RARE-EARTH INFORMATION CENTER NEWS

AMES LABORATORY

Iowa State University / Ames, Iowa 50010

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EDITORIAL —

The State of RIC

RIC is celebrating its first anniversary at about the time of writing this column. It is an appropriate time to reflect upon some of the events which occurred during the past twelve months.

RIC NEWS

The example most obvious to our 600 subscribers (80% United States, 20% Foreign) is *RIC NEWS*. We have endeavored to present you a broad view of the events, developments and publications which occurred in the rare-earth field. Perhaps we slighted some areas. If you feel this way we would appreciate your critical and constructive comments.

Your cooperation in the form of reprints, news releases and contributions to "RARE-EARTHERS AROUND THE WORLD" during this past year has been good and we hope that it will continue and even improve. For those of you who do not have all of the first four issues, we still have a few copies of each and we shall be happy to send you any one or more to complete your set.

INFORMATION INQUIRIES

During the past year the Center has answered 379 requests from persons not employed by the Ames Laboratory. The affiliations of the requesters are summarized in the accompanying table. Approximately 17% of these requests were from countries other than the United States, including Australia, Canada, Chile, India, Malaysia, New Zealand, Puerto Rico, Republic of South Africa, Russia, Thailand, and most of Western Europe.

RIC Users, 1966

Affiliation	*No.*	*%*
GOVERNMENT (Federal, State)	68	18
INDUSTRY	188	50
UNIVERSITY	81	21
INDIVIDUAL	29	8
MISCELLANEOUS	13	3

The requests have been varied. They were concerned with sources of rare earth materials, analytical procedures, mining, chemistry of particular rare-earth compounds, medical research applications, physical properties of certain materials, the metallurgical behaviors, the use of rare earths as biocides, and just general information about the rare earths. We have provided some unusual services such as locating missing persons (i.e. helping persons re-establish contact after one of them has relocated), suggesting high school research projects, and finding the reference source when only the title of the paper is known.

We thank the scientists on the Ames Laboratory staff who have assisted us in answering some of the requests: R. Z. Bachman,

(Continued on Page 5)

PRO Pr_O

The results of an extensive study of the praseodymium-oxygen system have been recently published in *Phil. Trans. Royal Soc.* (London) *259*, 583-614 (1966) by B. G. Hyde, D. J. M. Bevan and L. Eyring of Arizona State University, Tempe. An isobaric study of this system from 0 to 1 atm and from 200 to 1150°C permitted these men to construct a pressure-temperature-composition diagram over the composition region $PrO_{1.65}$ to $PrO_{1.64}$. Extension of these data resulted in the projection of the three-dimensional diagram on to the temperature-composition plane over the region $PrO_{1.50}$ to $PrO_{2.00}$.

At temperatures greater than 1000°C only three compounds exist between $PrO_{1.50}$ and $PrO_{2.00}$, but at 400°C seven compounds were found. The formation of metastable phases and phase transformation hystereses were observed. A model was proposed for explaining the appearance of these metastable phases. The authors noted that previous experimental data on this system are consistent with the proposed phase diagram.

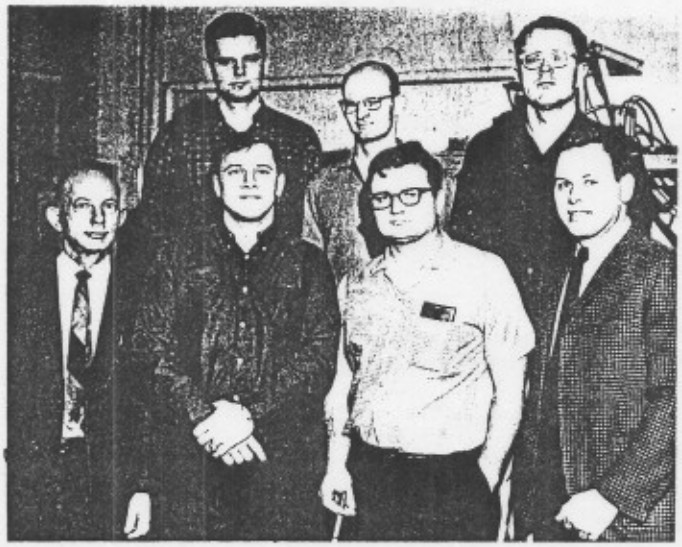
Rare Earthers Around The World

AMES LABORATORY –

Solid State Physics Group

Research programs of current interest to Experimental Physics Group II include magnetic and transport properties of rare-earth metals and alloys.

