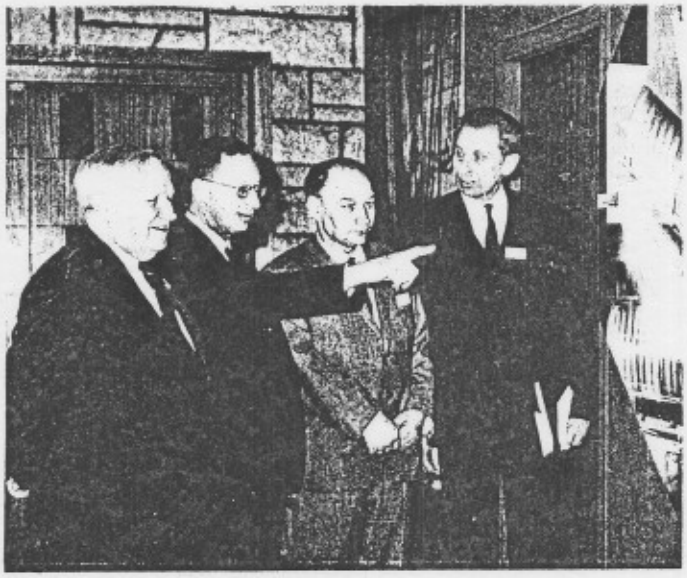
RARE-EARTH INFORMATION CENTER NEWS

SUPPORTED BY INSTITUTE FOR ATOMIC RESEARCH

IOWA STATE UNIVERSITY / AMES, IOWA

Volume IV | September 1, 1969 | No. 3



This internationally known group of rare-earth researchers got together to view a display of French-produced rare earths during the Paris-Grenoble meeting. From left are F.H. Spedding, Iowa State University, Ames, Iowa, USA; E.F. Bertaut, National Center for Scientific Research, Grenoble, France; E.M. Savitskii, Institute of Metallurgy of A.A. Baikov, Academy of Sciences, U.S.S.R., Moscow; and Felix Trombe, National Center for Scientific Research, Bellevue and Montlouis, France.

International Conference

In early May the French National Center for Scientific Research sponsored and served as hosts for a six-day meeting on the rare earths. Furthermore, their gracious financial assistance enabled a number of non-French scientists to attend the Conference who otherwise might not have participated. Of the 200 persons attending the Conference, most came from Western Europe, but there were also scientists from Canada, Hungary, Romania, the U.S.A. and the U.S.S.R.

The first three days (May 5-7) of the meeting were spent in Paris, where the Conference dealt with the metallurgy, chemistry and optical behavior of the rare earths (a complete list of the papers presented at the Conference follows this story). The last half of the Conference (May 8-10) was held in Grenoble, where the emphasis was on solid state physics.

The Paris portion of the Conference was organized by Dr. F. Trombe and his co-workers and the Grenoble portion by Dr. E.F. Bertaut and his co-workers. Both groups are to be commended for the excellent Conference and their kind hospitality.

The keynote speaker at the Conference was Dr. F.H. Spedding, Iowa State University, Ames, Iowa, who spoke on 'The Preparation, Handling and Properties of "Pure" Rare Earth Metals.'

All attendees were given a copy of the abstracts of the papers presented at the Conference. Furthermore, the Conference Proceedings will be published in two volumes, one for the Paris half and the other for the Grenoble half. As soon as these volumes are published *RIC News* will announce their availability.

Fifteen Firms Support RIC

The publication of *RIC News* for at least another year, and the resumption of RIC's inquiry answering function have been assured through a broadened base of financial support from 15 of the world's leading rare-earth producers.

Begun as a U.S. Atomic Energy Commission information center in 1966, RIC faced extinction when the AEC was forced to withdraw its support of the Center in 1968. However, grants to Iowa State University's Institute for Atomic Research from five American rare-earth companies made it possible to continue publication of *RIC News*.

The original five industrial supporters of RIC have been joined by 10 more companies representing seven countries, including the U.S., for support of the Center through July 1970.

Financial support for RIC now comes from American Metallurgical Products Co., USA; American Potash & Chemical Corp., a subsidiary of Kerr-McGee, USA; Elettrochimical Italiana delle Terre Rare, Italy; Th. Goldschmidt A.-G., Germany; W.R. Grace & Co., USA; Indian Rare Earths, Ltd., India; Leico Industries, Inc., USA.

Michigan Chemical Corp., USA; Molybdenum Corporation of America, USA; Pechiney-Saint Gobain, France; Research Chemicals Division, Nuclear Corporation of America, USA; Ronson Metals Corp., USA; Shin-Etsu Chemical Industry

(Continued on Page 7)

International Conference Program

PARIS SESSIONS

1. General Metallurgy

F.H. Spedding, B.J. Beaudry, J. Croat et P. Palmer: *The preparation, handling and properties of «pure» rare earth metals.**
E.M. Savitskii, V.F. Terekhova, R.S. Torchinova, I.A. Markova, O.P. Naumkin et V.E. Kolesnichenko: *L'étude des propriétés physiques et chimiques d'alliages des terres rares.**
E. Parthé: *Quelques principes structuraux des composés ternaires métalliques des terres rares.**
K.A. Gschneidner Jr: *Alloy theory of the rare earth metals.**
G. Schiffmacher, G. Malé et F. Trombe: *Préparation des métaux des terres rares par réduction métallothermique de leurs oxydes.*

