RARE-EARTH INFORMATION CENTER NEWS

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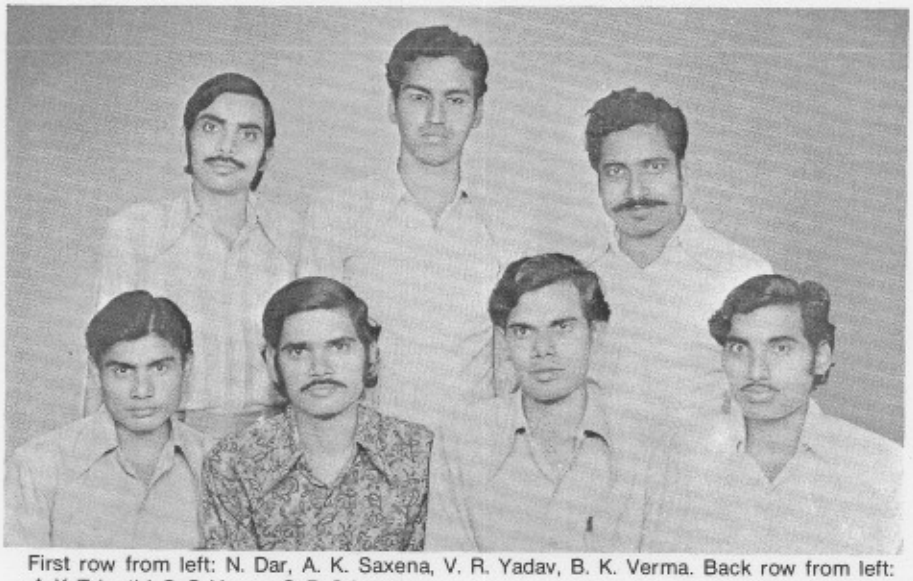
RARE EARTH RESEARCH IN INDIA



First row from left: N. Dar, A. K. Saxena, V. R. Yadav, B. K. Verma. Back row from left: A. K. Tripathi, S. C. Verma, O. P. Srivastava

University of Gorakhpur—

H. B. Lal

Research work on rare-earth compounds was initiated in the Physics Department of Gorakhpur University, Gorakhpur, 273001 India, in 1971 under the leadership of Dr. H. B. Lal. This group started investigating the electrical transport and dielectric properties of rare earth compounds. The main aim of the study was to understand the physical mechanism involved in electrical transport and the nature of localized or bound charge carriers. Besides synthesizing and characterizing these compounds, the measurements being carried out are (i) D.C. electrical conductivity as a function of electric field, time and temperature, (ii) A.C. conductivity as a function of temperature and signal frequency, (iii) thermoelectric power as a function of temperature, (iv) dielectric constant as a function of frequency and temperature, and (v) magnetic susceptibility as a function of temperature. The group has published about forty papers including research notes on these compounds. The compounds studied in detail are rare earth sesquioxides (R_2O_3), rare earth tungstates $R_2(WO_4)_3$, $EuWO_4$, CeO_2, Pr_6O_{11} and Tb_4O_7. R_2O_3 compounds are found to be electronic conductors with positively charged intermediate polarons as the charge carrier. They conduct by the usual band mechanism but are dominantly scattered by optical phonons having band gaps varying from 2 to 3 eV in different R_2O_3. It has been found that light rare earth sequioxides show Curie-Weiss law behavior down to 4.2 K mainly due to crystal field, whereas heavier ones have ordered magnetic structures below 4.2 K. $R_2(WO_4)_3$ compounds (except R = Sm, Ce and Pr) are electronic conductors with intermediate polarons (holes) in O^{2-}: $2p$ band as the charge carrier. Conduction in Ce and Pr tungstates is due to intermediate polarons (electrons) in R^{3+}: $5d$ band. The conduction in CeO_2, Pr_6O_{11} and Tb_4O_7 is mainly due to impurities and defects. The main contributors to these studies are Drs. H. B. Lal, A. Kumar, N. Dar and Messrs. V. Pratap and B. K. Verma.

New research efforts are concerned with rare earth molybdates, chromates, garnets and zirconates. Messers S. C. Verma, V. Pratap and A. K. Tripathi are studying the magnetic susceptibility and D.C. conductivity of heavy rare earth molybdates. Similar work is being

(continued on page 4)

Contributors

Five companies renewed their support of the Center during the second quarter of fiscal year 1980. They are Allied Chemical Corporation (8), American Metallurgical Products Co. (11), Cometals, Inc. (3), Eastman Kodak Company (3) and Research Chemicals (12). All five are from the USA. The number in parentheses is the number of years each company has supported RIC. The total number of benefactors to date is now twenty-nine. To correct an error made in the September issue, we hereby report that V/O Techsnabexport is from the U.S.S.R. rather than the U.S.A. Sorry 'bout that!

