RARE-EARTH INFORMATION CENTER NEWS

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Rare earth group at the Helsinki University of Technology. Pictured in the back row from left are M. Koskenlinna, J. Valkonen and M. Leskelä. In the front row from left are Dr. L. Niinistö, M.-L. Surakka, Dr. I. Yliruokanen, K. Nieminen and Dr. M.-L. Sihvonen. Missing from picture: L. Hiltunen and P. Minkkinen.

Helsinki University of Technology—

Rare Earth Synthesis and Analysis

Rare earth research at the Helsinki University of Technology has a long tradition. One of the early researchers in this field was Dr. J. Ant-Wuorinen who completed his Ph.D. thesis on yttrium in 1913 and later continued his rare earth research in Helsinki. Many of the current research projects were initiated by the late Professor Olavi Erämetsä who served as professor of inorganic chemistry nearly three decades until 1973 (see *RIC News* **X**, [3] 3 (1975)).

Current research at the Laboratory of Inorganic and Analytical Chemistry is focused on synthesis, structure and properties of rare earth compounds containing chalcogens and the occurrence of rare earths as trace elements in biological materials. In addition improvement of instrumental techniques for the analytical determination of rare earths is being researched.

Dr. L. Niinistö directs a group working on the synthesis, structure and thermal properties of compounds with general formula $R_2(XO_4)_3 \cdot nH_2O$ where X is S or Se and x = 3 or 4. All stable rare earths including scandium are involved in the research. X-ray crystallographic techniques are used to determine structural data with the aid of an automatic single-crystal diffractometer. Thermal stability of the compounds has been studied by thermal analysis methods in oxidizing, inert and reducing atmospheres as well as in vacuum. In reducing atmospheres oxysulfides and oxyselenides may be obtained and the effect of trace impurities on their luminescent properties have been studied. Other group members include doctoral candidates M. Koskenlinna, M.

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RE'S RATED HIGH

Rare earths finished strong placing seven products in *Industrial Research's* top 100 products for 1975. This is the most ever and reflects the increased availability and variety of uses to which the rare earths can be applied. These seven products are briefly described below.

Terbium-activated lanthanum oxybromide phosphors are now being used in X-ray intensifying screens for diagnostic medical radiography. These screens give improved resolution with less X-ray exposure to the patients while indirectly lowering costs because of the less expensive film that is required.

A lanthanum hexaboride cathode has been developed as a direct replacement for tungsten hairpin filaments in scanning electron microscopes (SEM). The new cathode gives good performance at low cost and runs off existing power supplies. Its higher brightness increases resolution by a factor of two in SEMs. Other applications of this cathode include transmission electron microscopes, Auger systems and electron-beam lithography machines.

A YAG:Nd laser is used in a new holographic laser system. This system could replace the pulsed ruby lasers now being used in holography because of its lighter weight, higher repetition rate, smaller size and shorter double-pulsed separations. In addition the unit can be run on batteries for field operations. Other applications include non-destructive testing, flow diagnostics and Raman spectroscopy.

The YAG laser strikes again in a

(Continued on Page 4)

MEETING

12th Rare Earth Research Conference

The 12th Rare Earth Research Conference committee has set deadlines for those wishing to present papers. Abstracts, sufficiently detailed to permit evaluation, should be sent to Dr. Charles E. Lundin, Denver Research Institute, University of Denver, Denver, CO 80210, U.S.A. no later than January 15, 1976. Authors of accepted papers will be notified by February 15, 1976.

Sessions are planned in the areas of bio-inorganics, physical chemistry, solid state chemistry, metallurgy, solid state physics, chemistry, magnetics, intermetallics and industrial use.