2. Oxides and Ternary Oxides

G. Weber et L.R. Eyring: *The transport properties of rare earth oxides.**
S. Anderson: *The change of oxide structures by anion sustitution.**
R. Hoppe: *Die ternären Oxide der seltenen Erden mit Alkalimétallen.**
H. Bärnighausen: *The crystal structure of* $LiEu_3O_4$*.
M. Gondrand et A. Waintal: *Étude des composés* $TLiO_2$. *Mise en évidence d'une nouvelle forme* $TLiO_2$ *(T étant une terre rare) obtenue par haute pression et à haute température.*
R.A. Paris, J.M. Paris, G. Szado, G. Paris et B. Vulliermet: *Obtention d'oxydes mixtes et de solutions solides contenant des lanthanides.*
J. Loriers, G. Villers, F. Clerc et S. Lacour: *Les grenats de néodyme-fer-scandium. Conditions d'existence. Étude cristallographique et propriétés magnétiques.*
A. Rouanet: *Diagrammes de solidification et diagrammes des phases de haute température des systèmes formés par la zircone avec les sesquioxydes des lanthanides.*

3. Metals and Alloys

K.H.J. Buschow: *Rare Earth Cobalt intermetallic compounds.*
R. Lemaire et D. Paccard: *Structures cristallines du composé* TbNi.
G. Bruzzone, M.L. Fornasini et F. Merlo: *Rare earth-zinc compounds close to the* 1:4 *composition.*
A. Palenzona et E. Franceschi: *The crystal structure of* RE_2Tl *compounds.*
G.L. Olcese: *Sur la structure électronique du cérium dans ses composés intermétalliques binaires.*
C.E. Lundin: *The structural characteristics of the samarium-type phase in intra-rare earth binary alloy systems.*
A. Iandelli et A. Palenzona: *Binary phase diagrams of ytterbium with Cu, Ag, Au.*
A. Percheron: *Étude du système étain-samarium.*
C. Boulesteix, M. Gasgnier et C. Henry La Blanchetais: *Étude des couches minces de samarium en microscopie électronique.*

4. Chemistry and Crystallography of Salts: Carbides, Nitrides and Phosphides, Etc.

C.K. Jørgensen: *Les déviations de trivalence dans les groupes f et le paramètre (E - A).**
G. Busch, E. Kaldis et P. Wachter: *Synthesis, crystal growth and physical properties of some rare earth nitride phases.*
N. Lorenzelli, J. Melamed et J.-P. Marcon: *Recherche de nitrures de terres rares sous-stoechiométriques. Étude des oxynitrures de gadolinium.*
A. Laplace et R. Lorenzelli: *Étude de monocarbures d'europium et d'ytterbium. Structure cristalline et valence des ions métalliques.*
J.S. Anderson et A.N. Bagshaw: *Thermodynamic studies of lanthanum, cerium and neodynium carbides.*
G. Lobier: *Étude par rayons X et par diffraction neutronique des carbohydrures et sulfohydrures d'yttrium.*
H. Barrere, J. Daou et R. Viallard avec la collaboration de J. Bonnet, J.-L. Leroy, Nguyen-Thi Kim Min: *Progrès récents dans la connaissance des hydrures de lanthanides.*
K.E. Mironov, I.G. Vasil'eva, Yu. I. Mironov et Ya. V. Vasil'ev: *Thermal stability of cerium and gadolinium monophosphides.*
D.A. Johnson et J.D. Corbett: *The relative stabilities of the rare earth metal diiodides.**

5. Optical Properties of Oxides and Salts

D.J. Newman, G.E. Stedman et M.M. Curtis: *The use of simplified models in crystal field theory.*
J.-P. Briffaut: *Champ cristallin au site de* Eu^{3+} *dans une série d'orthovanadates.*
C. Bonnelle et R.C. Karnatak: *Étude par spectroscopie X des distribution 4f du gadolinium et de l'europium dans le métal et l'oxyde.*
F. Gaume-Mahn, C. Linares et G. Boulon: *Intérêt de matrices oxygénées à base de terres rares pour l'étude de la fluorescence des ions* Eu^{3+} *et* Bi^{3+}.
S. Natansohn: *Luminescence phenomena in rare earth activated lanthanum oxychlorides.*

*Invited speaker

Rare-Earth Progress

The third volume of *Progress in the Science and Technology of the Rare Earths,* L. Eyring, Ed. (Pergamon Press, New York, 1968) has been released. This authoritative book surveys rare-earth metals and compounds and describes their applications in science and technology.

Included in this volume are chapters on electronic structure of alloys and inter-metallic compounds; optical transitions in crystals; coordination chemistry; liquid-liquid extraction; crystal chemistry of binary and ternary chalcogenides; monocarbides and mononitrides; thermodynamic properties of oxides; structures of oxides and hydroxides; thermodynamic and magnetic properties of chalcogenides, pnictides, halides and semi-metallic compounds; and rare-earth metal-refractory metal systems.

This series, *Progress in the Science and Technology of the Rare Earths,* is prepared biannually. The price of Volume 3 is $25.00.

New RIC Staffer

Nancy Ann Kippenhan has joined the staff of RIC as a half-time junior scientist. She replaces Mrs. Charla Bertrand.

Mrs. Kippenhan will be responsible for collecting and compiling new rare-earth data that become available, for researching and drafting replies to inquiries (a service RIC is resuming, see Page 1), and news-writing.

The new RIC staffer is a 1965 graduate of Lake Forest College, Lake Forest, Ill., with a B.A. in chemistry. She has been a research chemist with Abbott Laboratories, North Chicago, Ill., for the past four years. She is a member of the American Chemical Society and Phi Beta K ρa.