Ronald S. Lee has just completed a study on the Hall effect in single crystal Y, Lu, and Gd. The most interesting feature he found was a difference in sign for the Hall coefficients of Lu. With the magnetic field along the c-axis the sign was negative and for the field along an a-axis the sign was positive. This type of behavior is not totally unexpected in the heavy rare earths since they have multiple band carriers and highly anisotropic Fermi surfaces.



SOLID STATE GROUP — In the front row from left are Dr. Sam Legvold, C. Michael Cornforth, L. Roger Edwards and Donald Boys. In the back row from left are William Nellis, Durkee Richards and Ronald S. Lee (now assistant professor of physics, Kansas State University, Manhattan, Kansas).

L. Roger Edwards has grown a number of Tm single crystals and measured their electrical resistivity and Seebeck coefficients. The high sensitivity of the Seebeck coefficient to magnetic transformations pinpointed the order-order magnetic transition at 32°K.

There was no indication of the transition in the electrical resistivity results.

Durkee Richards, C. Michael Cornforth, and L. Roger Edwards are all deep in the throes of building a Foner magnetic susceptibility system for a new 100 kgauss superconducting solenoid. It is well on the way to completion. Edwards will be examining the magnetic properties of Tm. Richards and Cornforth will study the saturation moment of Gd, Tb, and Dy alloyed

(Continued on Page 7)

Ground States Are Identical

W. Weltner, Jr., has shown that the ground states of ScO, YO and LaO are identical and have the $^2\Sigma$ configuration, rather than the previously reported $^4\Sigma$, $^2\Sigma$, and $^4\Sigma$ configurations, respectively. He made this determination by trapping "hot" molecules at 4°K using a technique called matrix isolation. The trapped molecules were then examined by using electron paramagnetic resonance spectroscopy to reveal the ground state. The results were reported in an article entitled, "Stellar and Other High-Temperature Molecules," *Science* 155, 155-63 (1967).

Pitchblende from the Republic of the Congo (formerly the Belgian Congo) contains $(4.5 \pm 1.0) \times 10^{-6}$ percent Pm due to fission of U^{235} and U^{238} [B. T. Kenna, M. Attrep, Jr., *J. Inorg. Nucl. Chem.* 28, 1491 (1966)].

Medical Uses Of Yttrium

Epilepsy

Yttrium-90 treatment of certain types of epilepsy was effective in preventing further attacks in 9 out of 15 cases. However, two of the patients developed serious memory disturbances, ten others had less serious disturbances and three patients developed transitory confusion states.

Additional information on this radioisotopic treatment of epilepsy may be found in an article by J. Talairach and G. Szikle, *Neuor-Chir.* 11, 233-250 (1965).

Cancer

Eleven of 22 cases of breast cancer showed clinical improvement after treatment by Y-90 hypophysectomy,* according to G. H. Bateman, *J. Oto-Laryngol. Soc. Austral.* 1, 256-260 (1964). α-radiation from Au-198 had previously been used successfully, but with some damage to adjacent structures. The shorter range of Y-90 β-radiation was used in an attempt to avoid such damage.

* Removal of pituitary body

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International Happenings —

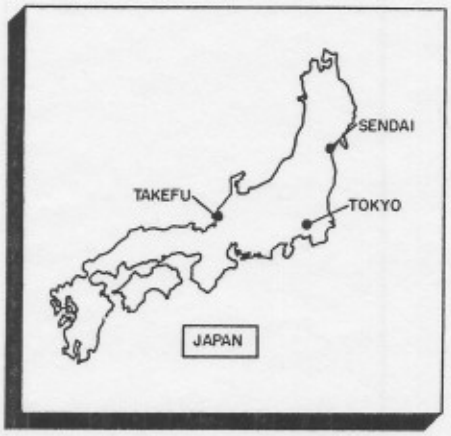
Rare-Earth Research-Japan

F. H. Spedding
Ames Laboratory, USAEC, Iowa State University, Ames, Iowa

During October I visited a number of universities and industrial laboratories in Japan. I found that the Japanese scientists were extremely friendly and were intensely interested in the work that is going on in the United States. Most of my scientific discussions in Japan were limited to the chemistry and metallurgy of the rare earths, thorium and uranium. Some of the institutions I visited are listed below.

