RARE-EARTH INFORMATION CENTER NEWS

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

Volume XXII | March 1, 1987 | No. 1

BUSINESS NEWS

Anatase—Rare Earth Source

Companhia Vale do Rio Doce, a Brazilian state-owned company, is planning to enter the world markets as a supplier of TiO_2 obtained by processing of anatase. From a pilot plant producing 15,000 mt/y of 90 percent TiO_2 they plan on scaling up to as high as 500,000 mt/y. What makes this so interesting to rare earthers is that one by-product of the process is rare earths high in europium and yttrium. At the 500,000 mt/y rate the yield could be 8,000 mt/y of rare earth oxides, more than doubling Brazil's present production.

Rhone-Poulenc's New Australian Ventures

Rhone-Poulenc recently announced that they will spend about $150 million (Australian) to build a gallium plant and a rare earth plant at Pinjara, Western Australia.

The rare earth plant at Pinjara is due on stream in 1989 and will produce 6,000 metric tons of rare earth oxides a year. The present market is about 25,000 metric tons/year. The Australian plant will complement the Rhone-Poulenc installations at Freeport, Texas, and LaRochelle, France, both of which were expanded in 1985.

The Pinjara plant will produce rare earth oxides from monazite ore from mines operated by Associated Minerals, Consolidated at Eneabba and Cabel.

Each year Western Australia produces some 12,000 tons of monazite valued at about $11 million. The new plant will add from $50 million to $60 million to the total value. Further added value could come from a vertically integrated rare earth industry.

The Western Australian minister of minerals and energy, Mr. David Parkerm, said the plants are a breakthrough in Australia's efforts to become a producer and not just a quarry. He said he had announced larger projects but this was the most significant one he had ever been asso-

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ACS Creative Award

Professor Samuel J. Danishefsky won the 1986 American Chemical Society (ACS) Award for Creative Work in Synthetic Organic Chemistry, which is sponsored by Aldrich Chemical Company, Incorporated.

A long-standing interest in the synthesis of natural products and in the development of new synthetic strategies has led to the construction of complex organic compounds, some with potential antibiotic or antitumor applications, by Danishefsky and his co-workers. Throughout his career he has displayed an ability to create a new concept, examine its stereochemistry and mechanism details, and adapt or alter the process to provide a new solution to some problem in the synthesis of natural products.

One of the most significant reactions developed by Danishefsky at Yale is the hetero Diels Alder reaction using europium or ytterbium complexes. Lanthanide complexes provide extremely mild conditions for catalysis of the hetero Diels Alder reaction as well as others. Furthermore, when lanthanides are employed that bear resolved ligands, cycloadducts are obtained with considerable enantiomeric excess. Another lanthanide that Danishefsky has employed as a catalyst in many of his reactions is cerium.

$T_c > 77$ K

The race is on and the winner is the field of superconductivity and all the applications in which it may be used. In 1973, Nb_3Ge set a new record for the highest superconducting transition temperature (also known as critical temperature T_c) at 23.2 K. Despite all the research done in the next 13 years, nobody could increase the T_c record, although many new superconducting systems were found.

The dam broke when J. George Bednorz and K. Alex Müller of the IBM Zürich Research Laboratory in Switzerland reported possible superconductivity at about 30 K in a mixture of crystalline phases in the La-Ba-Cu-O system. They published their results in *Z. Phys. B.* **64,** 189 (1986) and sparked an outpouring of papers on new records claimed for various La-Cu-O systems with either Ba or Sr replacing part of the lanthanum and with an unmeasured deficiency in the oxygen stoichiometry. There are many other laboratories throughout the world involved—too many to mention. Among the published results were onset temperatures above 40 K with pressure and a superconducting transition temperature of 36.2 without pressure [C. W. Chu et al., *Phys. Rev. Lett.* **58,** 405-7 (1986) and R. J. Cava et al., *Phys. Rev. Lett.* **58,** 408-10 (1986) respectively].

About the time of publication of these papers the Chinese Academy of Sciences in Beijing released word that a research team at their Institute of Physics had achieved superconductivity at 48.6 K. The Houston group then announced they had upped T_c to 52.5 K.

As the *RIC News* was going to press, we received confirmed reports of much higher T_c's *(the temperature at which the resistance goes to zero).* These are 94K for Y-Ba-Cu-O (Uni-

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Peter Debye Award

Dr. Harry G. Drickamer, professor of chemical engineering, chemistry, and physics at the University of Illinois, Urbana, Illinois, has been awarded the Peter Debye Award in Physical Chemistry.

One of his colleagues described Drickamer and his contributions in this way: "A true pioneer in fundamental studies of the physics and chemistry of solids, through his highly imaginative use of very high pressures in a wide variety of experiments on solids and through his brilliant interpretations of the properties that he has discovered."

