RARE-EARTH INFORMATION CENTER NEWS

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Left to right, M. J. Weber, S. E. Stokowski, J. E. Lynch, R. Morgret, R. R. Jacobs, A. J. DeGroot, R. A. Saroyan, C. B. Layne, and W. F. Krupke. In the foreground, disks of neodymium laser glass used in laser amplifiers.

Lawrence Livermore Laboratory

Rare-Earth Laser Research

Laser-induced thermonuclear fusion requires large, high-power lasers. The most powerful and versatile lasers presently available for fusion experiments are pulsed neodymium glass lasers. These lasers, which operate at 1.06 μm, consist of long amplifier chains and multiple beams. Nd glass disk amplifiers with beam apertures of 30 cm have been built. The largest neodymium glass laser in the world, the 100-1000 picosecond, 30-terawatt Shiva laser, is currently under construction at the Lawrence Livermore Laboratory in California. This laser contains approximately 1000 liters of rare-earth-doped materials.

The performance of fusion lasers is limited by materials properties. Improvements in the gain and efficiency of neodymium lasers are desired. The search for improved rare-earth laser materials at LLL is conducted in a group headed by Dr. M. J. Weber. Many different glasses have been investigated. In particular, the effects on the spectroscopic properties of Nd^{3+} ions of changing the glass network former (silicate, phosphate, borate, fluoroberyllate, . . .) and the network modifiers (alkali, alkaline earth, and higher valence state ions) are studied using special computer-controlled spectroscopy facilities assembled for this survey. The results have shown that large variations in absorption and emission cross sections, radiative transition probabilities, and the rate of nonradiative decay by multiphonon processes in glass are possible. Thus, the lasing properties can be tailored for specific laser performance by compositional changes.

The high optical fields in fusion lasers cause intensity-dependent changes in the refractive index of transmitting materials. This, in turn, leads to self-focusing of the laser beam and loss of energy to the fusion target. Therefore, optical materials with small refractive index nonlinearities are required. Because of

(continued on page 4)

Hydrogen Storage System

The electrochemical storage of hydrogen using a cathodic charge is the subject of recent research conducted by G. Bronoel, J. Sarradin, M. Bonnemay, A. Percheron, J. C. Achard and L. Schlapbach [*Int. J. Hydrogen Energy* **1**, 251-4 (1976)]. Using a 5N KOH medium at room temperature in an unpressurized system they observed a mass capacity of 5H per molecule of $LaNi_5$—much higher than predicted by thermodynamic equilibrium. The irreversibility of several reactions occurring at the solution-surface interface is employed by the authors to explain the non-equilibrium state in which the hydrogen is held. The effects of compound stoichiometry, substitution with calcium, strontium, yttrium, barium, titanium, etc. and temperature variation were studied. The best results were obtained at room temperature with minor substitution of copper or chromium for nickel. Electrodes, such as these, which can semi-reversably store large quantities of hydrogen are of possible use in the development of high density batteries.

NEW BROCHURE

As everyone knows, a lot of changes can take place in the course of ten years and the Rare-Earth Information Center is no different than anyone else. In light of these changes we felt it was time to update our brochure to let everyone know where RIC is today in terms of its scope and services provided. A new feature of this brochure is a listing on the reverse side of all the companies who have contributed to the support of the Center during the last two years. Copies are available by contacting the Center.

Distinguished Professor


W. E. Wallace

W. E. Wallace has retired as of April 1 of this year as chairman of the department of chemistry of the University of Pittsburgh, the post he has held for the last fourteen years. Upon retirement he was named Distinguished Service Professor of Chemistry. In relinquishing most of his administrative duties, Wallace hopes to be able to devote more time to his research activities which have included work on the magnetic properties, heat capacities and crystal field effects in rare earth metals and alloys.

RE CHAPTERS

USBM Bulletin 667, the 1975 edition of *Mineral Facts and Problems* is now available and contains two chapters of interest to rare earthers. Both the chapter "Scandium," written by R. V. Sondermayer, and "Yttrium and the Rare Earth Elements," written by J. H. Jolly, contain a wealth of information concerning rare earth industry size, organization and geographic distribution, applications, resources and reserves, technology, supply and demand relationships, byproducts, strategic considerations, economic factors and the future outlook. For more information contact the U. S. Government Printing Office, Washington, D.C. 20402.

