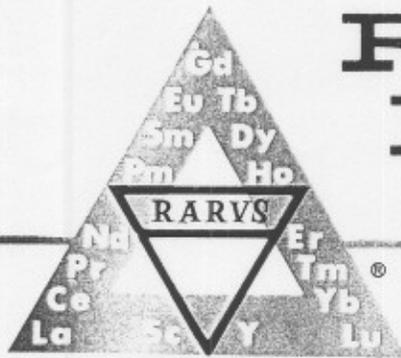


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RARE-EARTH INFORMATION CENTER NEWS

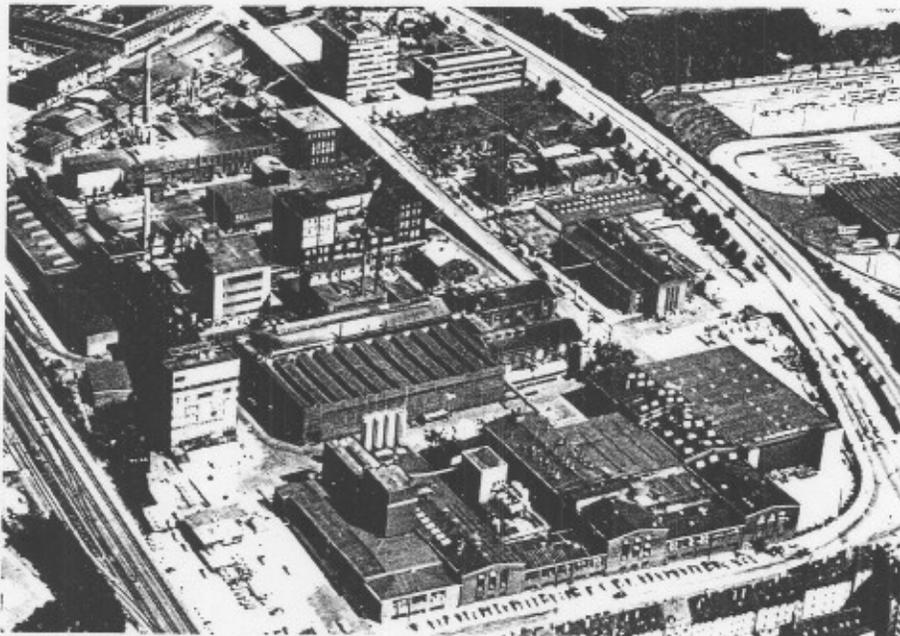
ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE
IOWA STATE UNIVERSITY / AMES, IOWA

Volume XII

September 1, 1977

No. 3

Who is 'The Rare Earth Industry'?



Plant at Essen, Germany

Th. Goldschmidt AG

Goldschmidt is an independent producer of chemical and metallurgical specialty products. The company is more than 125 years old and currently employs 3,000 people with sales of \$200 million.

Goldschmidt has been active in the rare earth field for about 30 years. They developed the extrusion process of rare earth metal lighter flints which was licensed to users in Austria, France, Great Britain and the USA.

Today, Goldschmidt has the highest production capacity for cerium mischmetal in the world, using the largest known electrolytic cells. Mischmetal is offered mainly to the steel industry in various shapes and forms. Goldschmidt's technical service staff is in touch with users to improve addition methods, e.g. addition of steel-clad

mischmetal wire for continuous casting of steel.

They have a unique process to make anhydrous rare earth chloride, mainly based on bastnaesite ore. The mischmetal process is used under license in the United States by Ronson Metals Corporation, Newark, N.J. Goldschmidt also has experience in making rare earth oxides and chemicals, however, these products are currently not being offered in the open market.

Recently, a new line of rare earth cobalt alloy powders has been introduced for rare earth cobalt magnets. Goldschmidt developed their own patented co-reduction process to reduce a suitable oxide-mix to alloy powders under calcium. The process offers uniform alloy powders of complex compositions containing

(continued on page 6)

FISCAL YEAR 1978...