A major focus of Drickamer's research has been optical absorption, yielding direct observations of the effects of pressures as high as 360,000 atmospheres upon the electronic behavior of solids. He also studied the effects of pressure on resistance and on crystal structure, including a variety of rare earth compounds.

Electronic Structure Cerium Intermetallics

Seven scientists from three California and two West German laboratories have collaborated to write a review entitled "Electronic Structure of Cerium and Light Rare-earth Intermetallics." J. W. Allen, S. J. Ohl, O. Gunnarsson, K. Schönhammer, M. B. Maple, M. S. Torikachvili, and I. Lindau give an overview of the use of the impurity Anderson hamiltonian to describe the spectroscopic and low-energy thermodynamic properties of cerium intermetallics with emphasis on interpreting 4*f* photoemission spectra. Valence-band resonant photoemission (RESPES), Bremsstrahlung isochromat (BIS), and 3*d* x-ray photoemission (XPS) spectra are shown and a theoretical analysis of the spectra for $CeRu_2$, $CeNi_2$, $CeIr_2$, and CeAl is presented. Details on RESPES spectra of $CeSi_2$, $CeOs_2$, $CePd_3$, $CeCo_2$, and $CeNi_5$ are given and the problem of obtaining the experimental 4*f* spectrum is discussed. The Liu-Ho and the Kotani-Toyozawa models are discussed. The review can be found in *Advances in Physics*, **35**, 275-316 (1986).

RE's in the News

Tougher Ceramics

In a recent technological development in the field of advanced ceramics, researchers from GTE Laboratories, Stamford, Connecticut, have developed a ceramic composite material that has exhibited significantly higher resistance to fractures and breaks than any other known ceramic material. The material is made from silicon nitride, Si_3N_4, containing 6 percent yttrium and 2 percent aluminum (perhaps as oxides) to which silicon carbide whiskers are added. The present goal is to prepare a composite with 30 percent whiskers by volume.

The aim is the development of ceramic parts for automobile engines that could provide many advantages according to Dr. J. Thomas Smith, director of GTE Lab's Ceramics and Metallurgy Technological Center. For instance, the engine might operate at 2,500°F—about twice that of a conventional engine—which would reduce fuel consumption and pollution. Ceramic engines would also be lighter, wear longer, corrode less, transfer less heat, and need no coolant.

Improved PLZT

Researchers of Sandia National Laboratories have increased the photosensitivity of lead lanthanum zirconate titanate (PLZT) in the near-UV by a factor of 10^4 with no reduction in image quality. This makes PLZT the most photosensitive, nonvolatile image storing material that is also erasable and reusable. The improvement is accomplished by ion implantation of inert gas ions along with chemically active ions such as aluminum or chromium or by thermally diffusing aluminum into the surface followed by ion bombardment with neon. An 80-μm diameter segment may be capable of storing 60 bits of information making PLZT a candidate for use in optical computers.

Holmium Laser

In *Appl. Phys. Lett.* **48**, 1562-3 (1986), E. W. Duczynski, G. Huber, V. G. Ostroumov, and I. A. Shcherbakov claimed that, to the best of their knowledge, they had achieved for the first time cw operation of a Ho^{3+} laser at room tem-

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RE——BYC 1787——1987

How Many REs?

K. A. Gschneidner, Jr.

The discovery of the black mineral ytterbite (also known as gadolinite) by Lieutenant Carl Axel Arrhenius in a quarry in the village of Ytterby near Stockholm was the beginning of our 200 year history. The first individual element isolated from this ore was yttrium (in 1794) as an impure oxide. But then things became both complex and confusing because of the great chemical similarity of the rare earths. Many so-called "newly discovered elements" were, in time, found to be mixtures of as many as six different rare earth elements. Furthermore, claims were made of the discovery of a large number of "elements" that were supposed to be members of this series but were not.

Fortunately, other major developments occurred that aided rare earth scientists in their quest for their "holy grail" of isolating these elements. The application of the spectrograph to chemical determinations by Bunsen in 1859 gave the scientists a powerful tool for following the progress of the fractional separations of the rare earths. The publication of the periodic law of the chemical elements by Mendeleev in 1869, although not of immediate help, pointed the way for the atomic theory of the "aufbau" of the elements spearheaded by Niels Bohr and other quantum theorists in the early 1910s. *The prime contribution, however, was the experimental work of H. G. J. Moseley in 1912 on the relationship of the x-ray spectra to atomic number which finally showed exactly how many rare earth elements should exist.* Furthermore, the anomaly that 14 elements with properties similar to lanthanum existed proved to be an extremely important clue in developing our present theory of atomic structure.