M. Laveant: *Étude de quelques facteurs modifiant l'émission de l'ion* Eu^{3+} *dans les matrices* Y_2O_3 *et* Gd_2O_3.
J.-P. Denis et J. Loriers: *Préparation et propriétés de luminescence du phosphate de cérium et des phosphates mixtes de cérium-lanthane activés au terbium.*
R.K. Datta et A. Pekar: *Reinvestigation of the system* Y_2O_3 - B_2O_3.
A. Babusiaux, M. Baron et J. Loriers: *Luminescence de l'europium dans des composés de terres rares par excitation interionique à l'aide du promethium* 147.

6. Chemistry and Crystallography of Salts with Oxygen Anions

A.N. Christensen: *Coordination of rare earth ions in hydrothermally prepared compounds.* *
P. Caro, J.-C. Achard et O. de Pous: *Propriétés physiques et stabilité thermique des carbonates, hydroxycarbonates et oxycarbonates de la série des terres rares.*
N.S. Stroganoba et L.V. Rousaikina: *Combinaisons de l'europium* (II) *et* (III) *et leur utilisation dans la pratique de l'analyse.*
I. Grenthe: *Steric effects in the formation of rare earth glycolate complexes.*
J. Albertsson: *Steric effects in some nine-coordinated lanthanide complexes.*
M. Beucher: *Données cristallographiques sur les polyphosphates de terres rares du type* $t(PO_3)_3$.
I.A. Bondar: *La synthèse des monocristaux des silicates et des germanates de terres rares.*
G. Garton et B.M. Wanklyn: *Crystal growth of gadolinium and dysprosium orthovanadates.*

7. Chemistry and Crystallography of Salts: Sulfides, Selenides, Etc.

M. Julien-Pouzol, M. Guittard et O. Gorochov: *Étude des systèmes* L_2Se_3 - Cu_2Se *et* L_2Se_3 - Ag_2Se.
M. Matrie, Nguyen Huy-Dung, N. Nikolova, M. Lepeltier et J. Flahaut: *Systèmes formés entre les sulfures* L_2S_3 *des terres rares et les autres sulfures* MS *des éléments de transition.*
P. Laruelle, J. Etienne et G. Collin: *Étude cristallographique du remplacement isomorphe de l'aluminium par des éléments divalents ou tétravalents dans des composés isotypes de* $L_6Al_{3,33}S_{14}$ *où* L *est une terre rare.*
S.A. Kutolin, R.N. Samoilova, G.I. Chramtsov et G.K. Chramtsova: *Investigation of dispersion correlations in polycrystal* R_2S_3 *type sulphides of rare earth metals.*
V.K. Val'tsev, A.A. Kamarzin et N.A. Doroshenko: *The synthesis of rare earth sexosulphides in natrium rhodanate melt.*
S. Aleonard et C. Pouzet: *Étude cristallographique de quelques fluorures complexes de terres rares de formule* A_2NaTF_6.
J. Portier, B. Tanguy, A. Morell et M. Pouchard: *Nouvelles structures d'hotes oxyfluores des ions lanthanidiques.*

GRENOBLE SESSIONS

1. Magnetism

J.-L. Feron et R. Pauthenet: *Propriétés magnétocristallines des terres rares monocristallines de la deuxième série.*
H. Bartholin et D. Bloch: *Effet des pressions hydrostatiques et uniaxiales sur les températures de transition magnétiques de monocristaux de terres rares (Gd, Tb, Dy, Er).*
T.S. Al-Bassam et W.D. Corner: *Magnetic domain structures in gadolinium.*
J. Pierre: *Propriétés magnétiques des composés équiatomiques terres rares-métaux nobles. Relation avec la structure de la bande de conduction.*
J.T. Christopher et K.N.R. Taylor: *The magnetic properties of* $Gd(CoNi)_2$.
J.-L Feron, D. Gignoux, R. Lemaire et D. Paccard: *Propriétés magnétiques des composés* T_3M *entre les métaux de terres rares et les métaux de transition de la première série.*
A. Marchand et R. Lancia: *Résonance magnétique à 9,3 GHz de composés intermetallique cobalt-terre rare.*
E. Burzo, I. Pop et V.L. Tchetchemikov: *Le ferromagnétisme du composé intermétallique* Co_2Gd.
W.P. Wolf, H.E. Meissner, C.A. Catanese et P.D. Scott: *Magnetic properties of the Rare Earth hydroxides.* *
R.L. Cohen, S. Hufner et K.W. West: *A first order phase transition in europium metal.* *
G.T. Meaden et N.H. Sze: *Des fluctuations et des indices critiques près de la température de Néel de l'europium.*
J. Schweitzer et J. Yakintos: *Structures magnétiques des composés intermetallic terre rare - cobalt de formule* TCo_3.
B.J.C. van der Hoeven Jr.: *The effect of shape and surface on thermal properties of ferromagnets at the Curie point.*
P. Fischer, W. von Wartburg, P. Schwob et O. Vogt: *Neutron diffraction evidence for magnetic phase transition in europium selenide.*
D.T. Teaney et V.L. Moruzzi: *The magnetic specific heat of EuO, EuS, impure Eu, and Ba. 12° to 300° K.*
R. Suryanarayanan et C. Paparoditis: *Préparation et propriétés des tellurures d'europium et d'ytterbium et de leurs solutions solides avec PbTe.*
O. Gorochov, Vo Van Tien, Nguyen Huy-Dung, Mlle E. Barthelemy et J. Flahaut: *Proprietes électriques et magnétiques de quelques composés ternaires contenant de l'europium II.*
S.J. Cho: *Spin-polarized energy bands in europium chalcogenides by the augmented-plane-wave method.*

MEETING

8TH RARE EARTH CONFERENCE

The Committee for the 8th Rare Earth Research Conference has issued a call for abstracts from participants intending to present papers at the April 19-22, 1970 meeting. The deadline for abstracts is Oct. 15, 1969, according to T.A. Henrie, chairman.