SUPPLEMENT

Supplement No. 1 to NBS Special Publication 363, *Bibliography on Atomic Energy Levels and Spectra, July 1971 through June 1975* by L. Hagan (January 1977) is now available from the U. S. Government Printing Office, Washington, D.C. Besides atomic energy levels and spectra there are notations when the references contain information on energy levels, new designations, classified lines, wavelengths, Zeeman effect, Stark effect, hyperfine structure, quantum field effects, ionization potentials, isotopic and isomeric shifts and various theories. Approximately 2150 references are included and there is an author index.

Soviet MHD Research

Recent Soviet research on high temperature materials for MHD power plants has involved two different materials that contain rare earths [Report from the Institute of High Temperatures of the USSR Academy of Sciences by A. I. Rekov, F. A. Akopov, E. G. Spiridonov, A. I. Romanov and D. A. Vysotskii, JPRS-67586, July 13, 1976]. A ternary system of the composition 85 mole % ZrO_2-12 mole % CeO_2-3 mole % Y_2O_3 has been prepared and examined as a possible ceramic electrode. A layer of the ternary material forms the working surface and is backed by a CeO_2 ceramic. This system was found to have 40 to 50% electron conductivity and may be used in channels of open-cycle MHD generators that operate on gaseous or low sulfur liquid fuel with wall temperatures above 2000°C.

A 60% $LaCrO_3$-40% Cr cermet also received attention as a possible electrode for future large MHD generators. This cermet displayed high electrical and thermal conductivities and suitable thermionic emission properties. Addition of 3 wt. % of palladium significantly reduced oxidation under channel conditions. The authors feel this electrode material would be useful for large stations with high heat fluxes because of its high heat resistance.

PROCEEDINGS

The proceedings of the International Meeting on Hydrogen in Metals held January 5-6, 1976 at the University of Birmingham, United Kingdom has been reprinted from the *Journal of Less-Common Metals* **49**, [1/2] (1976) in book form entitled *Hydrogen in Metals*. The book (508 pages long) is published by Elsevier Sequoia S. A., Lausanne.

Eleven of the forty papers presented deal with hydrogen interaction with rare earth metals and their alloys and intermetallic compounds with cobalt, iron, manganese, nickel and palladium. Topics covered include specific heat of the dihydrides, hydrogen equilibrium pressures, adsorption and absorption of hydrogen and deuterium, effect of hydrogen on crystalline properties, formation of stable hydrides, hydrogen solubility and nuclear magnetic resonance.

International Prize for New Materials


H. T. Hall

H. T. Hall has been named one of four co-recipients of the 1977 American Physical Society International Prize for New Materials as a result of his work in developing high pressure, high temperature procedures for synthesizing new materials. To date Hall and his associates have prepared and characterized over 100 new solid state compounds, many of which contain rare earth elements.

Hall earned his doctorate at the University of Utah in 1948 and worked for General Electric's Research and Development Center from 1948 to 1955. At that time he received an appointment as director of research with Brigham Young University which he held from 1955 to 1967. In 1967 he was named to the post of Distinguished Professor of Chemistry, the position he currently holds.

Possible Thin Film Capacitors

The dielectric properties of thin film rare earth oxides have been examined experimentally by A. T. Fromhold, Jr. and W. D. Foster to determine their suitability for use as thin film capacitors [*Electrocomponent Sci. and Tech.* **3**, 51-62 (1976)].

Various properties including breakdown voltages, capacitance, dissipation factor and dielectric constant were measured for thin film oxides of scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, dysprosium, holmium, erbium, and ytterbium. Comparison of ease of preparation along with dielectric properties has lead the authors to conclude that the oxides of lanthanum, cerium, praseodymium, neodymium, gadolinium and erbium show the greatest promise for development as thin film capacitors. Several avenues of research are proposed to aid in understanding the role of gaseous impurities, conduction channels, heating and subsequent decomposition of dielectric materials.

CONTRIBUTORS

Six companies renewed their support of the Center in the fourth quarter of fiscal year 1977 setting a new record for the total number of companies which came to the support of RIC. The record now stands at 41 and surpasses the mark of 40 set in 1973. Of the 41, eight companies joined the family of RIC benefactors for the first time this year. The contributors for this quarter are listed below (the number in parentheses is the number of years the company has supported RIC).