University of Tokyo

At the University of Tokyo I was taken through the Chemistry Department and saw N. Saito's research facilities for the study of radioactive rare earths and the separation of lithium isotopes by means of fused salt cells. I also visited their nuclear magnetic resonance laboratories. In the afternoon, I saw the Nuclear Engineering Department of the University and was shown linear accelerators, Van de Graaff machines, and apparatus for studies of critical assemblies and fuel elements.



Tohoku University

In Sendai, the home of Tohoku University, I spent most of the time in the Institute for Iron and Steel and was shown work on rare-earth separations by ion-exchange. They are attempting to use Japanese-made resins in their rare-earth pilot plants.

I was impressed with their studies involving the effects of magnetic fields on metals. The Institute is well-equipped with high-field iron core and super-conducting magnets.

They also have an excellent analytical chemistry division capable of doing the fine analytical work necessary for pure materials development. One of these is the preparation of pure titanium.

Shin-Etsu Company

I visited the Shin-Etsu site at Takefu where a pilot plant, similar to the one at the Ames Laboratory, is separating 200 lbs. of yttrium oxide monthly. They use American-made resins in what appears to be a successfully operating pilot plant. I was told that they are in the process of designing a large scale plant similar to Michigan Chemical's.

General Remarks

There seems to be a wide range of studies involving the rare earths under way in Japan. My opinion is that the laboratories have a real momentum. I am convinced that the Japanese will soon be producing television screens which incorporate europium, yttrium, and perhaps other rare earths.

I think that the importance the Japanese place on rare-earth technology is exemplified by the fact that Mr. H. Yanagida, Head of Shin-Nippon-Kinzoku-Kagaku, informed me that he was to receive a medal from the Emperor for having made the first industrial use of rare earths in Japan. His company manufactures lighter flints. *If the rare earths are significant enough for the Emperor to be aware of them, the Japanese must put considerable emphasis on their importance.*

MEETINGS

SIXTH RARE-EARTH CONFERENCE

Dr. Howard Kremers, American Potash and Chemical Corp., will give the keynote address, "Uses of the Rare Earths," at the Sixth Conference, according to Chairman W. C. Koehler.

There will be 30 contributed papers in solid state physics, 27 in chemistry, 7 in metallurgy and 9 in industrial processes (invited papers were listed in the December, 1966 *RIC NEWS*.) One day will be spent visiting the Oak Ridge National Laboratory facilities. Dr. Koehler has assured us that the details of the program will be sent early in April to everyone who has received previous notices concerning the Conference.

OBITUARY

Dr. William F. Meggers, world renowned spectroscopist, died at the age of 78 in his Washington, D.C. home on Nov. 19, 1966. He devoted much time to the unraveling of the complex spectra of the various ionic states of the rare-earth atoms, especially yttrium, thulium, ytterbium and lutetium. In addition to these studies he made valuable contributions to the description and analysis of spectra of other elements, physical optics, astrophysics, spectrochemical analysis, wave length standards, the periodic nature of the elements, and photography.

William Meggers was born on July 13, 1888 in Clintonville, Wisconsin. He received his B.S. degree from Ripon College (Wisconsin) in 1910, an M.A. from the University of Wisconsin in 1916 and a Ph.D. from John Hopkins University in 1917. Meggers joined the National Bureau of Standards in 1914 and worked for the Bureau the rest of his life. He received five medals from various scientific societies for his contributions to spectroscopy.

ACS Meeting —

Lanthanide and Actinide Symposium

Therald Moeller
University of Illinois, Urbana, Illinois

This symposium was a part of the scientific program of the 152nd Meeting of the American Chemical Society in New York City in September 1966. It was arranged under primary sponsorship of the Division of Inorganic Chemistry but with joint sponsorship by the Division of Nuclear Chemistry and Technology. Co-chairmen were Dr. Paul Fields, Argonne National Laboratory, who was responsible for papers in the actinide area, and Dr. Therald Moeller, University of Illinois, who was responsible for papers in the lanthanide area.

The program* was comprised of thirty papers plus an introductory summary dealing with recent advances in the two areas by K. W. Bagnall (Harwell) presented as one of the opening lectures of the Inorganic Division. The majority of these papers will appear in a volume in the Advances in Chemistry Series, scheduled for publication early in 1967.

Material from the lanthanide portion of the program is summarized below.

Physical Characteristics. Drs. W. T. Carnall and P. Fields (Argonne) described calculations of energy levels in the absorption spectra in terms of electrostatic, spin-orbit, and configurational interaction considerations and reported many close correlations between calculated and observed values.