Thirteen sessions to be held in five meeting periods are planned. Topics to be covered are solid state reactions, chemistry, physics, metallurgy, geology, and industrial processes.

Abstracts and requests for information about the Conference should be addressed to:

T.A. Henrie, Chairman
8th Rare Earth Research Conference
% U.S. Bureau of Mines
Reno, Nevada 89505 U.S.A.

Letters

To the Editor:

A recent item in *RIC News* entitled "Transparent RE Oxides" (Vol. IV, No. 2, p. 3) implies that preparation of transparent Y_2O_3 by press forging is a new achievement. I would like to call your attention to the paper by R.A. Lefever and John Matsko, "Transparent Yttrium Oxide Ceramics," *Mat. Res. Bulletin* 2, 865 (1967), in which the preparation of completely transparent discs of Y_2O_3 by vacuum press forging is described. The procedure involves a single vacuum hot swaging operation requiring temperatures and pressures on the order of only 950° C and 10,000 psi, respectively. . .

R.A. Lefever
Sandia Laboratories
Albuquerque, N.M. 87115

Rare! Earthly Goofs

Vol. IV, No. 2, June 1969.

If you had trouble finding the source material for our "Reappraisal" story, it's because we couldn't find it ourselves in the references listed. The worldwide review was contained in *Industrial Minerals*, NOT in *Industrial Metals* as reported. Also, the review of India's RE industry begins on page 23 instead of on page 22 in *Nuclear News*, Vol. 12. Sorry about that.

C.K. Jørgensen: *Le couplage de spin intra-atomique et l'extrême contraire des spins distants.*
B.R. Cooper: *Magnetic ordering and thermodynamic properties of induced moment systems.*
P. Boutron: *Anisotropie de la susceptibilite paramagnetique: application aux terres rares.*

2. Neutron Diffraction

W.C. Koehler et A.H. Millhouse: *Magnetic properties of Er-based binary rare earth alloys.**
C. Beele et R. Lemaire: *Propriétés magnetiques et structures magnétiques des composés equiatomiques de type DyM entre l'aluminium et les métaux de terre rare.*
R. Lemaire et D. Paccard: *Propriétes magnetiques et structures magnétiques des composés equiatomiques terre rare-nickel.*
T.J. O'Keefe, G.J. Roe et W.J. James: *The Ho-Fe binary system and related magnetic properties.*
Nguyen Van Nhung, J. Sivardiere et A. Apostolov: *Structure magnétique du monosiliciure d'erbium ErSi.*
H.B. Moller, M. Nielsen et A.R. Mackintosh: *Inelastic neutron scattering in rare earth metals.**
A.D.B. Woods, M.W. Stringfellow, T.M. Holden et B.M. Powell: *Exchange and crystal field interactions in erbium and holmium from inelastic neutron scattering measurements.*
E.F. Bertaut, K. Schweitzer et F. Tcheou: *Ordre magnétique de la terre rare dans les grenats.*
S. Quezel, E.F. Bertaut et G. Quezel: *Structures magnétiques et théorie des représentations dans les oxydes cubiques des terres rares.*
R. Ballestraci, G. Quezel, J. Rossat-Mignod et F. Tcheou: *Propriétés magnétiques des oxysulfures de terres rares.*
M.C. Montmory, E.F. Bertaut et K. Lövold: *Structure cristallographique et magnétique de Er_6WO_{12}.*
G. Busch et F. Levy: *Distorsion tétragonale et trigonale du réseau de certains composés trivalents des terres rares.*
M. Mercier et P. Bauer: *Mesures magnétoélectriques sur quelques cobaltites, aluminates et ferrites de terres rares.*
G. Lee, M. Mercier et P. Bauer: *Mesures de l'effet magnétoélectrique sur les grenats aux basses températures.**
A. Apostolov, A. deCombarieu, J. Mareschal, J.-C. Michel, J. Peyrard et J. Sivardière: *Chaleurs spécifiques, propriétés métamagnétiques, aimantations en champ faible et structures magnétiques des orthoferrites de terres rares.*
J.D. Cashion, A.H. Cooke, L.A. Hoel, D.M. Martin et M.R. Wells: *Magnetic properties of gadolinium ortho-vanadate.*
W.E. Wallace, R.S. Craig, A. Thompson, C. Deenadas, M. Dixon, M. Aoyagi et N. Marzouk: *Heat capacity studies of intermetallic compounds containing rare earth elements.**
E.F. Westrum Jr.: *Thermal and Electronic Behavior of the Rare Earth Hexaborides from Cryogenic Calorimetry.*
E. Belorizki, M.J.M. Leask et K.J. Maxwell: *Co-operative optical excitation in Erbium Aluminum Garnet.*
S. Hufner: *Optical investigations of magnetic rare earth oxides with the garnet and perovskite structure.*
G.M. Kalvius, G.K. Shenoy et B.D. Dunlap: *Hyperfine interactions in Er_2O_3 and Yb_2O_3 between 20°K and 1.5°K.*
J.-M. Baker et G. Currel: *Orbit-Lattice Interactions for Rare Earth Ions in Cubic Crystals: EPR under uniaxial stress.*
E.D. Jones: Pr^{141} *and* Tm^{169} *Nuclear Magnetic Resonances in Van Vleck Intermetallic Paramagnets.*