is upon us already and during the first three months contributions were received from twenty-seven companies representing eight countries. This response surpasses the record of twenty-three set in 1973 for donations in the first quarter of a fiscal year and hopefully signals another banner year for rare earths. Twenty-five of the companies renewed their support of RIC and we welcome two new members to our family of benefactors. 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. (9)
- Atomergic Chemetals Corp., U.S.A. (6)
- BBC Brown, Boveri & Company, Ltd., Switzerland (6)
- Cerac, Incorporated, U.S.A. (2)
- Denison Mines Limited, Canada (6)
- Eastman Kodak Company, U.S.A. (1)
- Th. Goldschmidt AG, Germany (9)
- W. R. Grace, Davison Chemical Division, U.S.A. (10)
- Hitachi Magnetics Corp., U.S.A. (4)
- Inland Motor Division, Kollmorgen Corp., U.S.A. (2)
- Kolon Trading Co., Inc., U.S.A. (5)
- Leico Industries, Inc., U.S.A. (9)
- Lunex Company, U.S.A. (8)
- Metalurgica Corona Ltd., Brazil (2)
- Mitsubishi Chemical Industries, Ltd., Japan (5)
- Molycorp, Inc., U.S.A. (10)
- Reactive Metals and Alloys Corp., U.S.A. (2)
- Reactor Experiments, Inc., U.S.A. (8)
- Research Chemicals, U.S.A. (10)
- Rhone-Poulenc-Chimie Fine, France (8)
- Ronson Metals Corporation, U.S.A. (10)

(continued on page 5)

GERMANY and ENGLAND—1977

The editor had an opportunity to visit several laboratories and universities and attend the Rare Earth and Actinide Conference in Durham in late June and July. The cool and sometimes wet weather in Europe was a welcome relief from the hot and humid, but rainless conditions in central Iowa.

The first port-of-call was the Institut für Festkörperforschung, Kernforschungsanlage Jülich (KFA), Jülich, West Germany. Most of my discussions were with the superconducting and low temperature group headed by Dr. F. Pobell. They are in the process of building a large adiabatic demagnetization cryostat with which they expect to reach at least 0.3 mK by using PrNi_5 as one material to cool the working chamber. Dr. J. Wittig of this group is conducting electrical resistance measurements at high pressure (up to 200 kbar) and temperatures as low as 50 mK. He is studying the superconducting behavior of solids, including rare earths, as a function of pressure. The KFA is one of the best equipped and supported laboratories in Europe.

From Jülich, I traveled to the Zentralinstitut für Tieftemperaturforschung (ZTTF) in Garching, just north of Munich. The ZTTF is also thinking about using PrNi_5 in their adiabatic demagnetization cryostat. There are some problems, especially in the preparation of thin rods of PrNi_5 , which need to be solved before many low temperature laboratories will be using it. My host, Dr. C. Probst, and I spent several hours discussing superconductivity of Sc, Y, Lu and Ce at high pressures and the significance of these results. Dr. Probst is working closely with Dr. Wittig at the KFA on this subject.

The next stop was the Clarendon Laboratory of the Oxford University, England. The main portion of my visit was spent with Dr. D. Hukin whose specialty is the growth of metallic rare earth single crystals and purification of metals by liquid zoning techniques. Dr. B. Wanklyn, who is another of twelve crystal growers at the Laboratory, described her efforts to grow mixed oxides, e.g. RaIO_3 , RAsO_3 , from a molten flux.

From Oxford, an hour and a half train ride took me to Birmingham to visit Dr. D. Jones and his staff at the Centre for Materials Science of the University of Birmingham. Their major effort is to purify rare earth

metals, single and polycrystals, by solid state electrolysis. This Centre has been set up to supply UK scientists with high purity metals, when their research requires the same. Other work at the University is concerned with de Haas-van Alphen measurements to obtain information about the Fermi surfaces of the rare earth metals under the guidance of Dr. R. Young and physical metallurgical studies on CeRh_3 - CePd_3 alloys under the supervision of Dr. I. R. Harris.

The last stop before the Conference was to see Dr. K. McEwen at the University of Salford. He is carrying out electrical resistivity, magnetoresistivity and neutron diffraction studies on the light lanthanide metals and some intra-rare earth alloys. He has found some interesting behaviors in Y-rich alloys containing Nd and Pr, e.g. $\text{Nd}_{0.2}\text{Y}_{0.8}$ orders antiferromagnetically with a basal plane spiral structure at 18 K, almost the same temperature as pure Nd.

It was a special pleasure for the editor to attend and participate in the Third Rare Earth and Actinide Conference, since he had the privilege to present the Introductory Address, and also because it was a wonderful opportunity to meet and talk to old friends, to make new ones, and to get the latest information on scientific studies in Europe. It was a well run Conference thanks to the organizing talents of our hosts Drs. Corner and Tanner. The weather cooperated beautifully, tempting scientists to miss part of the sessions. Of the nine invited papers, all of which were interesting, I thought three were outstanding. Those were the presentations by D. W. Jones on the preparation of metals, alloys and crystals, A. J. Freeman on band structure calculations and H. Kirchmayr on magnetic properties of intermetallic compounds. The ~ 70 papers are to be published by the Institute of Physics and when they become available we will announce this in the *RIC News*.