JOINT MMM - INTERMAG CONFERENCE

The Annual Conference on Magnetism and Magnetic Materials and the Intermag Conference will meet jointly June 15-18, 1976 at the Hilton Hotel in Pittsburgh, Pennsylvania. This will be the only meeting of either of these two major conferences during 1976. Both invited and contributed papers will deal with experimental and theoretical research in magnetism, the properties and synthesis of new magnetic materials, and advances in magnetic technology. Abstracts must be submitted by February 20, 1976 and those selected for presentation will appear in a program booklet prior to the conference. For information on the preparation and submission of abstracts contact either the Conference Chairman, E.W. Pugh, IBM Research Center, P.O. Box 218, Yorktown Heights, N.Y. 10598 or the Local Committee Chairman, F.E. Werner, Magnetics Dept., Westinghouse R&D Center, Beluah Road, Pittsburgh, Pa., 15235. Abstracts should be submitted to Dr. H.C. Wolfe, American Institute of Physics, 335 East 45th Street, New York, NY 10017. The Proceedings of the Joint Conference will be divided between the *AIP Conference Proceedings* and the *IEEE Transactions on Magnetics*. Firms wishing to participate in an exhibit of equipment, components, materials and technical information are urged to contact the exhibit manager, C&M Associates, P.O. Box 68, Maple Glen, Pa. 19002.

NEUTRON SCATTERING CONFERENCE

The Riverside Motor Lodge in Gatlinburg, Tennessee will be the site of a conference on Neutron Scattering, June 6-10, 1976. The conference is sponsored by the Oak Ridge National Laboratory and the United States Energy Research and Development Administration and will consist of both invited and contributed papers. Topics to be covered will include (not necessarily limited to) crystal structure, liquids and amorphous solids, magnetic structures and moment distributions, lattice dynamics, magnetic excitations, small angle scattering, phase transitions and critical scattering, and neutron optics. Abstracts should be sent to J. W. Cable, Solid State Division, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee 37830, U.S.A. by February 1, 1976. A booklet containing accepted abstracts will be available at the conference. The proceedings of the conference will be published and papers are due for this by May 15, 1976. Dr. R. Scherm, Institut Laue-Langevin, Grenoble, France is in the process of organizing a charter flight from a central location in Europe. Those wishing to take advantage of this transportation from Europe should contact Dr. Scherm as soon as possible. It should also be noted that the Conference on Neutron Scattering precedes the combined MMM/Intermag Conference which will be held in Pittsburgh, PA, June 14-18, 1976.

For more information contact Dr. W. C. Koehler, Solid State Division, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee 37830, U.S.A.

MAGNETIC BUBBLE CONFERENCE

The Second International Conference on Magnetic Bubbles will be held September 13-15, 1976 in Eindhoven, The Netherlands immediately following the International Conference of Magnetism in Amsterdam (September 6-10, 1976). The program will consist of invited talks and a limited number of contributed papers. Session topics will include amorphous materials, crystalline materials, wall dynamics, devices, device physics, fabrication and reliability. For more information contact Dr. P.F. Bongers, Philips Research Laboratories, Eindhoven, The Netherlands.

Lanthanum Stars in Absorbing Movie

Dr. C. G. Sluijter of the N. V. Philips Research Laboratories has produced a film, authored by H. H. van Mal, H. A. van Esveld and H. Zijlstra, showing the activation of $LaNi_5$-type hydrogen absorption compounds. Schematics and actual equipment are shown along with a comparison of hydrogen storage space requirements of $LaNi_5$ versus the conventional method. $LaNi_5$ and $LaNi_5$ doped with either copper or silicon are shown undergoing the visually dynamic process of activation.

The film (10 min, 16 mm optical sound, color) can either be obtained on short term loan with payment of return shipping .or purchased for $125.00. For more information contact:

Dr. C. G. Sluijter
Scientific Film Producer
Philips Research Laboratories
Eindhoven
The Netherlands

RIC-DD Acquisitions

RIC-DD-14 **Matrix Elements for Many-Electron Atoms. Electrostatic and Spin-Orbit Interaction Energies for One-Open-Shell Configurations** by J. Karwowski, K. M. S. Saxena and S. Fraga (1975) 85 pp (U.S. $8.50) [Airmail Rate B].