American Metallurgical Products Co., U.S.A. (8)
Colt Industries—Crucible, Inc., U.S.A. (3)
GTE Laboratories, Inc., U.S.A. (5)
Industrial Minera Mexico, S.A., Mexico (3)
Lunex Company, U.S.A. (7)
Santoku Metal Industry Co., Ltd., Japan (7)

If contributions to RIC are a barometer then it is apparent that excellent progress has been made by the rare earth industry in recovering from a rather gloomy economic picture in 1976. Fiscal year 1977 is almost history now so we hope 1978 will be an even better year for all rare earthers.

I. T. Oiwa Dies

RIC has received word that Dr. I. T. Oiwa passed away April 15 of this year following a lengthy illness. Up to the time of his illness he was employed as the Director of New Metals Division of Shin-Etsu Chemical Company, Ltd. The rare earth industry and RIC will miss his contributions as a scientist, colleague and friend.

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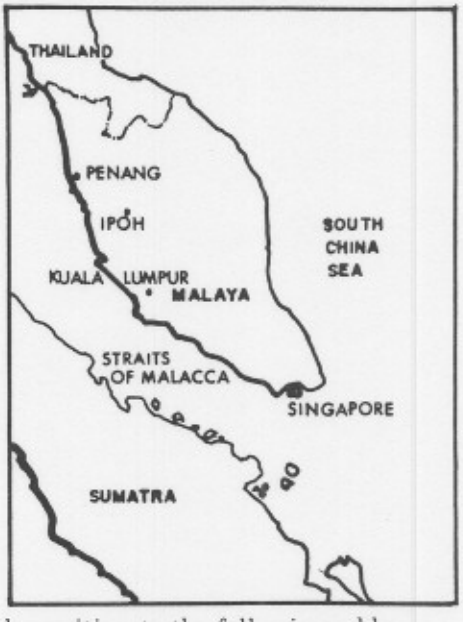
Who is .... 'The Rare Earth Industry'?

MAREC

MAREC which stands for the Malaysian Rare Earth Corporation is the first chemical plant in Malaysia to upgrade locally produced xenotime. Located at Ipoh in the state of Perak, MAREC represents a joint venture between Mitsubishi Chemicals of Japan and BEH Minerals Sdn. Bhd. of Lahat, Malaysia to recover xenotime from the waste products of the Malaysian tin mining industry. Initially conceived four years ago, MAREC's planning and construction stage culminated in August 1976 and its trial run and commissioning were completed November 1976. Incidentally the first overseas shipment also occurred on November 11, 1976. The plant was officially opened April 15, 1977. MAREC is running at full capacity today and is designed to produce 120 metric tons of a 50% yttrium concentrate per year. Principal officers include Mr. Loke Kong Kan, Managing Director; Mr. Leong Pak Cheong, Technical Director; Mr. T. Kobayashi, Plant Advisor (MCI); Mr. Chang Pek Hai, Plant Manager; and Encik Hamid bin Baharom, Administrative Manager.

More information can be obtained



by writing to the following address:

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Malaysia
Telex: BEHMIN MA 44088

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.

Lighter Flints Spark RE Education

F. C. Hentz, Jr. and G. G. Long have discovered that even the lowly lighter flint can be a key which unlocks some interesting rare earth chemistry [*J. Chem. Ed.* **53**, 651-2 (1976)]. When questioned most students did not know what a lighter flint was made of and most were amazed to learn that an 'ordinary lighter flint' contained such exotic elements as cerium, lanthanum, neodymium and praseodymium. Using the flints as the unknown, the authors devised four analytical experiments. These are determination of the hydrogen equivalent, determination of iron, determination of cerium and determination of both iron and cerium in the same sample. The iron and cerium determinations were checked and found to yield accurate and precise results. These experiments can provide the student in analytical chemistry good exercise in solution chemistry and oxidation-reduction techniques.

Segregated Platinum Is The Culprit

Following up on reports that $La_{0.7}Pb_{0.3}MnO_3$ displayed very promising catalytic properties, J. J. Croat, G. G. Tibbetts and S. Katz have discovered that platinum on the surface of the lanthanum lead manganite is responsible for much of the catalytic activity of these compounds [*Science* **194**, 318-20 (1976)].