I found that there was a great deal of interaction between research groups in Europe, not only within the

PROCEEDINGS AVAILABLE

The proceedings of the first joint conference of Magnetism and Magnetic Materials with the International Magnetism Conference, held in Pittsburgh, Pennsylvania, June 15-18, 1976, are now available as a two volume set.

Half of the proceedings are presented in *AIP Conference Proceedings No. 34, Magnetism and Magnetic Materials-1976*. Edited by J. J. Becker and G. H. Lander this clothbound volume measures 8¼ in. by 11¼ in., is 399 pages in length and costs \$19.50. Over one third of the papers included deal with rare earth materials. Fundamental topics, metals and alloys, transition metal systems, magnetoresistance in soft magnetic materials, superconductivity, surfaces and fine particles, domain walls, bubble physics, bubble materials, mixed valences, magnetic insulators, resonance in rare earth systems, microwave devices, amorphous magnetic alloys, crystalline alloys, spin glasses, critical phenomena and phase transitions are among the subjects discussed.

The other half of the proceedings appears in the *IEEE Transactions on Magnetics*, volume MAG-12, No. 6 (November 1976). This volume deals mainly with devices and applications. Hard magnetic materials including rare earth-cobalt permanent magnets are discussed in two sections.

same country, e.g. the KFA and ZTTF, Birmingham and Oxford, etc. but also across national boundaries—an indication of future research trends.

In the past 11 years since my first trip to Europe to visit various laboratories and universities there has been a notable change especially in the way these institutions are being funded and supported. All are well equipped with new and up-to-date apparatus. It is my impression (also confirmed by my discussions with other scientists, both American and European) that European support of science is now on par with or ahead of American support (ten years ago the U.S.A. was way ahead) and if this rate of change continues in the future American science will be second rate.

INTERNATIONAL C.N.R.S. COLLOQUIUM ON "PHYSICS OF METALLIC RARE EARTHS"

The colloquium will be held at St-Pierre de Chartreuse, some 30 km from Grenoble, France, during the period September 4-7, 1978. St-Pierre de Chartreuse is a village resort beautifully situated at 1000 meters on the western edge of the Alps.

The program will cover the following topics: intermediate valence, magnetism, crystal fields, critical phenomena, induced magnetism, theory and experimental determination of electronic structures, amorphous materials and liquids. A special session will be devoted to a review on technical applications.

Each subject will be presented by one or two guest speakers in a plenary session and several related papers will follow. Plenty of time is allocated for discussions during the sessions, and further informal discussions will be promoted by the fact that the participants are all to be lodged together.

Participation in C.N.R.S. colloquia is by invitation, and the total number of participants is limited to *one hundred*.

Planning will be greatly facilitated if each person who is interested in attending the colloquium will complete and return before November 1, 1977, the preliminary information form provided below.

(Detach)

INTERNATIONAL C.N.R.S. COLLOQUIUM ON "PHYSICS OF METALLIC RARE EARTHS"

St-Pierre de Chartreuse, France

September 4-7, 1978

Please complete the following and send before November 1, 1977 to:

The Secretary
Colloquium on "Physics of Metallic Rare Earths"
Laboratoire Louis Néel
C.N.R.S.
166X
38042 Grenoble Cedex, France

This form is for information only and carries no final commitment.

PLAN TO ATTEND Yes No

PLAN TO PRESENT A PAPER Yes No

(Please type or print)

Possible subjects: _____

Name _____

Address _____

CONFERENCE ON THE ELECTRONIC STRUCTURE OF THE ACTINIDES

The "Third International Conference on the Electronic Structure of the Actinides" will be held in Grenoble, France, from August 30 to September 1, 1978. The aim of the Conference is to review and discuss the progress made in the basic aspects of the solid state properties of the actinides and their alloys and compounds. Topics:

- Physical properties of metals and metallic compounds
- Physical properties of ionic and semiconducting compounds
- Correlation between electronic structure, thermodynamics and crystal structure
- Sample preparation and characterization for physical measurements.

Each subject will be presented by guest speakers and developed in poster sessions, and panel discussions.