For those of you who are not familiar with RIC's Document Depository (DD) service see *RIC News* VIII, [2] 8 (1973). A list of the available documents may be obtained by writing to the Center.

More RE's Quit Resisting

C. Reale has reported superconductivity in several lanthanide films prepared by vapor-quenching [*Thin Solid Films* 28, L29-L30 (1975)]. At low temperatures resistivity in La, Ce, Pr, Nd, Eu and Yb dropped to as near zero as could be measured while the other rare earths showed no superconductivity down to 0.1 K. The superconducting transition temperature, T_c, irreversably decreases with increasing annealing temperature, which removes structural imperfections frozen in during deposition, until superconductivity is quenched (Eu, Yb) or reaches a limiting value (La, Ce, Pr, Nd). T_c was also found to decrease with increasing film thickness, i.e. for La, T_c fell from 9.8 K for 100 Å film to 6.8 K for a 2100 Å film. While La is the only listed bulk superconductor the author suggests that Ce, Pr and Nd should exhibit superconductivity even in bulk samples at 1.16, 0.75 and 0.55 K, respectively.

RE'S IN PLANTS

A chemical study on the occurrence of rare earths in plants is the subject of a comprehensive review conducted by I. Yliruokanen [*Annal. Acad. Sci. Fennicae Ser. A II. Chem.* [176] (1975)]. Selected plant species were analyzed using spark source mass spectrometry to determine the rare earth content. In some cases the underlying soil and bedrock were examined for rare earths to study this effect on plant content. In general the rare earth concentration in the plants studied reflected the rare earth concentration in the underlying bedrock, however, some exceptions are noted.

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Telephone:
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K.A. Gschneidner, Jr. ..... Editor
Bernie Evans and Betty Verkade
Staff Writers

Young Rare Earther Dies

RIC has received word of the tragic death of H. H. Hill at the age of 36 in a one car accident. Hill, who worked for the Los Alamos Scientific Laboratory, Los Alamos, N.M., authored more than 35 papers, a quarter of which dealt with or were related to the rare earths. His range of interests was unusually broad as he attempted to bring the varied disciplines of physics, chemistry and metallurgy to bear on the lanthanides, actinides, their alloys and intermetallic compounds to improve the understanding of their electronic and physical properties. His research in superconductivity led to many experimental and theoretical advances. Recently, he had been working to provide a coherent picture of such varying aspects of the actinides as valence, bonding, cohesive energy, crystal structure, band structure, melting points and low temperature electronic behavior.

Hill received his BA in physics from Rice University in 1960, an MS from the California Institute of Technology in 1963 and his Ph.D. in physics from the University of California in 1968. His recent months had been unusually productive and his untiring efforts are already missed by his colleagues. Hill's untimely death is a great loss to his family, friends and the scientific community.

Moon ChemistRE

Rare earths keep turning up in a description of the chemistry of the moon as given by R. A. Pacer and W. D. Ehmann in *J. Chem. Ed.* **52**, 350-7 (1975). Rare earths are present in seven of the 33 lunar materials listed. In fact, one form of basalt found on the moon which is not present on earth, was named KREEP because of its potassium (K), rare earth element (REE) and phosphorus (P) enrichment.

Two chemical processes associated with the moon's crust are (1) the enrichment of refractory elements (which includes the rare earths) and depletion of volatile elements and (2) an europium anomaly. The anomalously low abundance of europium is thought to be related to a lower oxygen fugacity at the time of formation of the lunar basalt causing Eu^{3+} to be reduced to Eu^{2+} which led to fractionation.

