



RARE-EARTH INFORMATION CENTER NEWS

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Euophysics RE Meeting Summary

The Euophysics Study Conference on the Physics of the Rare Earth Metals was held at the LO-Højskole, Elsinore, Denmark, Aug. 29-Sept. 1, 1973. The aim of the conference was to review the present experimental and theoretical understanding of the physics of the rare earth metals. This was accomplished through invited half-hour review papers followed by extensive discussions and by the presentation of five-minute contributed papers.

A. R. Mackintosh and J. G. Houmann, conference organizers, provided *RIC News* with the following summary of the conference.

"As a result of these lectures, the short communications and the extensive discussions which took place, our present understanding of the rare earth metals was reviewed and placed in perspective, while promising lines for future research were outlined.

"Our experimental understanding of the magnetic properties of the heavy rare earths has reached a very sophisticated level, so that subtle effects of, for example, anisotropic exchange interactions may be studied in great detail.

"On the other hand, the theoretical understanding of the magnetic interactions is less satisfactory and further theoretical and experimental studies of the origins of the crystalline electric fields are now required. These crystal fields are of particular importance in the light rare earths, which have been relatively little studied experimentally, although a fairly thorough understanding of praseodymium is beginning to emerge. The valence changes which occur in cerium and a number of rare earth compounds, due to the partial promotion of a 4f electron to the conduction band, give rise to a fascinating variety of physical phenomena which are not

yet understood in detail.

"During recent years a large amount of systematic work has been performed on well-characterized rare earth compounds, in which the environment of the rare earth ion has a decisive effect on the magnetic properties. A striking example of such behaviour is provided by ions whose crystal field ground-state is a non-magnetic singlet. Both the experimental and theoretical understanding of such systems contain obscurities which require further examination.

"In general, it was felt that the complex magnetic interactions to which rare earth ions may be subjected, and the resulting rich variety of magnetic properties, are most likely to be further elucidated in the future by measurements on single crystals of compounds and on dilute alloys, using the extensive selection of experimental techniques, such as magnetization and transport measurements, electron spin- and nuclear-resonance, photoemission and especially neutron diffraction, which were discussed at the conference."

(Continued on Page 4)

Explosive

An explosive transition in Gd-doped SmS has been discovered by Bell Laboratory scientists A. Jayaraman, E. Bucker, P. D. Dernier and L. D. Longinotti [*Phys. Rev. Letters* 31, 700-703 (1973)].

When a SmS sample, in which 15 to 22% of the Sm atoms have been substituted for by Gd atoms, is cooled to below 120°K (-150°C) the golden-yellow metallic crystals explosively disintegrate to a black powder. Upon warming the black powder regains its golden-yellow color.

The explosive nature of this material is due to a sudden expansion of the lattice from a lattice parameter of 5.68 to 5.82 Å (a volume change of 7.5%). There is no change in the crystal structure; both phases have the NaCl-type structure. The authors believe this expansion is due to the transfer of about half a valence electron per Sm atom to a localized 4f level which causes the lattice to expand because of this fractional loss of a bonding electron.

Season's Greetings
best wishes for the New Year
from RIC

Alcohol Intake

A study on the accumulation of yttrium and lanthanides in human and rat tissues by M. -L. Sihvonen has been published in *Ann. Acad. Sci. Fennicae, Ser. A, II. Chem.* [168] 1-62 (1972). Mrs. Sihvonen has analyzed by mass spectrometric methods the rare earth contents of several organs of humans who died suddenly. The organs studied were the spleen, kidney, liver, pancreas, hypothalamus, thyroid gland and heart.

In some samples rare earth distribution did not resemble that found in plants or rare earth minerals. One noticeable difference was the high samarium and europium contents of the spleen of alcoholics as compared to non-alcoholics.

On the basis of this observation, Sihvonen began experiments on two strains of rats by including rare earths in their diets and offering a free choice between alcohol and water. One strain preferred alcohol to water and the second abstained from alcohol. She found that the rare earth accumulation in the livers, kidneys, pancreases and spleens of both strains of rats to be about the same. But the alcohol consumption for both strains increased within a few days after beginning the rare earth-containing diet.