The International Advisory Committee includes: E. F. BERTAUT (France), J. M. FOURNIER (France), A. J. FREEMAN (U.S.A.), J. FRIEDEL (France), J. CRUNZWEIG-GENOSSAR (Israel), S. IMOTO (Japan), K. MENDELSSOHN (England), W. MÜLLER (F.R.G.), M. V. NEWITT (U.S.A.), R. PASCARD (France), W. I. SPITZYN (U.S.S.R.) and W. TREBIATOWSKI (Poland).

The Conference is sponsored by C.E.A. (French Atomic Energy Commission, C.E.N.-GRENOBLE), Euratom (I.T.U.), E.P.S. (European Physical Society), S.F.P. (French Physical Society), I.U.P.A.P. (International Union of Pure and Applied Physics) and S.F.E.N. (French Society for Nuclear Energy).

For further information write to:

J. M. FOURNIER, An 78
DRF/PHS - C.E.N.-G
85 X - 38041 GRENOBLE CEDEX
France.

P. W. Bridgman Award

The International Association for the Advancement of High Pressure Science and Technology has chosen Dr. H. G. Drickamer to be the first recipient of the P. W. Bridgman Award. Drickamer, currently a professor of chemical engineering and physical chemistry at the University of Illinois, Urbana-Champaign, is being cited for his development of high pressure techniques to investigate the electronic behavior of solids and liquids, crystal structures and electronic transitions. Current research interests include high pressure luminescence studies on phosphors doped with rare earths.



H. G. Drickamer

Russian RE Semiconductor Bibliographies

In the past few months RIC has received *Redkozemel'nye Poluprovodniki. Tekushchaya Bibliograficheskaya Informatsiya 4 [Rare Earth Semiconductors. Current Bibliographic Information, No. 4]*, V. P. Zhuze, editor, Fiziko-Tekhnicheskii Institut im. A. F. Ioffe, Akademii Nauk SSSR, Leningrad (1976), and also No. 5, which carries the same title, editor and publisher as No. 4, except that it was published in 1977. The fourth bibliography on semiconductors has 954 citations while the fifth has 665. The references are printed in their original language—English, Russian, French, etc. A brief subject index (20 entries) is also included in each volume.

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Bernie Evans. . . Staff Writer

Spectroscopy

An international conference on Spectroscopie des Elements de Transition et des Elements Lourds dans les Solides was held at the Lyon I University in France June 28-July 3, 1976. Sessions were devoted to electronic states and chemical bonding, electron-phonon interaction, radiative and non-radiative processes, the migration and energy transfer between ions at different sites, the study of the real structure in solid state, optical study of magnetic interactions, new materials and recent progress in solid state spectroscopy. Over half of the forty-eight papers presented contain information on rare earth materials. The proceedings of this conference have been published as a single volume 302 pages in length which is available from Editions du C.N.R.S., 15, quai Anatole France, 75700 Paris, France. The cost is 190 francs.

Fiscal year

(continued from page 1)

Shin-Etsu Chemical Co., Ltd., Japan
(8)

V/O Techsnabexport, U.S.S.R. (1)

Transelco, U.S.A. (2)

Treibacher Chemische Werke AG,
Austria (6)

U. S. Radium Corp., U.S.A. (8)

Wako Bussan Co., Ltd., Japan (9)

In addition the following companies are being recognized for their important role in the success of the Rare-Earth Information Center. With this year's contribution each of these companies has contributed to the support of RIC for ten years.



Distinguished Professor

Ames Laboratory rare earther Sam Legvold has been named Distinguished Professor of Physics by Iowa State University. This appointment recognizes exceptional teaching and research activities and is accompanied by a \$500 honorarium. Legvold joined Ames Laboratory in 1947 after receiving his Ph.D. from Iowa State University in 1946. Before that he was an assistant professor of physics at Luther College and a Lydia Roberts fellow at Columbia University. Legvold is primarily known for his research on the electrical, magnetic and transport properties of the pure rare earth metals and their alloys.



S. Legvold

SCANDIUM ECONOMY

The economics of scandium is the subject of a report published by the Roskill Information Services Ltd., 14 Great College Street, London, SW1P 3RZ England in September 1974. Information on scandium-containing ores, their sources, world production figures, commercial sources, end uses, economic factors such as import tariffs and an analysis of current research is presented and discussed. The cost is 220DM (~\$100 U. S.). More information and details for obtaining this report are available by contacting the company directly.