The spectra of the gaseous trihalide molecules were shown by D. M. Gruen and C. W. DeKock (Argonne) to provide excellent testing ground for energy-level and intensity calculations involving *f-f* transitions. Hypersensitive bands were found to be ~10 times as intense as those observed for crystals or solutions.

Solid-State Chemistry. The present status of thermochemical and thermal data for the metals, chalcogenides, borides, halides, and ethyl sulfates was summarized by E. F. Westrum, Jr. (Michigan). Trends and ambiguities in data were discussed in terms of magnetic and electronic phenomena, cooperative transitions, Schottky anomalies, and low-lying electronic levels.

The preparation of divalent ions in alkaline earth halide matrices was described by P. N. Yocum (R.C.A. Laboratories). Absorption, emission, and electron paramagnetic resonance spectra were used in establishing similarities in energy-level schemes with those of the isoelectronic tripositive ions.

J. D. Corbett, R. A. Sallach, and D. A. Lokken (Iowa State) used magnetic and resistivity data to define LaI_2, CeI_2, and $LaI_{2.42}$, which result by metal reduction of RI_3 melts. Properties of LaI_2 were consistent with the formulation $La^{3+}(I^-)_2(e^-)$, but $LaI_{2.42}$, a semiconductor, was found to contain La^{2+} ions.

The equilibrium of complexing of Dy^{3+} ions in doped CaF_2 by either gamma radiation or calcium vapor was discussed by F. K. Fong, M. A. Hiller, and F. G. Krajenbrink (North American Aviation).

L. Eyring (Arizona State) reviewed structural data on fluorite-related oxide phases of the lanthanides and actinides in terms of polymorphism, hysteresis, ordered phases, homologous series, and nonstoichiometry.

Coordination Chemistry. The preparation and crystallographic properties of new Pr(IV) compounds, $Na_7Pr_6F_{31}$ and Na_2PrF_6, were described by L. B. Asprey, J. S. Coleman, and M. J. Reisfeld (Los Alamos). PrF_4 was obtained by extracting NaF from Na_2PrF_6 with liquid, anhydrous HF in a fluorine atmosphere.

Single crystal x-ray diffraction data were used by B. Lee, M. D. Lind, and J. L. Hoard (Cornell) to establish a sexadentate, ten-coordinate structure for $HLa(EDTA)(H_2O)_4$ and sexadentate, nine-coordinate structures for $[La(EDTA)(H_2O)_3]^-$ and $[Tb(EDTA)(H_2O)_3]^-$ the coordination spheres being *quasi*-D_{2d} dodecahedral. The laser properties and structures of Eu(III) 1,3-diketone chelates were described by D. L. Ross and J. Blanc (R. C. A. Laboratories).

Retention times in gas chromatographic separations and isomerization rates in solution of volatile rare-earth tris chelates based upon 1, 1, 1, 2, 2, 3, 3-heptafluoro-7,7-dimethyl-4,6-octanedione and 2,2,6,6-tetramethyl-3,5-heptanedione were described by R. E. Sievers, K. J. Eisentraut, D. W. Meek, and C. S. Springer, Jr. (Wright-Patterson A.F.B. and Ohio State).

Nuclear magnetic resonance data were used by S. J. Lippard (Columbia) to demonstrate stepwise ligand exchange in $CDCl_3$ between $(C_6H_5)_4As[Y(CF_3COCHCOCH_3)_4]$ and $(C_6H_5)_4As[Y(CF_3COCHCOCF_3)_4]$.

Potentiometric and calorimetric titration evaluations of the thermodynamic parameters for the formation of the species RF^{2+} were used by J. B. Walker and G. R. Choppin (Florida State) to show that, unlike the other halo complex species RX^{2+}, the fluoro complexes are of the inner sphere type.

Various *N*-substituted iminodiacetic acids containing bonding groups were reported by L. C. Thompson, B. L. Shafer, J. A. Edgar, and K. D. Mannila (Minnesota-Duluth) to form both 1:1 and 2:1 chelates in which 4 donor sites in the ligands are utilized.

A series of complexes formed by $R(NO_3)_3$ and triphenylphosphine oxide or triphenylarsine oxide, and

(Continued on Page 8)

Abstracts of these papers will be found in *Am. Chem. Soc. Abstracts of Papers, 152*, Sect. O. (1966).