RIC-DD Acquisitions

New additions to RIC's Document Depository include two theses. Although we receive a number of theses each year they are usually not included in our Document Depository, since most of the information contained in a thesis also appears in a scientific journal. However, if a person sending us a thesis states that *most of the information in the thesis will not be published elsewhere, we will include it in our Document Depository holdings.*

RIC-DD-5 *A Model Useful in Interpreting the Behavior of Binary Oxide Systems: With Application to Rare Earth Catalysts*, by J. L. Moriarty, Jr., (1971) 12 pp + 1 glossy print (U.S. \$1.60) [Airmail Rate A].*

RIC-DD-6 *A Structural Study of Thin Films of the Lanthanide Metals, Hydrides, and Sesquioxides*, (in French) thesis by M. Gagnier (1973) 173 pp + 11 glossy prints (U.S. \$21.70) [Airmail Rate C].*

RIC-DD-7 *An Electron Microscope Study of the Twinned Sesquioxides of the Monoclinic Rare Earths*, (in French) thesis by C. Losier (1973) 56 pp + 25 glossy prints (U.S. \$15.60) [Airmail Rate B].*

*See *RIC News* VIII, [2], 8 (1973).

Shifty Characters

R. E. Sievers has recently rounded up several shifty characters from the Lanthanide gang who have "complexed" the scientific community for some time now and the police aren't even interested! For anyone who is interested, however, descriptions can be found in *Nuclear Magnetic Resonance Shift Reagents* edited by R. E. Sievers (Academic Press, Inc., New York, 1973) 428 pp. \$9.50.

Samples of the voluminous research currently being undertaken in the field of lanthanide shift reagents are included. Sixteen articles which cover the spectrum from theory to application, are based on the papers presented at the Symposium on the Chemistry of NMR Shift Reagents held at the 165th National American Chemical Society Meeting in Dallas, April 9-11, 1973.

A 50-page bibliography is divided into topics for easier access. Among them are fundamental aspects, chemical and physical properties, structural determinations, and general applications of lanthanide shift reagents.

Chemical Thermodynamics

In continuing a comprehensive revision of NBS Circular 500, the National Bureau of Standards has announced the publication of NBS-270-7, *Selected Values of Chemical Thermodynamic Properties, Tables for the Lanthanide (Rare Earth) Elements (Elements 62 through 76 in the Standard Order of Arrangement)*. (Editor's note: This arrangement of elements is unique to the NBS Circular 500 and NBS-270-X series.)

This report gives in tabular form the standard heats and Gibb's energies of formation, entropies, enthalpies, and heat capacities at 298.15°K and the heats of formation at 0°K for the rare earth elements, their ions, and a wide variety of rare earth compounds. Also included is a list of corrections for NBS Technical Notes 270-3, 270-4, 270-5, and 270-6. Unfortunately, no references are given to

RIC to Initiate Service Charge

Effective January 1, 1974, the Rare-Earth Information Center will collect a service charge for answering most information inquiries. A minimum charge of \$25 has been set to cover the expenses involved in answering most typical inquiries. If a particular inquiry requires more work the charges will be increased accordingly. If the charges are expected to be more than \$50 the requester will be notified and we will proceed with the request only upon his approval.

There are some exceptions to imposing the service charge: (1) No charges will be assessed to those companies which contribute to the support of RIC—at least up to the amount of their contribution. (2) Charges will be waived for those who certify they do not have resources available to pay for the service, e.g., students. (3) No charges will be made for (a) routine requests, such as information about a rare earth conference, (b) requests for information about the availability of commercial rare earth products or (c) requests for additional information on articles or material presented in the *RIC News*.

The rationale behind this change is that the users of the Information Center benefit from the information obtained, and thus they or their institutions should be willing to pay for these services.

We believe that one of our important functions is to make information available to *anyone who needs it*. It is for this reason that we have attempted to keep the service charges as low as possible and to waive charges when imposing them would constitute a hardship.

the original source of information which, in many cases, is quite valuable.

NBS-270-7 is available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, for \$1.25 Domestic Postpaid or \$1.00 if purchased at the GPO bookstore.

MEETING

OPTICAL PROCESSES OF PHOSPHORS

The Spring 1974 meeting of the Electro Chemical Society to be held in San Francisco, Calif., May 12-17, will include a symposium on the optical processes in rare earth phosphors, according to Melvin Tecotzky, symposium chairman.