3. Resistivity, Kondo Effect

A. Blandin: *Interactions d'échange dans les métaux et alliages de terres rares.*
J.-J. Rhyne: *Anomalous hall effect in rare earth metals.*
F.M.K. Lodge et K.N.R. Taylor: *Electrical conductivity of dysprosium thin films.*
H.H. Hill et R.O. Elliott: *Virtual bound states in plutonium: the Kondo effect in LaPu and PrPu alloys.*
H.J. van Daal et K.H.J. Buschow: *Investigations on electrical and magnetic properties of rare-earth intermetallic compounds.*
S. Methfessel: *Magnetic, electric and optical properties of rare earth chalcogenides.*
B. Coqblin: *Considérations théoriques sur les changements de valence de terres rares.*
C. Chr. Schüler: *Optical properties of rare-earth metals.*

Rare-Earth Halides

A 280-page book by D. Brown, *Halides of the Lanthanides and Actinides,* has been published by Wiley - Interscience Publishers, John Wiley and Sons, New York (1968). Its cost is $11.00.

Halogen and oxyhalogen complexes of lanthanides and actinides including yttrium and scandium are extensively reviewed. The first chapter presents an overall picture of halide chemistry and its special problems. Fluorides, chlorides, bromides and iodides and their respective oxyhalides are dealt with in four succeeding chapters each of which are subdivided by valence states. Preparation, chemical and physical properties, structures, and halogeno-complexes are discussed. Differences and similarities between the lanthanide and actinide series are presented in parallel.

Thermochemical data, infrared vibrational frequencies and mixed halides of trivalent and tetravalent uranium are listed in separate appendices for convenient location. Literature coverage through the end of 1967 is provided.

Chelates Point to Novel Separation

Thermodynamic properties have recently been reported on a series of remarkably volatile and thermally stable lanthanide chelates, *J. Am. Chem. Soc.* 91, 3476 (1969).

J.E. Sicre and co-workers at the Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio, have found large differences in the vapor pressures, heats of vaporization, and heats of sublimation of the lanthanide chelates of 2,2,6,6-tetramethyl-3,5-heptanedione, H(thd). Their findings corroborate the trend detected earlier by gas chromatography and reported by Eisentraut and Sievers in 1965. Complexes of the higher atomic number lanthanides are more volatile than those of the lighter, larger ones; this is an effect of the lanthanide contraction.

Vapor pressure as a function of temperature was measured for 13 lanthanide complexes. The differences were large enough to permit novel separation of these elements.

A recent patent of Eisentraut and Sievers (U.S. Patent 3,429,904) describes the use of the tetramethylheptanedionato complexes to separate cleanly and purify lanthanide mixtures by fractional sublimation. For example $Lu(thd)_3$, $Yb(thd)_3$, and $Tm(thd)_3$ sublime at temperatures about 100°C lower than those required for $La(thd)_3$, $Pr(thd)_3$ and $Nd(thd)_3$. A thermal gradient fractional sublimation apparatus is used to effect separation.

Rare Earths In the News

NORWEGIAN RE PRODUCER

The Metal Extractor Group of Norway, MEGON, was formed in April of this year by ten Norwegian industrial firms to produce rare earths (primarily yttrium oxide) and other metals and materials from various Norwegian ore sources.

CANADIAN YTTRIUM OXIDE

Denison Mines has announced that it is resuming production of yttrium oxide from tailings of the uranium mining operation. This material is being shipped to Molycorp for further processing.

1000 WATT Nd LASER

Sylvania has announced it will be producing a 1000 watt CW Nd-doped yttrium aluminum garnet laser. Delivery on the first models is scheduled for January 1972.

ULTRAVIOLET Nd-DOPED LASERS

The use of a frequency doubler and a special output mirror which is reflective to 1.06μ but transmits 0.53μ enables quadrupling the frequency of Nd lasers to 0.265μ . The Nd-doped glass laser which is manufactured by Korad, has an average energy of 5 mjoules, and is particularly useful for initiation of photochemical reactions and the study of living tissues.

Rare Moon Dust

"To all scientists this is a very, very exciting time," claimed a geologist at the Lunar Receiving Laboratory as he opened the first samples from the moon. Soon to share his excitement are the 142 principal investigators from the U.S. and eight foreign countries who will be receiving nearly 50 pounds of lunar material as the two-month quarantine period nears an end.

Speculation on the presence and concentration of rare earths runs high. A number of the principal investigators will be using highly sophisticated techniques to seek out traces of the rare earths including mass spectrometry, neutron activation, and emission spectroscopy.

Among the principal investigators involved in the search for rare earths are: P.W. Gast, Lamont Geological Observatory; L.A. Haskin, University of Wisconsin; A.W. Helz, U.S. Geological Survey; T.P. Kohman, Carnegie Institute of Technology; V.R. Murthy, University of Minnesota; G.W. Reed, Argonne National Laboratory; and R.A. Schmitt, Oregon State University.

The preliminary findings of these studies will be presented in Houston by the principal investigators three months after they receive their samples about September 20.

Not So Refractory PrP

In striking contrast to the high melting point of praesodymium monophosphide, 2850 ± 50°C, reported in the last issue of *RIC News*, is the 2400°C melting point for non-stoichiometric PrP observed by E. Francheschi and G.L. Olcese, *J. Phys. Chem. Solids* 30, 903 (1969). This reported melting point places PrP as about the eighth highest melting rare-earth compound.

Non-stoichiometry in PrP was determined by evaluating the variation of the lattice constant and density with composition. Quasi–stoichiometric phases occurred in the composition range PrP to $PrP_{0.85}$. The magnetic properties of these phases showed that the effective valency of Pr was approximately 3.3, and that PrP could not be regarded as a simple ionic compound.