Reports, Brochures, Booklets

RE PRODUCTS SUPPLIERS

In response to requests for information about the various forms and purities of rare-earth products available commercially, RIC has compiled a catalog (IS-RIC-1) containing such information and the names of commercial suppliers. The report, "Compilation of Rare-Earth Products Available from Commercial Suppliers," was compiled from data gathered over a 6-month period from both United States and foreign firms.

The data are organized into six categories: metals, alloys, compounds, mixtures, solutions, and special products. Information regarding special services, e.g. chemical analyses, is also included.

The catalog may be obtained without charge from RIC after April 1. Requests are being accepted now.

RUSSIAN TRANSLATION

The U. S. Atomic Energy Commission has translated the Russian book *Problems in the Study of Rare Earths* by D. N. Trifonov. The translation, AEC-tr-6635, may be obtained from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151, for $5.00. The Russian original was published in Moscow in 1962.

This is an unusual book, in that it contains no references. The book primarily deals with the history of the discoveries and false discoveries of the rare-earth elements and their relationship to the other elements in the periodic table (seven chapters).

Two chapters of the book are devoted to the properties and to the isotopes and radioactivity of the rare-earth elements. Unfortunately the author did not avail himself of the latest information. For example, in one figure he shows the melting points of Pr, Sm, Eu and Yb to be too high by about 70, 330, 280 and 980°C, respectively, and those of Nd and Er too low by 120 and 220°C, respectively. The remaining two chapters are concerned with practical applications and with the un-

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The State of RIC

(Continued from Page 1)

C. V. Banks, B. Beaudry, H. Burkholder, J. D. Corbett, V. A. Fassel, J.W.O'Laughlin, D. T. Peterson, J. E. Powell, M. Smutz, F. H. Spedding and D. R. Wilder.

RIC REPORTS

In response to many requests we have compiled a catalog of both U.S. and foreign companies which supply rare-earth products. The compilation is nearing completion and should be available after April 1 (see REPORTS, BROCHURES, BOOKLETS, above).

RIC LOOKS AHEAD

We will continue to improve our services to the scientific and technological community. One of these steps will be to feature articles by non-RIC staff specialists dealing with rare-earth developments they are best able to cover. We are fortunate to have in this issue two such reports by Professors T. Moeller from the University of Illinois and F. H. Spedding from Iowa State University. Dr. Moeller has written a summary of the chemistry symposium on the rare earths which was held in New York last September (page 4). Dr. Spedding has written an account of his Far-Eastern trip (page 3).

We hope to computerize our reprints, references, reports, books, booklets, etc. so that we may be able to give better and quicker answers to your information requests.

Color TV Outlook

As a result of increasing color television (TV) production, H. Günzel and B. Knörr (*Metall 20*, 764 [1966]) predict that in 1980 26,000 kg of Y_2O_3 and 1200 kg Eu_2O_3 will be used in the production of the red phosphor for color TV. This compares to 9300 kg Y_2O_3 and 420 kg Eu_2O_3 used in 1966. Their prediction is based on the projected quantities of color TV that will be sold in the United States and in Western Europe.

Annual United States sales are expected to climb from the 1965 level of 2.6 million sets to 6.7 million in 1973 and Western European sales are expected to go from zero in 1965 to 2.55 million sets in 1973.

The number of color TV sets in homes will increase in the United States and Western Europe respectively from 5.5 million and none in 1965 to 80 million and 44 million in 1980. In the same period yearly production of color sets will increase from 2.6 million in the U.S. and none in Western Europe to 6.0 million for both areas.

Yttria Crucible

Yttria is the best refractory oxide crucible for preparing uranium metal by carbon reduction of uranium oxide. This was reported in a paper entitled "Uranium Metal by Carbon Reduction of Uranium Oxide in Vacuum;" which was presented by H. A. Wilhelm, R. V. Strain and E. P. Neubauer (Iowa State University) at the Vacuum Metallurgy Conference, June 27-9 (1966) in New York.

The crucible is fabricated by means of slip casting yttria and then firing it in vacuo. This process produces a crucible having near theoretical density, a very smooth surface and high strength.

Less than 100 ppm of yttrium was picked up by the uranium metal prepared in these crucibles.

Rare Earths In the News

IR MODULATOR

Infrared light passing through a gallium-doped crystal of yttrium iron garnet may be modulated by reversing the crystal's internal magnetic field. The garnet crystal in the form of a thin rod is placed within a coil. The varying current in the coil continuously modulates the light passing through the rod.