Materials of interest are rare earth-activated materials in powder, single crystal, liquid, thin-film, or glass form. Tecotzky listed the following topics of interest: 1. relation of structure and spectra, 2. charge transfer, 3. energy transfer—up conversion, 4. radiative and non-radiative transitions, and 5. thermal and concentration quenching.

Papers of approximately 25-minute duration (including discussion) are being solicited. Direct inquiries to Tecotzky at United States Radium Corp., P.O. Box 409, Hackettstown, N.J. 07840, U.S.A.

Rare Earths In the News

BUBBLE MEMORIES

A bismuth thulium garnet film developed by RCA's physical electronics laboratory could make computer "bubble" memories a reality. The film forms magnetic "bubbles"—tiny cylinders of reversed magnetism—having greater light sensitivity than earlier films. This makes possible optical readout at about one hundred times the rate of nonoptical methods.

COMING ATTRACTIONS

Another new rare earth-cobalt permanent magnet, this one by Hitachi Metals Ltd., has proceeded to the commercial development stage. A samarium-cobalt material, the magnet has a maximum energy product of 23 MG·Oe (184 kJ/M³) thus making it the most powerful on the present market, say its makers.

(Continued on Page 4)

Langmuir Award

Prof. Harry G. Drickamer, department of chemical engineering, University of Illinois at Urbana-Champaign, has won the 1974 Langmuir Award in Chemical Physics for his use of very high pressure to study the electronic structure of solids, including new states of matter not attainable at lower pressures.



H. G. Drickamer

Drickamer's high pressure work on the rare earths includes x-ray, compressibility and electrical resistivity measurements on the metals and alloys and optical properties of the ions in CaF₂ and other saline hosts.

The Langmuir Award, sponsored by the General Electric Foundation, is given in alternate years by the American Chemical Society (ACS) and the American Physical Society. The ACS named this year's award winner and will present it to Drickamer in Los Angeles next April.

INTERMETALLICS

Persons interested in bulk magnetic properties and low temperature specific heats of rare earth intermetallic compounds will be naturally attracted to a book by W. E. Wallace entitled *Rare Earth Intermetallics*. In 266 pages Wallace reviews the magnetic and low temperature specific heat research of the last ten years covering the elements of the groups VIIIA - IVB. Approximately one-eighth of the book is devoted to theory while the remainder, richly illustrated with tables and figures, treats susceptibility, magnetic moments, Weiss constants, ordering temperatures, specific heats and third law entropies.

Rare Earth Intermetallics is available from Academic Press, Inc., New York (1973) for \$22.50.

Letters

To the Editor:

In the last issue of *RIC News* you reported on "a new metal phase" observed in thin films of Gd, Tb, Dy, Ho, Er and Tm, whose structures in bulk form are usually hexagonal close-packed. I think that the authors, A. E. Curzon and A. G. Chlebek, mislead when they attribute this new observed structure to a metal phase, because the lattice parameters they give for this face-centered cubic structure are practically the same as those of the corresponding dihydrides. The dihydrides have been extensively studied in the two last decades not only by our team, but also by other research workers in the United States and Eastern Europe. In a recent thesis (May, 1973), M. Gasgnier of the Faculté des Sciences d'Orsay concluded, as I do, that the observed structure is not that of a metal phase. [*This thesis is available as RIC-DD-6, see p. 2.*] I add that dihydride surfaces may show metallic reflectivity, and that these compounds possess a lower resistivity than the corresponding metals.

Sincerely yours,

R. Viillard

Directeur de Recherche au C. N. R. S.
Laboratoire de Chimie Physique
Université de Paris, France

(Dr. Paul Caro, Laboratoire de Terres Rares, Bellevue, France, who recently visited the Information Center also verbally expressed a similar view concerning the "new metal phase" reported by Curzon and Chlebek.—Ed.)

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Additional Support

Contributions from four more firms have come in since September when support from 23 companies was reported. Financial support was received from Brown, Boveri & Co., Ltd., Switzerland, and from GTE Sylvania, Inc., Chemical and Metallurgical Division, U.S.A., both contributing for the second time, from five-time contributor American Metallurgical Products Co., U.S.A., and from Research Chemicals, U.S.A., which is a six-year contributor to RIC.