Metamagnetic Eu_3O_4

A Russian team headed by A.A. Samakhvalov has measured the magnetic properties of Eu_3O_4 single crystals (*Zh. Eksp. Teor. Fiz.* 54, 1341 [1968]). They conclude that Eu_3O_4 is metamagnetic with a strong magneto-crystalline anisotropy and not a ferromagnet as proposed in earlier studies which had examined only polycrystalline samples. A metamagnetic material is one which is antiferromagnetic at low applied magnetic fields, but becomes ferromagnetic when the field is high enough to change the spin alignment.

They believe that the magnetic structure of Eu_3O_4 consists of ferromagnetic linear chains with antiferromagnetic coupling between chains. Neutron diffraction studies, however, are needed to confirm this proposed structure.

OXIDE ELECTROLYTES

A double cell containing two combinations of oxides (ZrO_2-CaO, ThO_2-Y_2O_3) to measure emf values over a wider range of oxygen pressures than has been heretofore possible is described by Tretyakov and Muan in *J. Electrochem. Soc.* 116, 331 (1969).

The ZrO_2-CaO electrolyte permits cell operation at high oxygen pressure, and the ThO_2-Y_2O_3 electrolyte at very low oxygen pressures. The electrolyte compositions are 85 m/o ZrO_2-15 m/o CaO and 92 m/o ThO_2-8 m/o Y_2O . The cell is described and its behavior and operating conditions are discussed.

ROMANIAN MAGNETISM

A comprehensive review of the rare-earth elements has just come to *RIC News'* attention. This book, *Magnetismul Păminturilor Rare* [Magnetism of the Rare Earths] by I. Pop, was published by Editura Academiei Republicii Socialiste România, Bucharest (1968).

The first chapter is concerned with basic definitions and behaviors, the magnetic properties of ionic compounds of the rare earths, magnetic resonance phenomena, energy levels, and crystal field effects. The next three chapters deal exclusively with the magnetic behaviors of the metals, alloys and intermetallic compounds, and ferrites. The fifth and last chapter is on applications.

This 416-page book with almost 700 references costs 28 Lei (approx. $4.60).

INTERNATIONAL HAPPENINGS -

RE's in Grenoble, Zürich and Moscow

While in Europe during and after the French International Rare Earth Conference the Editor took the opportunity to visit several laboratories which are conducting research on the rare earths.

In Grenoble the Conference was held at the Nuclear Center, and the conferees had an opportunity to visit some of the laboratories there. Unfortunately, because of the lack of time I saw only their crystal growing laboratory. This laboratory is probably one of the largest of its kind in the world. They grow a variety of materials, including rare-earth garnets and aluminates, by a number of different techniques. Of course, the Nuclear Center, under the direction of L. Néel, and the National Center for Scientific Research's laboratories, under E.F. Bertaut, are well known for the excellent studies on the magnetic properties and x-ray and neutron crystallography of rare-earth materials.

After the Conference, I traveled by train from Grenoble to Zürich. In Zürich I visited the Institute of Solid State Physics of the Swiss Federal Institute of Technology which is headed by Dr. G. Busch. Dr. Busch's group is doing a great deal of work on the rare-earth non-metallic compounds RX, where X is N, P, As, Sb or Bi and R is a trivalent lanthanide, and EuX where X is O, S, Se or Te. They are primarily interested in semi-conducting ferromagnets and are studying magnetic and optical properties, crystal structures and photoemission. They have recently found that they can obtain polarized electrons (35% polarization) from photoemission of EuS (see *Solid State Comm.* 7, 775, 1969). A great deal of effort is also being spent on preparing high-purity samples and on better characterization of their materials for solid state studies.

After my visit to Zürich I traveled to Moscow to visit Professor E.M. Savitskii and his research group, the Laboratory of Rare Metals and Alloys in the Institute of Metallurgy of A.A. Baikov of the Academy of Sciences of USSR. Again, the shortage of time prevented my spending more than a day there. Professor Savitskii has five groups working under his supervision. Only one of these groups deals exclusively with the rare earths. The rare-earth group is primarily concerned with the determination of rare-earth alloy phase diagrams. Presently, those of La, Ce, Pr, Nd, Gd, and Sc with a variety of other metals including other rare earths are of greatest interest. Other groups which deal with thermionic emission, superconductivity, and rhenium alloy chemistry only indirectly or occasionally work with the rare earths. A great deal of their work is directed toward finding technological applications, especially in electronic and electrical areas.

RARE EARTHERS on the move

Dr. Therald Moeller (RE complexes), professor of chemistry at the University of Illinois, will become chairman of the Department of Chemistry at Arizona State University, Tempe, in September. Moeller replaces Dr. LeRoy Eyring (RE oxides), chairman of the Arizona State Chemistry Department for the past 8 years, who returns to research and teaching.

At the AEC's Ames Laboratory, Iowa State University, Ames, Dr. V.A. Fassel (RE analytical spectroscopy) has been named deputy director to replace Dr. Morton Smutz (RE liquid extraction). Smutz is now associate dean and director of research in the College of Engineering, University of Florida, Gainesville. A member of the Ames Laboratory staff since 1942, Fassel is also a professor of chemistry at Iowa State University.

Alloy Advances

SUPERALLOYS

The addition of lanthanum, cerium or yttrium to superalloys used for marine turbine applications has proved to be beneficial in increasing the high temperature corrosion resistance of these alloys. Lanthanum or cerium is added to the nickel-based superalloys and yttrium to the cobalt-based alloys. Without the 0.1 to 0.2% rare-earth addition the corrosion rate may be as much as ten times more severe.

