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_2 compounds. Magnetostriction, magnetization, magnetic anisotropy, elastic properties, and magnetomechanical coupling of binary, pseudobinary and amorphous R-Fe_2 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 "Yα". 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 "Yα" 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 Magnetics Conference (INTERMAG) has been scheduled for May 12-15, 1981 at the Alpes Congrés 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 magnetics and related magnetic phenomena, magnetic recording, memory technologies, control and power conversion, magnetometry and transducers, magnetic printing, magnetics in life sciences, magnetic separation, magnet field calculations, magnetic materials properties and 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.

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.

'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 $LaNi_5$ in the race for commercial application of the metallic storage of hydrogen, ϵ-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 ϵ-FeTi is that oxygen impurity causes the formation of $Fe_7Ti_{10}O_3$ which in turn leads to the formation of Fe_2Ti; neither of which absorb hydrogen. The addition of 6% cerium was sufficient to getter most of the oxygen from the FeTi samples, thus suppressing the formation of $Fe_7Ti_{10}O_3$ and Fe_2Ti 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.

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

Telephone: Area Code 515-294-2272
FTS...865-2272
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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 4*f* and 5*f* 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.

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.

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.

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