RARE-EARTH INFORMATION CENTER NEWS

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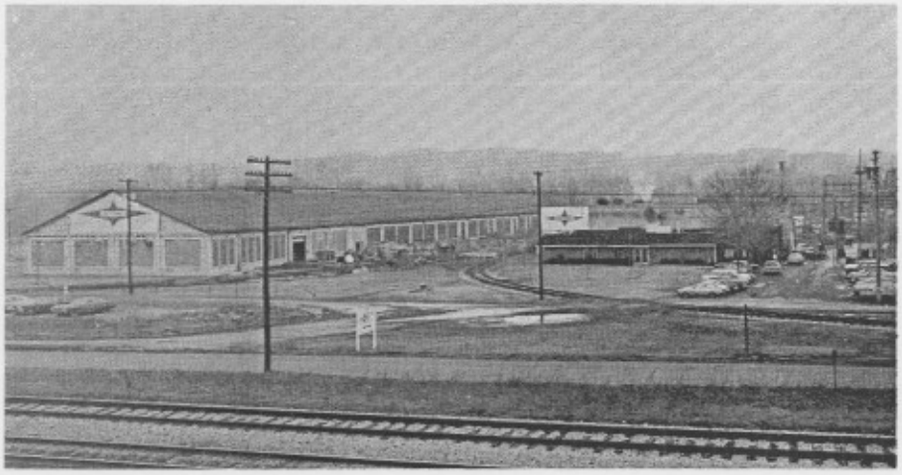
Who is .... 'The Rare Earth Industry'?



Reactive Metals & Alloys Corporation

Reactive Metals & Alloys Corporation (REMACOR) was formed in March of 1975 and has grown dramatically during the past three years. Today REMACOR employs 150 people and occupies 210,000 square feet of manufacturing and office facilities on a 25 acre industrial site in West Pittsburg, Pennsylvania. West Pittsburg is located approximately 40 miles north of Pittsburgh.

REMACOR manufactures cerium mischmetal by fused salt electrolysis and presently has a 4 million pound capacity plant which is the world's largest. In addition, REMACOR also manufactures various grades of rare earth silicide, single ladle desulfurizing compounds, and other specialty alloys for the iron and steel industries.

The rapid growth of REMACOR is attributed to a close technical relationship with users in developing practical and economical methods in the applications of their products. Three patents have resulted and a fourth has been applied for in addition to the publication of numerous technical papers on the use of rare earths in steel. The most significant patents are two that were granted for the method and apparatus used in adding mischmetal to molten steel by plunging a reactive mixture of magnesium and mischmetal. This technique is presently being used by steelmakers worldwide to treat molten steel in the ladle with mischmetal. REMACOR's activity in the steel industry over the past three years is actually a continuation of an extensive and aggressive marketing effort that started in early 1973. Today, rare earths are becoming more important in the new microalloying technology which is a significant tool used to obtain the physical properties that are necessary for today's applications of high strength low alloy steels and other critical grades of steel.

Recently REMACOR began manufacturing special electrolytic mischmetal alloys that are being used by the magnet industry in the production of mischmetal-cobalt magnets. Further research and development of other rare earth products are also being planned.

A brochure and catalog are available by writing to REMACOR, P.O. Box 366, West Pittsburg, PA 16160. Telephone 412-535-4357. TWX 510-461-0208.

EDITORS NOTE:

This is one of a continuing series of features on rare earth industry. The information contained herein was supplied by the company featured and its publication should not be construed to constitute an endorsement by RIC or Iowa State University of the products or services offered by the company.

FISCAL YEAR 1979

The new fiscal year is upon us and judging from the response so far the economic picture for the rare earth industry looks as bright as a rare earth phosphor! To date twenty companies have renewed their support of RIC and over 60% were able to increase this year's contribution. First quarter contributors are listed below. The number in parentheses is the number of years the company has supported the Center.

American Metallurgical Products Co., U.S.A. (10)
Atomergic Chemetals Corp., U.S.A. (7)
BBC Brown, Boveri & Co., Ltd., Switzerland (7)
Denison Mines, Ltd., Canada (7)
Ferro Corp., Transelco Div. (formerly Transelco), U.S.A. (3)
Th. Goldschmidt AG, Germany (10)
W.R. Grace, Davison Chemical Div., U.S.A. (11)
Hitachi Magnetics Corp., U.S.A. (5)
Indian Rare Earths, Ltd., India (10)
Inland Motor Div., Kollmorgen Corp., U.S.A. (3)
Kolon Trading Co., U.S.A. (6)
Leico Industries, Inc., U.S.A. (10)

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13th Proceedings Published

The proceedings of the 13th Rare Earth Research Conference held at Oglebay Park, West Virginia in October 1977 are now available as a book entitled *The Rare Earths in Modern Science and Technology,* edited by G. J. McCarthy and J. J. Rhyne. The book, published in 1978, is 629 pages in length and costs $49.50. Copies may be obtained by writing to Customer Service, Plenum Press, 227 West 17th Street, New York, NY 10011. Prepaid orders from individuals receive a ten percent discount.