MAGNESIUM

The American producers of mischmetal for alloy additions to magnesium expect an increase in output during the next few years, because of the interest shown by U.S. foundries for a magnesium--zinc-rare earth-zirconium alloy (ZE41) for a casting alloy. Although this alloy has been widely used in Europe for many years, it is just becoming popular in America.

The improved castability, lower reject rate and better welding efficiency of ZE41 over the standard casting alloys (magnesium-aluminum-zinc alloys) has all but turned the tide in its favor, even though the costs are slightly higher.

COPPER

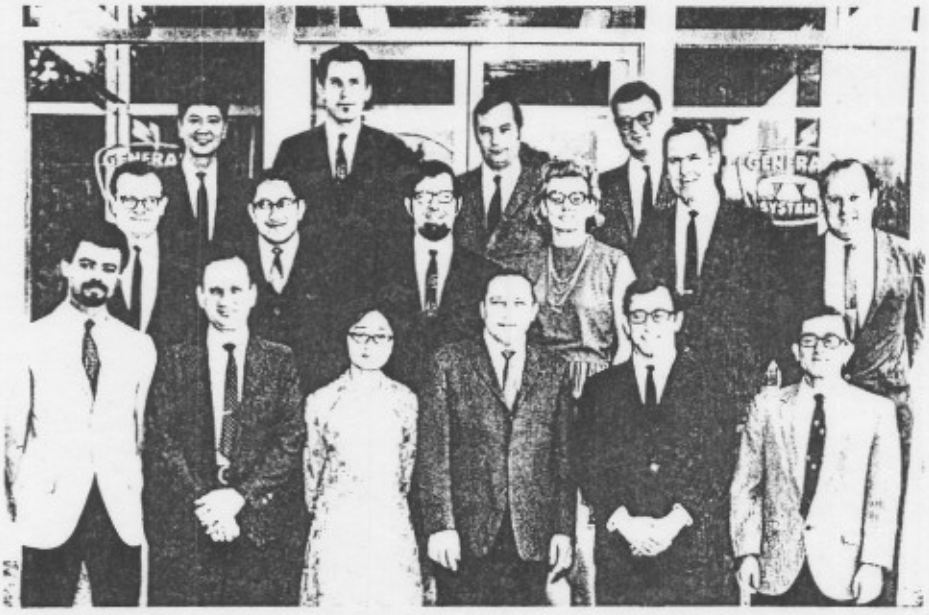
The addition of 2 vol % Y_2O_3 to OFHC (oxygen-free high-conductivity) copper as a fine dispersion increases the strength by a factor of 5 over hard-drawn OFHC copper without altering the electrical conductivity. Although many applications require high-strength - high-conductivity copper, the use of Y_2O_3 in these materials will be given serious competition from Al_2O_3.

Reviews "Terres Rares"

A review, *Les Éléments Des Terres Rares,* by J. Flahaut has been published by Masson et Cie, Editeurs, Paris (1969) 165 pp. Topics covered are general properties, history of the periodic classification, natural abundance, extraction and separation procedures, preparation and properties of the metals, compounds, and the uses and applications.

GT&E Laboratories –

LUMINESCENT MATERIALS GROUP



LUMINESCENT MATERIALS GROUP - In the front row from left are Brian O'Reilly, Frank Avella, Lily Ho, Frank Palilla, Richard Klein and Victor Abbruscato. Pictured in the center row from left are Vincent Meyer, Thomas Sisneros, Robert Amster, Maija Tomkus, Thomas Peters and Samuel Natansohn. In the back row from left are Taisuke Yoshioka, Ojars Sovers, Rene Simon and Gleb Gashurov.

Luminescent materials research at the Bayside Research Center of the General Telephone & Electronics Laboratories located at Bayside, New York, covers all aspects of luminescence in inorganic solids. This program, under the direction of Frank C. Palilla, emphasizes research on rare-earth phosphors because of their tractability to theoretical investigations and because of their importance in color TV and lighting applications.

The basic studies cover the gamut of excitation, energy transfer and emission processes in inorganic phosphor systems. Examination of the response of phosphors to various excitation modes helps to identify the processes by which energy is absorbed or lost, and thereby to determine the ultimate radiant efficiencies obtainable.

Studies of the lifetimes of excited states clarify the host-activator and activator-other atom interactions involved in energy transport. In addition, precise spectroscopic studies of intensities and positions of the discrete emission characteristics observed with rare-earth activators in selected hosts are used to describe quantitatively the internal crystalline field experienced by the activator.

Concomitantly, exploratory synthesis research is carried out in a search for materials with high luminescent response throughout the visible spectral range. Emphasis is placed on the coupling of visibly emitting lanthanide ion activators (Ce, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb) to hosts containing rare-earth cations (Y, La, Gd, Lu). The significant features of the latter are that they are optically inert and they easily accommodate the former.

The experimental phosphors resulting from this research are evaluated for commerical use, and significant new developments are promptly transferred to the Chemical and Metallurgical, Lighting, and Electronic Components Divisions of Sylvania Electric Products Inc., a subsidiary of General Telephone &

(Continued on Page 8)

Support RIC

(Continued from Page 1)

Co., Ltd., Japan; Typpi Oy, Finland; and Wako Bussan Co., Ltd., Japan.

The first industrial support of RIC came from these companies: American Potash, Grace, Molycorp, Research Chemicals, and Ronson.

The resumption of RIC's inquiry answering service is a direct result of increased industrial support for Fiscal Year 1970. A half-time staff member has been added to provide this and other services (see story on Page 2). Despite RIC's curtailed activities, information requests are running 50% ahead of a year ago.