Europhysics RE Meeting Summary (Continued from Page 1)

PROGRAMME†

Electronic Structures

The Electronic Structures of the Rare Earth Metals and Actinides, A. J. Freeman

Photoemission Studies of Rare Earth Metals, Y. Baer

Renormalized Atom Theory of Rare Earth Metals, R. E. Watson

Magnetic Structures and Magnetization

Magnetic Structures and Conduction Electron Spin Densities, R. M. Moon

Magnetic Form Factors in Rare Earth Metals and Compounds, T. O. Brun

High Field Magnetization of Rare Earth Metals, L. W. Roeland

Valence Changes

Theory of Valence Transitions, L. M. Falicov
The Electronic Properties of Ce, B. Coqblin
Demagnetization of Rare Earth Ions during Valence Changes, D. Wohlleben

Magnons and Phonons

Magnon Dispersion Relations and Exchange in Rare Earth Metals, R. M. Nicklow

Magnetoelastic Effects and Elastic Constants, J. Jensen

Phonons, Magnon-Phonon Interactions and Magnetic Anisotropy, J. C. G. Houmann

Singlet Ground States and Hyperfine Interactions

Magnetic Properties of Pr, B. D. Rainford

Singlet Ground States in Rare Earth Compounds, R. J. Birgeneau

Rare Earth Hyperfine Interactions, R. L. Cohen

Dilute Alloys and Domains

Electron Spin Resonance in Dilute Rare Earth Alloys, R. Orbach

Superconductivity and Electron Scattering in Dilute La Alloys, D. K. Finnemore

Magnetic Domains in Rare Earth Metals, T. Egami

Summary and Discussion

Theoretical, R. J. Elliott

Experimental, A. R. Mackintosh

†There will not be a published proceedings.

Replacement of calcium by lanthanide ions forms isomorphous heavy atom derivatives suitable for x-ray analysis of calcium binding proteins.

ANALYSIS AND APPLICATIONS

In an attempt to form a closer alliance between those working in analytical and technological areas of the rare earths, the NATO Advanced Study Institute sponsored a conference entitled "Analysis and Application of Rare Earth Materials" at Kjeller, Norway, in August 1972. Twelve papers dealing with chromatography, various spectroscopic methods, and neutron activation were presented. The uses of rare earth materials were discussed in eleven papers which covered optical, magnetic, ceramic, nuclear, catalytic and metallurgical applications.

The proceedings of this conference are now available in a book entitled *Analysis and Applications of Rare Earth Materials*, O. B. Michelsen, ed. (Universitetsforlaget, Blindern, Oslo, 1973) 375 pp., \$28.00.

RE in the News

(Continued from Page 3)

CATALYST MAKES TOP 100

A rare earth phosphate catalyst for the production of synthetic cresol and xylenols has made *Industrial Research's* list of the top 100 new products introduced during 1973. The catalysts, either lanthanum or cerium phosphate, made by Gulf Research & Development Co., eliminate the corrosion and pollution problems associated with the presently used caustic hydrolysis process and cut production costs in half.

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Thermochemistry Report Issued

In continuing a study and analysis of the thermochemical data of rare earth compounds involved in the manufacture of steel, the Rare-Earth Information Center has just published *Thermochemistry of the Rare Earths, Part 1, Rare Earth Oxides, Part 2, Rare Earth Oxysulfides, Part 3, Rare Earth Compounds with B, Sn, Pb, P, As, Sb, Bi, Cu and Ag* (IS-RIC-6). It contains a complete compilation of heats and free energies of formation of the rare earth oxides in the temperature range 25 to 2500°C. A two-color figure compares the free energies of formation of these compounds with common non-rare earth oxides. Revised and estimated formation values for the rare earth oxysulfides are presented, as well as a summary of the available thermochemical data for rare earth compounds containing B, Sn, Pb, Sb and As. For rare earth compounds containing P, Bi, Cu and Ag, the free energy of formation values were estimated.

This report is a follow-up to *Thermochemistry of the Rare Earth Carbides, Nitrides, and Sulfides for Steelmaking*, (IS-RIC-5), published August 1971. The preparation and publication of both IS-RIC-5 and IS-RIC-6 were sponsored by Molybdenum Corporation of America. Copies of either or both of these reports may be obtained free from RIC or from Molycorp, 6 Corporate Park Drive, White Plains, NY 10604, U.S.A.