The modulator, developed by R. C. LeCraw of Bell Telephone Laboratories, Murray Hill, N. J. exhibits a band width of 200 megahertz with a modulating power less than 0.1 watt. This is sufficient to transmit about 50,000 telephone calls or thirty television programs simultaneously.

GADOLINIUM THERMOSTAT

A novel thermostat utilizing a gadolinium-containing element as a sensor mounted on one closable contact arm in alignment with a permanent magnet on another contact arm has been patented by Sam Legvold of Iowa State University (U. S. Patent No 3,292,124). The thermostat will allow control of temperatures in the vicinity of the Curie point of gadolinium. By the addition of scandium, lutetium and yttrium to the sensor, the Curie point may be lowered below 22°C. The Curie point may be raised by the addition of carbon.

NEODYMIUM ON TELEVISION

Neodymium oxide is being incorporated into glass filter plates manufactured for color television tube makers by Chicago Dial Company. The compound is said to improve the selective spectral absorption properties of the glass filter plates which are laminated to the viewing surface. This results in improved brightness and contrast of pictures received on color television sets.

Chicago Dial's use of neodymium oxide in its filter plates brings to four the number of rare-earth oxides which have had a significant impact on the color television industry. Cerium, europium and yttrium oxides are currently used in the production of color television picture tubes.

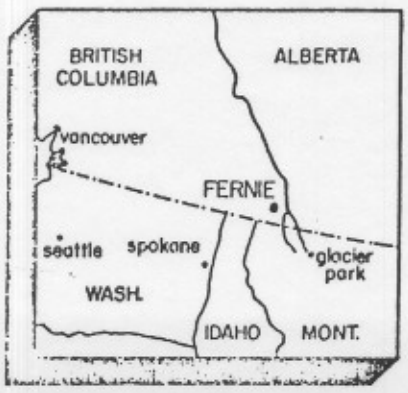
ACQUIRES FEEDSTOCKS

Michigan Chemical Corp. (MC) has purchased Porter Brothers Corp., an Idaho mining concern, as part of a program to secure long term sources of yttrium and other rare-earth feed materials. The newly-acquired deposit is said to be the largest operable deposit of yttrium-bearing mineral in the United States. The deposit also contains uranium, columbium, tantalum and other minerals.

In addition MC has completed contractual agreements with several companies including Canadian uranium producers for yttrium feedstock. They are also expanding facilities at their St. Louis, Mich. ion-exchange plant to permit doubling its current annual production of 35 tons of yttrium oxide.

NEW RARE-EARTH FIND

Western Co-operative Fertilizers Limited of Alberta, Canada has found significant rare-earth content in low grade sedimentary phosphates of the Fernie basin, British Columbia. Indications from semi-quantitative spectrography are that total lanthanides plus yttrium and scandium are present to the extent of 1.0% of fluorapatite mineral present. This is many times the rare-earth content of Florida apatites, as noted in *RIC News* 1, No. 4, 8 (1966). For more information concerning this find contact: C. Warren Hunt, Box 2500, Calgary, Alberta, Canada.



RONSON PLANT EXPANSION

Ronson Metals Corp. has completed an expansion program at its Newark, N.J. plant. The 3800 square foot addition provides increased laboratory and toolroom facilities and incorporates a new general office. Also included is space for metallographic and physical testing equipment.

Metals Frontier

"Metals Frontier," a semitechnical documentary film designed for an audience with an appreciable degree of scientific sophistication, primarily seniors and graduate students in the physical sciences and engineering, is available from the USAEC motion pictures libraries. Although produced in 1961, the film may be of special interest to some of our readers. An excerpt from the AEC film catalog is given below:

"Highlights in the operations of the Ames Laboratory, a major installation of the USAEC, are shown by illustrating the steps in the development of the process for the production of yttrium metal. The film also gives insight into the facilities and the pioneering tradition of the Ames Laboratory in the investigation of the rare earths. The film is panoramic in style, showing how basic research, development, and production go along together. The following steps in metal processing are shown: separation of yttrium from rare earths, conversion to fluoride, reduction, and arc melting. Special emphasis is given to purity and to the need for careful analytical control. The film also shows how the graduate student fits into the laboratory's research program."