Future Energy Source

I. T. Oiwa has published a 'state-of-the-art' review of hydrogen as a future energy source in *Chem. Econ. & Eng. Rev.* **7**, [6]13-7 (1975). A rare earth alloy, specifically $LaNi_5$, figures prominently in the transportation and storage of hydrogen fuel. Some of the advantages include the following. The energy density of $LaNi_5H_6$ is 12 times greater than compressed H_2 gas and twice as large as liquid H_2. The pressure requirement is a factor of 50 less than liquid H_2. Hydrogen is released from intermetallic compounds by an endothermic process. For $LaNi_5H_6$ the energy requirement is significantly less than other compounds and the hydrogen discharge from $LaNi_5H_6$ is rapid. The purity of the hydrogen is not critical in the formation of $LaNi_5H_6$ and the quality of the $LaNi_5$ remains nearly constant in spite of repeated cycling of hydrogen adsorption and desorption.

Helsinki Univ.

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Leskelä and J. Valkonen.

Drs. M.-L. Sihvonen and I. Yliruokanen are studying the occurrence of rare earths in biological materials such as human and animal tissue and plants. K. Nieminen is involved with studies concerning rare earths and other elements in plants. These studies have been recently extended to include the underlying soil and rock in an effort to evaluate the use of certain plants as biogeochemical indicators. Nieminen is also studying, with M.-L. Surakka, scandium content of wolframite samples and its extraction from this source.

Analytical methods employed include the following spectroscopic techniques: spark source mass spectrometry, X-ray fluorescence, optical emission spectrometry and atomic absorption. Graduate students L. Hiltunen and P. Minkkinen are working to improve the instrumental techniques.

CONTRIBUTORS

Eleven contributions have been received raising the number of Center benefactors to twenty-three. Those contributing in the second quarter are:

- Denison Mines Limited, Canada (4)*
- Foote Mineral Co., U.S.A. (4)
- GTE Sylvania, U.S.A. (4)
- Indian Rare Earths, Ltd., India (7)
- Lunex Co., U.S.A. (6)
- A/S Megon, Norway (7)
- Nippon Yttrium Co., Ltd., Japan (6)
- Nuclebras-Empresas Nucleares Brasileiras S.A. (formerly Companhia Brasileira de Tecnologia Nuclear), Brazil (4)
- Research Chemicals, U.S.A. (8)
- Rhone-Poulenc-Chimie Fine (formerly Rhone-Progil), France (6)
- United States Radium Corp., U.S.A. (6)

*Number in parentheses indicates the number of years that company has contributed to the Center's support.

While the number of contributors is still running behind last year, we have made up some ground so that we are not as far behind now as was noted in the last issue of *RIC News*.

Ho-Tb-Fe Single Crystal

J. B. Milstein, N. C. Koon, L. R. Johnson and C. M. Williams have developed a method for producing single crystals of cubic Laves phase compounds, RM_2, in the holmium-terbium-iron system [*Mat. Res. Bull.* **9**, 1617-22 (1974)]. These compounds have generated a lot of interest because of their large room temperature magnetostrictive strains [see *RIC News* **VI**, [4] 7 (1971)]. Single crystals were needed to determine magnetostrictive and anisotropy constants. Problems associated with single crystal preparation from these phases include incongruent melting, volatilization of the rare earths and attack of rare earths on crucible materials. The authors used the Czochralski method to grow single crystals of the composition $Ho_{1-x}Tb_xFe_{1.95}$ ($x = 0.12$ to 0.15) which were up to one centimeter in diameter by several centimeters in length.

RE's in the News

RE'S AID IN GAS CRUNCH

A device composed of zirconium and yttrium oxides which monitors the oxygen content in exhaust gases of automobiles has been developed by UOP Inc. The device measures the difference between oxygen content in the exhaust and in unburned air. This information is electronically transmitted to a miniprocessor which then adjusts the carburator for the optimum air/fuel mixture.

NEW RE LASER HOST

$La_2Be_2O_5$ has undergone tests as a Nd^{3+} laser host and has had favorable results. Compared with YAG:Nd^{3+}, $La_2Be_2O_5$:Nd^{3+} offers improved efficiency and energy storage in pulsed and Q-switched operation. The new host will be useful in applications where polarized radiation is desirable.