Fiscal Year
(continued from page 1)

Mitsubishi Chemical Industries, Ltd., Japan (6)
Reactor Experiments, Inc., U.S.A. (9)
Rhone-Poulenc-Chimie Fine, France (9)
Ronson Metals Corp., U.S.A. (11)
V/O Techsnabexport, U.S.S.R. (2)
Treibacher Chemische Werke AG, Austria (7)
United States Radium Corp., U.S.A. (9)
Wako Bussan Co., Ltd., Japan (10)

Additionally, five companies receive special recognition this year for their role in the success of the Rare-Earth Information Center. With this year's contribution they qualify for the RIC Honor Roll which signifies 10 years of support of RIC.

Finally, we would like to correct a rare earthly goof in the "Contributors" story in the June 1978 issue of the *RIC News.* The story stated that eleven companies contributed during fourth quarter of fiscal year 1978, however, as most of our sharp readers noticed, only ten companies were listed. Unfortunately, GTE Sylvania Inc. was inadvertently left out of the list. We apologize for this omission and hope that in the future we will be perfect.

LETTER

To the Editor:

It has come to our attention that in current chemical literature element symbols are misused for the abbreviation of organic radicals. In the June edition of *Angewandte Chemie* **90,** 483, 490 (1978) the chemical symbol Pr is not used as the legitimate symbol for element 59, praseodymium, but as the symbol for the organic group propyl, $C_3H_7^-$. I have filed a sharp protest with the editors of *Angewante Chemie.* After asking one of the authors in question, it turns out that the IUPAC nomenclature commission has allowed the use of the symbol Pr for propyl. Another example of the misuse of element symbols is Ac. The symbol for element 89, actinium, is frequently misused for the acetyl group or the acetate ion.

May I therefore suggest that a formal protest against this practice be filed with the International Union. In this protest, it is requested that the use of element symbols should be restricted to denominate these elements and nothing else.

It is further requested that the following sentence be added to the general rules for chemical nomenclature: "Element symbols appearing in the Periodic Table of Elements should be reserved solely for the elements they represent. They should never be used as abbreviations for any radicals, groups or ligands."

Sincerely,
Fritz Weigel
Inst. Anorganische Chemie
Universität München
Meiserstrasse 1
München 2,
West Germany

EDITORS NOTE: Readers interested in discussing Dr. Weigel's proposal are encouraged to contact him directly at the above address. Dr. Weigel has suggested that this be discussed at the 14th Rare Earth Research Conference. Those interested in the latter suggestion should address their thoughts or comments to the Conference Chairman, Dr. J.B. Gruber, North Dakota State University, Fargo, ND 58102, U.S.A.

Source Compilation

Sources of single crystals in the United Kingdom and Scandinavia have been compiled and published in March of this year by B. M. R. Wanklyn. Sources of single crystals of a plethora of rare earth materials including rare earth metals, alloys and intermetallic compounds with Al, Fe, Co, Ni, Ag, Ca, oxides, chlorides, fluorides, garnets, aluminates, titanates, vanadates, molybdates, ferrites, phosphates, borates, silicates, germanates, stannates and tungstates are listed.

Copies may be obtained by writing to Mrs. B. M. R. Wanklyn, Clarendon Laboratory, Parks Road, Oxford OX1 3PU, United Kingdom. Scientists outside of the United Kingdom should include International Postal Reply Coupons in the amount of £0.80 for surface mail or a banker's draft in the amount of £3 drawn in sterling for airmail postage.

Durham 1977 Proceedings

The Proceedings of the International Conference on Rare Earths and Actinides held in Durham, England, July 4-6, 1977 are now available as a book entitled *Rare Earths and Actinides 1977, Institute of Physics Conference Series Number 37.* Edited by W.D. Corner and B.K. Tanner and published by the Institute of Physics, London, in 1978 the book is 346 pages in length and costs $42.00 in North America, £22.00 in all other countries. To obtain a copy in the USA, Canada or Mexico write to: American Institute of Physics, Dept. B/N, 335 East 45 Street, New York, NY 10017, U.S.A. All other countries should contact the Institute of Physics, The Distribution Center, Blackhorse Road, Letchworth, Herts SG6 1HN, England.

The book contains ten invited and forty eight contributed papers on material preparation, structural and elastic properties, excitations and spin waves, band structure and Fermi surfaces, crystal and hyperfine fields and magnetic properties of the rare earths and actinides. Another chapter was devoted entirely to rare earth intermetallics and several papers discussed economic aspects and applications of rare earth materials. Only eight of the 58 papers deal exclusively with actinides.