This film may be borrowed from one of the ten AEC motion picture film libraries. The address of the area film library serving you may be obtained from the Audio-Visual Branch, Division of Public Information, U. S. Atomic Energy Com-

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Lanthanide Soaps

Preparation and properties of the trisoaps of lanthanum, cerium, praseodymium, and neodymium have been discussed in "Synthesis and Properties of Heavy Metal Soaps," by R. C. Mehrotra of the University of Rajasthan, Jaipur, India in *Wiss. Z. Friedrich-Schiller-Univ. Jena, Math. - Naturwiss. Reihe 14*, 171-80 (1965).

The lanthanide soaps were prepared in aqueous solution by treatment of their nitrate or chloride solution with sodium carboxylate solution. They were subsequently found to be monomeric in benzene by ebullioscopic methods.

As a result of viscosity measurements performed in the benzene solution, it was concluded that the relative viscosity of the lanthanide soap solutions increases with concentration and that relative viscosity at the same concentration generally increases with the molecular weight of the parent acid. The viscosities for Ce (III) soaps were found to be higher than the corresponding lanthanum soaps at the same concentration. The author also reports that the thermogravimetric behavior of these soaps was found to be analogous to that of the aluminum soaps.

SOLID STATE PHYSICS

(Continued from Page 2)

with thorium. They hope to learn something about the density of states of the conduction electrons at the Fermi level from the excess magnetic moment above the theoretical value for the rare-earth ions present.

Donald Boys is measuring the low temperature thermal conductivity of heavy rare-earth single crystals. William Nellis is looking into the possibility of a direct determination of superzone energy gaps using electron tunnelling through sandwiches made by evaporating aluminum on oxidized rare-earth single crystals. He is devising techniques for making these sandwiches, as well as considering other approaches to this problem.

Cathodoluminescence

The cathodoluminescence spectrum of Tb^{3+} in $InBO_3$ is dominated by the group of emission lines (530 and 567 microns) arising from $^5D_4 \rightarrow {}^7F_5$ electronic transitions. The $^5D_4 \rightarrow {}^7F_{6,4,3}$ transitions produce only a small fraction of the emitted energy. Frank J. Avella of the General Telephone & Electronics Laboratories, Bayside, N.Y., reported these results in *J. Electrochem. Soc. 113*, 1225 (1966).

Cathodoluminescence data for the $InBO_3$:Tb and other green-emitting phosphors are compared to those of ZnCdS:Ag phosphor of color television fame.

Expands Solid Laser Wave Lengths

Investigators using a neodymium solid-state laser may find a greater range of applications for the laser due to research at Union Carbide's Korad Corp., Santa Monica, Calif. The basic wave length of the neodymium laser (10,600 A) can be converted into other wave lengths with an accessory which makes use of the stimulated Raman emission of certain liquids.

Although the stimulated Raman emission is normally a weak effect, it is said to become much stronger when coupled with the power from the solid-state laser. For example, in neodymium, by first doubling the light frequency and then passing the resulting 5300 A radiation through dimethylsulfoxide, a laser radiation of 6257 A is obtained.

The many available Raman-active liquids expand the scope of this method considerably. Among them are carbon disulfide, benezene, toulene, nitrobenzene and acetone.

METALS FRONTIER

(Continued from Page 6)

mission, Washington, D. C. 20545, or from RIC. The film may be purchased from the Iowa State University Film Production Unit, Alice Norton House, Ames, Iowa 50010, at a purchase price of $75.48.

EUXENITE

Yttrium content in euxenite ore residue has been upgraded from less than 11 wt % to 29 wt % in a process developed by the Colorado School of Mines under contract with F. H. Lenway, a California industrialist, and Metal Traders, Inc.

The residue is first homogenized into a milkshake-like slurry, then diluted with water until the slurry ranges from 8-9% solids. The ultimate recovery of yttrium and the heavy rare earths is dependent upon control of this solid to liquid ratio. Next the slurry undergoes three stepwise leachings by concentrated sulfuric acid. In the second step hydrogen peroxide is added to oxidize Fe(II) to Fe(III). The undesirable solids are then removed by filtration.

The pH of the filtrate, a clear solution of yttrium and rare-earth sulfates, is raised to 9.0 by addition of soda ash and caustic soda. The resultant insoluble carbonates are ready for marketing after recovery by filtration and a drying process.

Ce-Mg-Nitrate Thermometer

At a low temperature conference held in Finland late last summer, J. C. Wheatley of the University of Illinois, Urbana, described a low temperature thermometer using cerium-magnesium nitrate (CMN) powder. The CMN thermometer is routinely used to measure temperatures between 1.5 and 4×10^{-3}°K. From the magnetic susceptibility of CMN, the absolute temperature is easily obtained by standard techniques. The details and some of the associated problems are discussed in the published conference proceedings, *Ann. Acad. Sci. Fennicae*, Ser. A. VI, No. 210, 15-30 (1966).