Although it appears that the Center will be operating at a near normal level through July 1970, its future is still uncertain. With little likelihood of Federal support, RIC's programs will depend on financial aid from additional companies in the rare-earth business.

The Center needs grants totalling $10,000 annually in addition to the support provided by Iowa State University to meet minimum objectives. To date about 60% of the needed funds have been received or pledged. If your firm would like to join our present benefactors in supporting RIC, contact Director K.A. Gschneidner, Jr.

"A continuing commitment on the part of rare-earth users and producers will enable the Center to plan farther into the future," according to Gschneidner. "Until then, we must necessarily operate on a year-to-year basis," he concluded.

RIC News
Vol. IV, No. 3 September 1, 1969

published in
March, June, September and December
by
Rare-Earth Information Center
Institute for Atomic Research
Iowa State University

* * *

Second-Class postage
paid at Ames, Iowa.

* * *

Telephone: Area Code 515 294-2272
K.A. Gschneidner, Jr. . . . . Editor
Charla Bertrand, Nancy Kippenhan and W.H. Smith
Staff Writers

☆☆☆☆☆☆☆☆☆☆☆☆
☆ Reports ☆
☆ Booklets ☆
☆ Brochures ☆
☆☆☆☆☆☆☆☆☆☆☆☆

GERMAN BOOKLET

The June 1969 issue of *Goldschmidt informiert*, 1/69 Nr. 6, contains seven articles on the metallurgical applications of the rare earths. These articles, which are all written in German, deal with: (1) a general survey by I.S. Hirschhorn*; (2) a direct high temperature chlorination process by W. Brugger and E. Greinacher; (3) cast iron with spherical graphite by W. Brugger; (4) rare-earth steels - Brugger; (5) rare-earth magnesium alloys - Brugger; (6) rare earths in copper and copper-base alloys by W. Hilgers; and (7) rare earth-cobalt permanent magnets by C. Herget.

This issue is available free and may be obtained by writing to Th. Goldschmidt A.-G., 43 Essen 1, Postfach 17, Germany.

*A closely related paper by Hirschhorn, "Metallurgical Applications of the Rare Earth Metals" (in English) appeared in the June 1969 issue of *Modern Castings*.

Magnetic Semiconductors

The state-of-the-art on magnetic semiconductors has been summarized in an excellent review by S. Methfessel and D. C. Mattis, p. 389 in *Handbuch der Physik [Encyclopedia of Physics]*, Vol. XVIII/1 (1968). Although it covers all known magnetic semiconductors, about half of the 180-page article deals with the rare-earth magnetic semiconductors, especially the europium 1:1 chalcogenides.

The review covers all aspects of these materials, including band structure; theory of transport properties; indirect exchange, both theory and experimental evidence; optical properties; and electrical properties. This chapter is highly recommended for anyone actively working or interested in these materials.

GEOCHEMICAL PROSPECTING

The occurrence of trace elements such as cobalt, europium, and scandium in ocean floor samples may be useful in determining origins of undersea sediments.

Texas A and M University's Activation Analysis Research Laboratory is developing methods which use these elements in "geochemical prospecting" on the ocean floor. Although work is now limited to analyses of five major elements – silicon, oxygen, aluminum, magnesium, and iron.

MAGNETISM IN TECHNOLOGY

In an invited paper presented at the 14th Annual Magnetism Conference, I. S. Jacobs discussed the "Role of Magnetism in Technology," [his complete talk is published in the March, 1969, issue of *J. Appl. Phys.* 40, 917]. Jacobs notes that magnetism has an economic impact of over 1% on the gross national product of America, and presumably a similar percentage in other technologically advanced countries. The magnetism market, research, history, and esoteric role of magnetism are all discussed.

In addition to Jacob's paper, this issue of *J. Appl. Phys.* contains about 75 more papers dealing directly or indirectly with rare-earth materials.

Thermocouple Insulator

Yttrium oxide was found to be better than BeO and as good as ThO_2 for thermocouple insulators at temperatures between 1800 and 2000°C using tungsten/25% (or 3%) rhenium-tungsten thermocouple wires and Ta, Mo, Re, W and Nb Sheaths. It was found that Y_2O_3-insulated thermocouples maintained their calibration for more than one month at 2000°C. [J.W. Droege, *et al., Battelle Memorial Institute Report* BMI-X-10246 (November, 1968)]

Publications Available

Fraternal Fifteen, an elementary introduction to rare earths, may be obtained free from RIC.

IS-RIC-1, *Rare Earth Products Catalog*, is available for $3.00 from Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Virginia 22151, USA.

Back numbers of *RIC News* are available as follows: Vol. III, Nos. 2, 3 and 4 and Vol. IV., Nos. 1 and 2 are available free from RIC.

Xerox copies of earlier numbers can be obtained from Iowa State University Library, Reference Department, Ames, Iowa 50010. Charge is $.10/page; Minimum order, $1.00. Bold face numbers in the table below indicate number of pages in earlier issues, e.g. Vol. II, No. 2 consisted of 10 pages.

Vol.	Issue Number			
	1	2	3	4
I	4	8	4	8
II	8	10	4	4
III	4	-	-	-

Luminescent Materials Group

(Continued from Page 7)

Electronics Corporation. An example of such a development is the YVO_4: Eu phosphor which has had a major impact in the lighting, television and rare-earth chemical industries.

Rare-Earth Information Center
Institute for Atomic Research
Iowa State University
Ames, Iowa 50010

Second-Class postage paid at Ames, Iowa.

RARE-EARTH INFORM CTR
AMES LAB USAEC
IOWA STATE UNIVERSITY
AMES, IOWA 50010