 mm diameter coil which carries voice modulator current. In addition to amplitude modulation, frequency modulation of the beam can be accomplished by varying the frequency of the current fed to the coil. The modulation also depends on the thickness of the the YIG disk; a 2 mm thick disk is optimum for wavelengths from 1.2 to 2.4μ.

Nd-GAGARINITE LASER

Soviet physicists plan to use gagarinite, a natural mineral discovered in 1958 and named after the Soviet cosmonaut, to build lasers of increased power. By employing a crystal of gagarinite doped with Nd, researchers calculate that laser power can be increased 30 to 40%. Such crystals have been formed into laser rods 100-150 mm long with plane-parallel ends. The rods emit infrared light when excited.

(Continued from Page 3)

does not affect the advantageous infrared (IR) transmission characteristics of V_2O_5-P_2O_5 glasses in the 2.5-5 μ region, they are useful because they extend the upper end of

Single Crystals

The rare-earth compounds ROF, $R_2Ti_2O_7$, R_2TiO_5, $RNbO_4$, and R_3NbO_7 have been prepared as small crystals by the flux-melt method. These compounds may be of interest for magnetic experiments because the rare-earth ions are closely spaced and may magnetically order at low temperatures. Garton and Wanklyn report in *J. Mat. Sci. 3,* 395 (1968), on the experimental conditions for the flux growth. They present x-ray diffraction data and unit cell dimensions for those compounds not previously reported.

Harari, Thery and Collongues report in *Rev. Int. Hautes Temp. Refract. 4,* 207 (1967) on the growth of CeO_2 single crystal from a Na_2O-B_2O_3 flux. Evaporation of the solvent causes growth from a supersaturated solution; the growth is more rapid than by slow cooling and produces cubes of 1-2 mm on a side.

Gunpowder

Europium and dysprosium tracer-labeled primers in concentrations of 200 to 300 ppm have been incorporated into commercial gunpowder for neutron activation detecting of gunpowder residues. The experimental studies were described by K. K. S. Pillay *et al.* in *Trans. Am. Nucl. Soc. 11,* 79 (1968).

After tests of both single and multiple firing series, paraffin casts were taken of the subjects' hands. The casts were irradiated at a flux of $4\text{-}5\times10^{12}$ n/cm^2 sec and analyzed for their appropriate tracers from gamma-ray spectra. Results showed that the rare earth tracers were as successful and perhaps more efficient for detecting gunpowder residues than the barium-antimony method. As a result of these experiments, a possible addition of Eu and Dy to gunpowders may be of assistance to law enforcement agencies in criminal cases.

Lanthanum Strain

Lanthanum salts have made it possible to stain extracellular regions which otherwise cannot be made opaque with conventional methods of fixation and staining for electron microscopy, *J. Cell Biol. 38,* 248 and 447 (1968).

The extracellular structures of interest are Langerhans granules. No function is known, but they appear continuous with the plasma membrane-particularly the free surface of intestinal epithelium. Lanthanum tracers have now enabled cell biologists to describe the character and fine structure of this region by the selective staining of these granules.

The authors suggest that La either replaces Ca, or stains by non-specific trapping, or stains complex molecules. The stained material breaks down after treatment with EDTA, trypsin or pronase and reveals its fibrillar structure.

Rare-Earth Information Center
Institute for Atomic Research
Iowa State University
Ames, Iowa 50010

Second-Class postage paid at Ames, Iowa.