ACS MEETING

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containing 2, 3, or 4 moles of the oxide per mole of $R(NO_3)_3$, was described by D. Cousins and A. Hart (Queen Mary, London).

Separation and Purification. E. J. Wheelwright, F. P. Roberts, U. L. Upson, and L. J. Kirby (Pacific Northwest Laboratory) described the isolation of kilogram quantities of Pm by a modified DTPA ion-exchange elution process.

Research Trends. Current and future research trends were reviewed in detail by E. V. Kleber (Atomics International).

In addition to the symposium papers, the following discussions at this meeting are of interest to rare-earth chemists: P. A. Pilato and H. A. Eick (Michigan State) discussed the thermodynamic properties of SmC_2 obtained from Knudsen effusion and mass spectrometric data. J. R. Gump and W. E. Kelley (Central Michigan) reported very high separation factors for the separation of Y from Nd, Sm, and Tb using mono- and di-decyl phosphoric acids as extractants in an inert diluent. M. D. Joesten and R. A. Jacob (Vanderbilt) described the syntheses and properties of the complexes $La(ClO_4)_3 \cdot 4OMPA$ and $R(ClO_4)_3 \cdot 3\ OMPA \cdot xH_2O$ (OMPA = octamethylpyrophosphoramide; R = La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Ho, Er, Y; x = 1, 2, 3). T. Moeller (Illinois) summarized the significant trends in the coordination chemistry of the lanthanides as a contribution to the Alfred Werner Centennial Symposium. C. A. Vincent (Illinois) discussed the formation of RSO_4^+ complexes in solution by means of ultra-sonic absorption data.

Rare-Earth Stockpile

The U. S. Office of Emergency Planning has announced stockpile objectives for the rare earths of 3000 tons and 800 tons for conventional and nuclear war levels, respectively.

Nuclear Potpourri

Four articles of interest to rare-earthers have appeared in the conference proceedings, *Nuclear Applications of Nonfissionable Ceramics,* A. Boltax and J. H. Handwerk, eds., Am. Nucl. Soc., Hinsdale, Ill. (1966). The first of these is a brief paper entitled "Sublimation Pressures of Refractory Fluorides," by R. A. Kent, K. Zmbov, J. D. McDonald, G. Besenbruch, T. C. Ehlert, R. G. Bautista, A. S. Kana'an and J. L. Margrave, all of Rice University (p. 249). Vaporization data is summarized for the Sc di- and trifluorides and the Y, La, Ce, Nd, Dy, Ho and Er trifluorides. Also presented are appearance potential data for Nd, Dy, Ho and Er trifluorides, and values of the dissociation energies of the rare-earth monofluorides.

The "Compatibility of Metals and Ceramics" is the subject of a paper by G. W. Cunningham of the Battelle Memorial Institute (p. 279). Dr. Cunningham discusses general parameters affecting compatibility and outlines some guidelines for predicting the compatibility of metals with oxides, nitrides, carbides and borides.

Yttrium oxide is evaluated as a thermionic insulator for high temperature use in ceramic-to-metal seals by L. N. Grossman and A. I. Kaznoff of the General Electric Co. ("Insulators for Thermionic Energy Converter Application," p. 421). Among the factors considered were compatibility with cesium vapor; compatibility with niobium, tungsten, molybdenum, and rhenium; and electrical conductivity. A comparison of the properties of yttria and alumina was also made.

The fourth paper of interest is entitled "Nuclear Poisons and Control Applications of Ceramic Materials." In it, C. F. Leitten, Jr. of Oak Ridge National Laboratory examines the use of the lanthanides as neutron-absorbing materials. Corrosion resistance, fabrication techniques, physical and chemical properties, and irradiation stability of the rare earths are discussed.

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solved problems as related to the rare-earth electronic structures and their position in the periodic table.

UPDATED DATA

The Lunex Co. has announced revision of its data sheets for the rare earths and chromium. More than 50 physical properties of each of these elements are listed. The data sheet packet is available from Lunex free of charge. Send requests to J. L. Moriarty, Lunex Company, P. O. Box 493, Pleasant Valley, Iowa 52767.

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Second-Class postage paid at Ames, Iowa.