ALLIED PLANT EXPANDS

Allied Chemical will expand operations with a new plant in Charlotte, North Carolina to be used in growing synthetic crystals for laser and electronics applications. One of the major products will be magnetic garnet films for magnetic bubble memories.

NEW RE COMPANY

Joseph R. Jackman has formed a new rare earth company under the name Reactive Metals and Alloys Corporation, REMACOR. Taking over the former Rare Earth Industries plant and equipment, Jackman resumed operations in March of this year. Rare earth products include mischmetal and rare earth silicide.

Analyse Ions Using Europium Emissions

John Wright, a University of Wisconsin chemist, has developed a technique using rare earth elements and lasers to detect trace amounts of ions in solutions. A substance containing Eu is added to the solution which then precipitates taking Eu and unknown ions with it. The Eu is then activated by a laser and gives off a spectra which is characterized by the ions, e.g. phosphate, chloride, nitrate, etc., surrounding the Eu. So far Wright has been able to identify phosphate ions at concentrations of less than 1 ppm.

Rated RE's

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laser micromachining system which combines high precision and speed with versatility. Possible applications for this device include programing ROMs, wafer scribing, resistor trimming and microengraving.

Lanthanum-modified lead zirconate, lead titanate (PLZT) ceramics form electro-optic shutters in a steroscopic viewer for viewing 3-dimension displays on cathode ray tubes. The device is worn like an ordinary pair of glasses. The primary application is analysis of 3-D structural data. Additional uses include navigation, range-finding, traffic control and geographical contour studies.

The final rare earth products in the top 100 are high temperature Haynes alloys 556, 1000 and 1002 all of which contain lanthanum. Haynes Alloy 556 features improved fatigue resistance, reduced cracking and improved weldability. Haynes Alloys 1000 and 1002 were developed for the investment casting process and feature resistance to hot corrosion and oxidation.

Rare-Earth Information Center
Energy and Mineral Resources Research Institute
Iowa State University
Ames, Iowa 50011

Russian Books

In the past few months RIC has added the following Russian books to our collection of documents. *Lantanoidy v Rudakh Redkozemel'nykh i Kompleksnykh Mestorozhdenii* [*Lanthanides in Ores. Rare Earths and Complex Deposits*], D. A. Mineev, Izdatel'stvo Nauka, Moscow (1974). *Poluchenie i Issledovanie Svoistv Soedinenii RZM* [*Production and Investigation of Properties of REM Compounds*], G. V. Samsonov, Yu. M. Goryachev, V. I. Marchenko and T. G. Kutsenok, eds., Akademiya Nauk Ukrainskoi SSR, Kiev (1975). *Poroshkovaya Metallurgiya Katodnykh Materialov* [*Powder Metallurgy of Cathode Materials*], G. V. Samsonov, V. Ya. Shlyuko, Yu. A. Kunitskii, V. V. Morozov, Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya Ukr. SSR, Kiev (1975). *Metallovedenie Redkozemel'nykh Metallov* [*Metal Science of the Rare Earth Metals*], E. M. Savitskii and V. F. Terekhova, Izatel'stvo Nauka, Moscow (1975).

SLOW AIRPLANES DOWN

Nickel-Gd_2O_3 and nickel-La_2O_3-LaF_3 composites were among materials tested by R. C. Bill for application as high energy brake lining materials [*NASA-TN-D-7756*]. Simulation of actual aircraft brake application was used to find a material with reduced squeal and friction-induced vibration. Copper-Gd_2O_3 and copper-La_2O_3-LaF_3 were also tested but lacked structural integrity during braking experiments. Bill concluded that nickel-Gd_2O_3 and -La_2O_3-LaF_3 composites were comparable or superior in friction and wear performance to presently used materials and are considered to be worthy of further development.