Crystal Field Effects

Crystal Field Effects in Metals and Alloys [A. Furrer, Ed., Plenum Press, New York (1977)] is the published proceedings of the second international conference bearing the same name held September 1-4, 1976 at Zurich, Switzerland. The book consists of 58 papers which deal with spin waves and excitons, soft modes and critical effects, magnetic properties, physical properties influenced by crystal field effects, and valency. Theoretical aspects as well as new experimental data on crystal field effects in metals and alloys are comprehensively discussed. Information on a wide range of rare earth materials is presented. The book is 365 pages in length and costs \$37.50.

Nodularization Theory in Cast Iron Aided by REs

S. Yamamoto, B. Chang, Y. Kawano, R. Ozaki and Y. Murakami have conducted several experiments involving rare earths to test the role of gas bubbles in molten cast iron during the nodularization process and to determine the mechanism of graphite nodularization [*Metal Science* 9, 360-9 (1975)].

One of the experiments involved the addition of cerium, lanthanum or yttrium which had absorbed a large amount of hydrogen to the cast iron melt. The typical structure of nodular cast iron was obtained. When the rare earths were degassed before they were added to the melt only undercooled graphite resulted. The authors postulate that the hydrogen is evolved in the form of small bubbles from the rare earths as the temperature rises. Graphite nucleates around the bubbles and grows inward. Several other features such as density and hollow nodules are satisfactorily explained by the proposed gas bubble theory.

RE's in the News

Annular Momentum-Control Device (AMCD)

Research performed by J. Lyman, C. H. Henrikson and F. M. Manders for the Langley Research Center has resulted in the development of an AMCD, a rotating ring used to store momentum in a mechanical system, which contains samarium cobalt permanent magnets. The magnets, placed at 3 inch intervals in the rim, provide magnetic discontinuities which are required by the drive system.

Amorphous Conductivity

The electrical conductivity of amorphous materials can be increased up to nine orders of magnitude according to S. R. Ovshinsky, head of Energy Conversion Devices, Inc. Modifiers, including rare earths, are co-sputtered with glass onto a substrate and then bombarded with argon to knock bits of the metal and glass into the substrate. Generating electricity from sunlight is a potential application for these materials.

Observe Domains

B. K. Tanner, M. Safa and D. Midgley have applied cryogenic X-ray topography using synchrotron radiation to observe magnetic domains in various materials including terbium and DyVO₄ [*J. Appl. Cryst.* 10, 91-9 (1977)]. The peculiar properties of synchrotron radiation make X-ray topography at temperatures from room to liquid helium relatively straightforward. Other apparatus, such as an electromagnet, can easily be incorporated in the set-up. Four different successful cryostat designs are described and the first observations by X-ray topography of ferromagnetic domains in terbium and Jahn-Teller domains in DyVO₄ are reported.

Goldschmidt

(continued from page 1)

rare earths with Co, Cu, Ti, Zr, Fe and other metals. The company has no intention to make magnets, but specializes in supplying the worldwide magnet industry. In cooperation with magnet makers, Goldschmidt's objective is to offer magnet alloys with optimum relations between raw materials availability, performance and cost.

Catalogues of rare earth products and other product lines are available from Th. Goldschmidt Products Corporation, 175 Main Street, White Plains, N.Y. 10601, or directly from Th. Goldschmidt AG, Metal Division, Postfach 17, 4300 Essen 1, Germany.

EDITOR'S 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.

STEEL IMPROVED

Rare earth metal's ability to absorb large amounts of hydrogen has been applied by C. S. Kortovich to inhibit hydrogen embrittlement in high strength steel [AD-A-037355 (February 1977)]. Mechanical property tests showed that lanthanum or cerium additions to AISI 4340 steel in the 0.1 to 0.2 weight percent range resulted in a material which met most of the aircraft quality specification minimums. A notable exception was the Charpy impact strength which sharply decreased with increased rare earth content due to the continuous grain boundary inclusions which were formed. Delayed failure tests were employed to determine the hydrogen embrittlement resistance of the rare earth treated steel. Results indicate a substantial improvement manifested by longer time to crack initiation, longer time to failure and higher values of lower critical stress intensity. The mechanism responsible for the improved characteristics, according to the authors, is the gettering and entrapment of hydrogen by cerium and lanthanum which inhibits movement of hydrogen to the stressed area.

Chemistry Conference

The Association of Finnish Chemical Societies is sponsoring an EUCHEM Conference on the chemistry of the rare earths to be held June 12-15, 1978 in Helsinki, Finland. For more information contact Professor L. Niinistö, Department of Chemistry, Helsinki University of Technology, SF-02150 Espoo 15, Finland.

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