Manganites containing as little as .005 atomic percent Pt showed much higher catalytic activity than platinum-free samples. Analysis revealed an almost 100-fold segregation (.5 at. %) of platinum on the surface of the crystals. Assuming this platinum has the same activity as platinum supported on alumina, then much of the activity of the manganites is attributable to the segregated platinum. Etching the crystals increased catalysis but the authors feel this due to the exposure of a more reduced form of platinum on the surface.

More X-Ray Screen Parameters Examined

Nine different rare earth x-ray screen/film systems have been investigated by B. A. Arnold, H. Eisenberg and B. E. Bjarngard for line spread function (LSF) and modulation transfer function (MTF) under practical conditions [*Radiology* **121**, 473-7 (1976)]. The screens consisted of yttrium, lanthanum or gadolinium oxysulfides doped with terbium and were compared with two fast calcium tungstate systems. Results indicate that the rare earth screens offer a significant advantage over calcium tungstate in that better screen MFTs are possible at a given speed. In addition smaller focal spots can be used to increase resolution which at the same time reduces patient exposure.

R. P. Rossi, W. R. Hendee and C. R. Ahrens have examined several commercially available rare earth screen/film combinations for base-plus-fog density, relative speed, average gradient, resolution, noise and overall performance [*Radiology* **121**, 465-71 (1976)]. The screens consisted of lanthanum, gadolinium or yttrium oxysulfide doped with terbium, and lanthanum oxybromide. The rare earth systems were up to 13 times faster than conventional screens and still had acceptable retention of detail and low image noise. Other advantages cited included reduced patient exposure and improvement of several operational parameters, e.g. use of small focal spots and ability to make better use of direct magnification techniques. The main disadvantage according to the authors would be the problems associated with switching over from calcium tungstate systems to the new rare earth systems.

Possible Merger for Molycorp and Union Oil

Molycorp officials have agreed in principle to a proposal by Union Oil to acquire all of Molycorp's common stock (~ four million shares) in an exchange of 1.035 shares of Union Oil stock for each share of Molycorp. The ~ $200 million deal would make Molycorp a wholly owned subsidiary of Union Oil and is still subject to approval by the boards of directors of each company and Molycorp's shareholders.

RE Laser Research
(continued from page 1)

the low refractive indices of fluoride-containing glasses such as fluorophosphates and fluoroberyllates, these materials are currently being investigated for fusion laser applications.

Rare-earth materials are also used in optical isolators. These devices are based upon paramagnetic Faraday rotation and provide isolation between amplifier stages and between the laser and the fusion target. Rare-earth ions which have large Verdet constants and which transmit in the visible-near infrared spectral range of interest for fusion lasers are Tb^{3+}, Ce^{3+}, and Eu^{2+}. Both crystalline and amorphous host materials are being studied.

In addition to research on Faraday rotator and Nd laser materials, other activities of Dr. Weber's group include the study of new rare-earth lasing schemes, fluorescence sensitization, and the application of laser-induced fluorescence line narrowing techniques to the investigation of rare-earth sites in amorphous materials.

While Nd glass lasers are powerful and versatile sources for fusion research, because of their low efficiency and pulse repetition rate they are not adequate for fusion power plants. The transition from a solid to a gaseous lasing medium could reduce damage and self-focusing problems and permit high average power usage via flowing the gas. The search for such laser systems is conducted in the Advanced Laser Research program headed by Dr. W. Krupke. Among various gas laser systems under investigation are three rare-earth vapor carriers: RE^{3+}-trihalogens, RE^{3+}-transition metal trihalides, and RE^{3+}-chelates. Measurements of fluorescence kinetics, determination of rates of radiative and nonradiative processes, and demonstration of gain and oscillation in rare-earth molecular vapors are underway. Other activities include the use of efficient gas lasers to pump selected excited states of other rare-earth lasers.

RE's in the News

Laser Separates RE's

Lasers which are efficient in the ultraviolet region have been successfully used by T. Donohue of the Naval Research Laboratory to separate rare earths from aqueous solutions. The laser photochemically reduces europium which then forms a relatively insoluble salt with sulfate ions and can be easily recovered. Donohue believes the procedure will also work for samarium, ytterbium and the actinides.

Shortest Wavelength Laser

Researchers at the Naval Research Laboratory have been successful in producing the seventh harmonic of Nd-YAG laser light which resulted in the generation of coherent radiation at 380 Å . The ultimate goal of this research is the development of an x-ray laser (~ 100 Å or less) which could be used to study crystals or in the manufacture of microcircuits.

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