Editor's Comments: *The response to our request to help celebrate the 200th anniversary of the discovery of the rare earths (see pages 1-2 of December 1986 issue of* RIC News*) was nonexistent. We still have three more issues left this year for you to partake. Sit down, right now, and jot down those 200 to 800 word stories and send them to RIC—it shouldn't take you more than 30 minutes. (At the time of going to press we did receive one contribution. We still need more.)*

Intermediate Valence And Heavy Fermion Systems

In *Physics Reports,* **143,** 277-345 (1986), C. Czycholl presents "Approximate Treatments of Intermediate Valence and Heavy Fermion Model Systems." Copies of this report may be purchased from the publisher, Elsevier Science Publishers, for Dfl. 47 (~U.S.$23.00).

The development and applications of approximations for the electronic properties of intermediate valence and heavy fermion systems during the past six years are initially reviewed by Czycholl. This introduction is followed by the largest section of the paper dealing with the single impurity and the lattice version of the Anderson model of magnetic moments within a metal. The methods described from a unifying point of view are mean-field approximation, alloy analog approximation, low-order and higher-order equation of motion decoupling, and systematic infinite-order perturbation theory. These methods are also considered from the aspect of a "1/n expansion." The paper contains a short overview of other recent theoretical work and discussions on the Falicov-Kimball model and on theoretical attempts to describe heavy fermion superconductivity. The paper ends with a bibliography containing 190 entries with many entries containing more than one reference.

RIC News
(USPS 464-960)
Vol. XXII, No. 1 March 1, 1987

Published
quarterly in March, June
September and December
by
Rare-earth Information Center
Energy and Mineral Resources
Research Institute
Iowa State University
Ames, Iowa 50011-3020

Second-class postage
paid at Ames, Iowa

Postmaster: Send address changes to
RIC News, Rare-earth Information Center,
Energy and Mineral Resources
Research Institute,
Iowa State University,
Ames, Iowa 50011-3020

Telephone: (515) 294-2272
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(Xerox 295)-(Group 1, 2, or 3)

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CONFERENCE CALENDAR

2nd Intl. Conf. on the Basic and Applied Chemistry of the f-Transition (Lanthanide and Actinide) and Related Elements (2nd I.C.L.A.)
Lisbon, Portugal
April 6-10, 1987
RIC News, **XIX,** [4] 3 (1984) and **XX,** [2] 2 (1985)

Intl. Symposium on Magnetism of Intermetallic Compounds (ISMIC)
Kyoto, Japan
April 20-22, 1987
RIC News, **XXI,** [1] 4 (1986)

9th Intl. Workshop on Rare-Earth Magnets and Their Applications and 5th Intl. Symposium on Magnetic Anisotropy and Coercivity in Rare Earth-Transition Metal Alloys
Bad Soden, West Germany
August 31-September 3, 1987
RIC News, **XXI,** [1] 4 (1986)

18th Rare Earth Research Conference (RERC)
Interlaken, Lake Geneva, Wisconsin, U.S.A.
September 11-15, 1988
RIC News, **XXI,** [3] 1 (1986)

?? Mailing List ??

We would like to ask your help in updating our mailing list. If you are receiving the *RIC News* with someone else's name on it, please advise us so we can delete the old name and add your name. Since the newsletter is free, there should be no reason for not letting us know. If you are receiving more copies than you want or if your address is not completely correct please let us know also.

In the News

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perature. The laser hosts are yttrium scandium aluminum and yttrium scandium gallium garnets doped with trivalent Cr, Tm, and Ho. The crystals were pumped via the Cr^{3+} ($^4T_2$) absorption band with a krypton laser beam at 647.1 nm. The excited Cr^{3+} excites the Tm^{3+}, which excites the Ho^{3+}. The Ho^{3+} lases via the $^5I_7 - {}^5I_8$ transition at 2080 nm.

Gadolinium-153

Oak Ridge Laboratory has redesigned its production facilities for producing Gd-153. The new facility is much safer, reducing the exposure of workers' hands by 100-fold and enabling ORNL to meet the demand for the radioisotope used to diagnose and measure osteoporosis (bone mineral loss).

* Contributors *

The growth of sponsors has continued through the third quarter of our fiscal year. We received support from 17 sponsors including six new family members. The total number of sponsorships received this year reached 77, nine more than last year at this same time.

The 17 additions to our list of benefactors, with the number of years the sponsor has been with us in parentheses, are listed below.