L. F. Bates Dies

RIC has received word of the death of Professor L. F. Bates on January 20 of this year at the age of 80 following a short illness. Professor Bates, an Emeritus Professor of Physics at Nottingham University is best known for his work on permanent magnetic materials and his study of the magneto-thermal effects accompanying magnetization which included work on several of the rare earths during the late 1950's and early 1960's before his retirement in 1964.

RE's in the News

Magnetic Bubbles

Researchers at the IBM Thomas J. Watson Research Center, Yorktown Heights, NY, seem to have no respect for words like 'small' and 'dense' when it comes to magnetic bubbles in garnets. They have discovered stable magnetic bubbles with 0.4 μm diameters which compares to currently available diameters in the 3 to 5 μm range. If these new bubbles can be developed bubble memory storage density would jump from 0.47×10^6 bits/cm^2 to 16×10^6 bits/cm^2.

More Magnetic Bubbles

While IBM researchers have been working on 'small' and 'dense', researchers at Philips Research Laboratories, Eindhoven, The Netherlands, have been working on 'fast'. By incorporating a layer which allows for a magnetic field parallel to the bubble layer, bubble speeds of 100 m/sec have been demonstrated.

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COEXISTANCE?

A political dispute? No, a question that has puzzled many researchers concerning superconductivity and magnetic order. S. Roth has attempted to shed some light on the subject with a review of the experimental work on materials which show evidence of the coexistence of superconductivity and long range magnetic order [*Appl. Phys.* **15,** 1-11 (1978)]. Among the candidates for coexistance are intra-rare earth alloys, Laves phases between rare earths and ruthenium, osmium and aluminum, Chevrel phases and even a few stoichiometric compounds. Besides discussing critical temperature and fields, the author examines experimental techniques including magnetic susceptibility, specific heat, Mössbauer effect and neutron diffraction. Roth concludes that most of the materials being studied should be called superconducting spin glasses rather than ferromagnetic superconductors. Furthermore, it is possible for magnetic order to coexist with superconductivity when the correlation length associated with magnetic order is larger than the superconductive coherence length.

3rd RE-Co WORKSHOP

The *Proceedings of the Third International Workshop on Rare Earth-Cobalt Permanent Magnets and Their Applications,* held June 27-30, 1978 at San Diego, California and edited by K. J. Strnat, are now available as a 400 page paperbound volume for $25.00. Thirty articles describe various applications of samarium cobalt base alloys including electric motors and actuators, generators, magnetic bearings, microwave tubes, coaxial couplings, line printers, watches and applications in modern medicine. New materials and processes, raw materials availability and economic questions are discussed.

Likewise, the *Proceedings of the Second International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth-Transition Metal Alloys,* held July 1, 1978 at San Diego and also edited by K. J. Strnat, are available as a 175 page paperbound volume for $10.00. As the title states the nine articles deal with the

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Magnetic Heat Pumps Revisited

On page 3 in the December 1976 issue of the *RIC News* we made note of a magnetic heat pump developed by G. V. Brown which used gadolinium as the refrigerant. Now S. S. Rosenblum, W. A. Steyert and W. P. Pratt, Jr. have also constructed a continuous magnetic refrigerator operating near room temperature [LA-6581 (May 1977)] and with the help of J. A. Barclay, developed a continuous demagnetization refrigerator that operates near 2 K [*Cryogenics* **17,** 689-93 (December 1977)]. The room temperature refrigerant was gadolinium while the low temperature refrigerant was $Gd_2(SO_4)_3 \cdot 8H_2O$. In addition, Er_2O_3, Dy_2O_3, $Gd_3Al_5O_{12}$, $Dy_2Ti_2O_7$, $DyPO_4$, $Gd(OH)_3$ and $Gd(PO_3)_3$ were examined for suitability as low temperature refrigerants.

A Sterling-type cycle is used in which the magnetically ordered refrigerant is exposed to the low temperature side, (*via* a liquid heat-exchanger), absorbs heat and disorders. The refrigerant then rotates to the high temperature side and in the presence of a magnetic field orders magnetically and gives off heat.

The authors feel that these prototypes clearly demonstrate the feasibility of this type of refrigeration although improvements can still be made in materials selection and fabrication. Possible applications include providing a suitable environment for superconducting devices.

NEW RE JEWELRY

Yttrium aluminum garnet (YAG) has long been accepted as a setting for rings, substituting for the more expensive diamond. Now samarium, in the form of samarium cobalt permanent magnets, has made a hit as the latest thing in jewelry, the magnetic earring. The earrings avoid risks of infection, allergic reaction and tearing often associated with pierced ears. There is some question as to how the magnets, which weigh .001 pound per set, will affect such medical devices as hearing aides, artificial pumps and pacemakers which also use magnets. At any rate, if the demand for the earrings continue to grow, the production of the samarium cobalt magnets will have to double to meet the demand; good news to the rare earth industry.

Electronic Structure of the Heavy Rare Earths

The Electronic Structure of Rare Earth Metals and Alloys—The Magnetic Heavy Rare Earths is the title of a new book written by B. Coqblin. Published by Academic Press in 1977, the book is 656 pages in length and costs $57.75. Coqblin concentrates on the heavy lanthanides, gadolinium, terbium, dysprosium, holmium, erbium and thulium. They are considered 'normal' lanthanides in that they have a valence of 3 which does not vary under pressure. A brief overview of the elementary properties of the lanthanides is given. The the experimental observations on the magnetic structures are presented and molecular field theory and spin wave theory for magnetic ordering are discussed. Experimental evidence of spin waves is shown. The last half of the book deals with variation of magnetic periodicity, superzones, magnetoelastic effects, magnetic structure transitions, magnetic resonance, magnon-phonon interaction, band structure effects and transport properties. This book should prove to be an excellent reference work for solid state physicists as well as any other field that requires knowledge of the electronics of metals.

RE-Co Workshop
(continued from page 3)

magnetic anisotropy and/or coercivity of samarium-cobalt base permanent magnetic alloys.

Both of these books may be obtained by writing to the University of Dayton, School of Engineering, Attn.: Mrs. A. Fox, KL365, Dayton, OH 45469. There are still copies of the *Proceedings of the Second International Workshop on Rare Earth—Cobalt Permanent Magnets and Their Applications,* K. J. Strnat, ed., June 1976, available. It is 396 pages long, costs $25.00 and can also be obtained by writing to the Dayton address.

One of the papers presented during the 3rd Workshop entitled "Availability of Rare Earths for the Rare Earth Cobalt Permanent Magnets Market," but not included in the Proceedings may be obtained by writing to J.-P. Fort, Rhodia Inc., Chemicals Division, P.O. Box 125, Monmouth Junction, NJ 08852, U.S.A.

Molycorp Expansion

Citing growing demands for samarium for use in permanent magnets in solid armature motors, self holding jewelry, and data printout equipment and for gadolinium for use in magnetic bubble memory systems in computers, Molycorp has announced a multimillion dollar expansion of their Mountain Pass, California bastnasite processing facilities. Six new solvent extraction circuits are to be constructed.

Analogous to RE's

L. A. Boatner and M. M. Abraham have reviewed the available experimental data and techniques involved in measuring the electron paramagnetic resonance (EPR) from the actinide elements [*Rep. Prog. Phys.* **41,** 87-155 (1978)]. This review should prove interesting to those f-shell enthusiasts in our readership since there is an emphasis on comparing the results obtained for the actinides with those obtained for the rare earths. EPR theory is discussed with respect to crystal field effects, hyperfine interactions and 'pseudonuclear' g factors.

CADANG-CADANG?!!?

This article's title might arouse several questions like "What is cadang-cadang?" and "What has it got to do with the rare earths?" To answer the first question, cadang-cadang is a disease that attacks coconut trees reducing their productivity and eventually killing them. To answer the second question, nothing, we hope. J. R. Velasco, L. E. Domingo, Z. N. Sierra and F. F. Coronado have undertaken a study to determine if the rare earths have any connection to cadang-cadang [*Philippine J. of Coconut Studies* **11,** [2] 1-6 (1977)]. Researchers suspect the disease to be caused either by a virus or by a toxic concentration of a normally innocuous element. Although the present research did indicate a higher concentration of rare earths in the cadang-cadang affected groves the authors noted many procedural and experimental difficulties which rendered their results inconclusive.

GIANT Magnetic Hardness

Materials which exhibit an extremely large magnetic hardness as an intrinsic solid state property is the subject of a review by H. Oestereicher [*Appl. Phys.* **15,** 341-54 (1978)].These materials differ from other magnetically hard materials in that the hardness is not due to the presence of fine particles or precipitate phases, but rather, to exchange interaction fluctuations. Characteristics of these materials include partly randomized crystallography and high magnetic anisotropy. Pseudobinary compounds of the rare earths with iron, aluminum, cobalt, nickel and copper with the stoichiometries RM_2, RM_3, R_2M_{17} and RM_5 are representative of this type of material. Likewise are the compounds Dy_3Al_2, TbGa, $SmCo_3B_2$ and $ErCo_3B_2$ and amorphous materials such as YFe_2, $SmFe_2$, $TbFe_2$ and $DyFe_2$. The effect on coercivity of concentration, crystal field effects, temperature and time are examined. The author suggests measurement of the intrinsic magnetic hardness as a probe to determine the suitability of technologically interesting materials for permanent magnet applications.

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