Aimants, UGIMAG, S.A., France (2)
Alcan International, Canada (1)
Allied-Signal Incorporated, U.S.A. (15)
Anderson Physics Laboratory Incorporated, U.S.A. (1)
Baldor Electric Company, U.S.A. (1)
Baotou Research Institute of Rare Earth, People's Republic of China (2)
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Th. Goldschmidt AG, West Germany (18)
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Lawrence Livermore Laboratory, U.S.A. (1)
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Rare Earth Products Limited, England (15)
Ronson Metals Corporation, U.S.A. (19)
Sumitomo Special Metals Company, Limited, Japan (2)
Vollbrecht Associates, U.S.A. (3)

LETTER TO THE EDITOR

Dear Editor:

In the December 1, 1986 issue of the *RIC News* in the "Dy" article, p. 2, an important use of Dy has been left out. It is being employed at a 3-4 wt.% concentration to enhance the coercivity of sintered $Nd_{15}Fe_{77}B_8$ magnets. [*Appl. Phys. Lett.* **48,** 548-50 (1986)].

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HOLWECK AWARD

Professor Denis Jérome of the Laboratory of Physics of Solids of the University of Paris-Sud at Orsay, France, won the 1985 Holweck medal and prize awarded by the Institute of Physics and the French Physical Society. He received the Holweck Prize for his ". . . impressive achievements with organic conductors and superconductors." Earlier in his career at Orsay, he had set up a group to study phase changes in conductors under pressure and at low temperatures. Among the phenomena he studied were valence changes and exchange interactions in rare earth metals such as cerium and ytterbium and compounds such as ytterbium chalcogenides and aluminides of cerium and lanthanum.

Superconductivity

(Continued from page 1)

versities of Houston and Alabama at Huntsville, and Lockheed Research Laboratory) and 70K for Lu-Ba-Cu-O (Brookhaven National Laboratory and Ames Laboratory). There are other reports of higher T_c's, but most of these are for the onset of superconductivity which may be much higher than the above noted temperatures. The next issue of the *RIC News* (June) will bring our readers up-to-date with the developments that will occur in the next few months—stay tuned.

These new developments could have vast applications provided reasonable critical current densities can be achieved in these phases. Some of these include the generation and transmission of electricity, medical diagnosis, enormously powerful electromagnets, supercomputers, and magnetically levitating the world's fastest trains. The achievement also could be applied to the proposed superconducting atom smasher and its 52-mile acceleration ring with a tremendous savings in cost. The proposed supercollider will use ~10,000 superconducting magnets.

The big savings in the costs of these applications is due to the fact that liquid nitrogen (boiling point 77 K) could be used to cool them rather than liquid helium (boiling point 4.2 K).

Business News

(Continued from page 1)

ciated with. To further exploit this development, the Federal Department of Science has set up a Rare Earth Working Party and other departments are investigating possible industrial developments using rare earths.

The Applegate Group

Wales A. "Bud" Otis has announced the forming of a marketing agency, The Applegate Group. This group will act as a sole agent for the sale of products from Foskem Pty. Ltd. and Ronson Metals Corporation. Among these products are mischmetal, cerium, lanthanum, didymium, neodymium, lighter flints, and certain alloys. Bud will have his office at Ronson Metals in Newark, New Jersey.

Haynes International

In 1985, the Cabot Corporation decided to get out of the metals business and offered to sell that part of its organization. No satisfactory bids were received so in October 1986 the Cabot Board of Directors approved a plan to incorporate the Kokomo High Performance Alloys Business of Cabot Corporation as an independent business entity. In December 1986, Haynes International, Incorporated, was selected as the name for the new company.

"In selecting the new name we are acknowledging a long tradition," said Paul F. Troiano, chief executive officer. Haynes Stellite Works was founded in Kokomo, Indiana, in 1912 by the noted inventor, Elwood Haynes, and incorporated in 1915 as the Haynes Stellite Company. It was purchased by Union Carbide in 1920 and became part of Cabot Corpora-

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tion in 1970.

Haynes International, Inc. produces high performance alloys that resist extreme conditions of heat and corrosion or have other special properties. Some of these special properties are due to rare earth additions.

ELEKTRON® WE54

A new magnesium casting alloy designated WE54 has been developed and patented by Magnesium Elektron, Limited, of England. The extended stability of the alloy at temperatures up to 300°C (572°F) is said to be higher than that of any magnesium-based alloy now available. Another interesting aspect of this alloy is its resistance to corrosion. This alloy typically contains 5.5 percent yttrium, 3.5 percent other rare earths, and 0.5 percent zirconium.

RHONE-POULENC APPOINTMENTS

The Fine Inorganic Chemical Division of Rhone-Poulenc Incorporated, Monmouth Junction, New Jersey, has announced the following appointments.

Daria Carlin was named venture analyst in the Business Development Department. Daria will be responsible for studying and recommending new business opportunities for inorganic chemicals in the United States.

Paul Benn and Herman Mihalich were named product development managers in the Commercial Development Department. Paul will be responsible for finding new, high value-added markets for cerium products while Herman will be responsible for developing new applications for rare earths and for proposing new areas for research in rare earth chemistry.

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