Tm

1879

Thulium rounds out the foursome of rare earths that were discovered during the banner year of 1879 and share 1979 as their 100th birthday. Thulium, like holmium, is a third generation rare earth by way of yttria and erbia. Noticing anomalies in the atomic weight of what was then thought to be pure erbia, P. T. Cleve successfully separated the "pure erbia" into erbia, holmia and thulia. While Cleve had to share the discovery of holmia with the Swiss chemist, J.-L. Soret, he alone is given credit for the discovery of thulium. The word thulium is derived from Thule, an old name for Scandinavia. Applications of thulium include phosphors, ferrite bubble devices, catalysts and portable X-ray units.

NMR REVIEWED

M. A. H. McCausland and I. S. Mackenzie's review of the nuclear magnetic resonance (NMR) in rare earth metals, [*Advances in Physics* **28**, 305-456 (1979)], has appeal for both specialists and beginning students in the field of NMR spectroscopy. Several sections are devoted to introducing basic concepts such as Russell-Saunders coupling, spin-orbit splitting, magnetic dipole moments and the Zeeman interaction, electrical multipole moments and the crystal field interaction, hyperfine interactions in isolated ions, structural and magnetic properties of rare earth metals, alloys and compounds, and basic theory of rare earth magnetism. For the specialist, sections describe the dipole term, quadrupole term and second order effects of intra- and extra-ionic hyperfine interaction, nuclear energy levels and the NMR line spectrum, signs of hyperfine parameters, inhomogeneous broadening and satellite spectra, different NMR methods, NMR spectra and nuclear spin relaxation of rare earth metals, alloys and compounds. Areas where more NMR research is needed have been noted by the authors.

Bromides and Iodides

Book C6 of the *Gmelin Handbuch der Anorganischen Chemie, System 39, Rare Earth Elements* deals with compounds formed between Sc, Y and the lanthanides and bromine and iodine. Compounds covered include rare earth di- and tribromides, basic bromides, bromates, bromide-fluorides, alkali-bromometallates, di- and tri-iodides, basic iodides, iodates, periodates and alkali-iodometallates. Topics include preparation, crystallography, thermodynamic, chemical, optical and solution properties and complexes. Book C6 features an English table of contents, preface, margin notes, and a brief review at the beginning of each chapter. Published in 1978 by Springer-Verlag, this volume is 274 pages long and costs $352.70.

Business News

Mitsubishi + Megon

RIC incorrectly reported in the September 1, 1979 issue of the *RIC News* that Mitsubishi had purchased fifty percent of A/S Megon. Actually Mitsubishi and Megon have entered a joint venture for the production and sale of high purity yttrium oxide. A new company, MCI-Megon A.S., was formed to operate the facility at Kjeller, Norway, which was previously run by Megon. Megon and Mitsubishi each own fifty percent of the new company. The plant's present capacity is 30 metric tons (not 3 metric tons) of yttrium oxide per year.

Molycorp European Office

Molycorp, Inc. has announced the opening of a new European marketing and technical development base with the establishment of Molycorp International at 30, avenue George-V, 75008 Paris, France. Ir. H. E. Aldorf, formerly Assistant Sales Manager, Europe Chemicals, for Climax Molybdenum, will head up the new office as director of marketing.

Industry Profile

An extensive rare earth industry profile and market review has been presented in the March 1979 issue of *Industrial Minerals*, pp. 21-59. Lists of the major mineral producers and processors have been compiled and rare earth activities in Australia, Austria, Brazil, France, Germany, India, Japan, Malaysia, Norway, United Kingdom and the United States are discussed. Mineral sources are described and various market applications including flints, steel, permanent magnets, glass, phosphors, hydrogen storage, bubble devices, and catalysts are reviewed.

RE HANDBOOK

Volume 2: Alloys and Intermetallics of the *Handbook on the Physics and Chemistry of Rare Earths*, K. A. Gschneidner, Jr. and L. Eyring, eds., North-Holland Publishing Co., Amsterdam (1979) is now available. Volume 2 is 620 pages in length and costs $85.00 (Dfl. 200). Subscription price is $72.25 (Dfl. 170). Chapters and authors are listed below.

"Crystal Chemistry of intermetallic compounds," A. Iandelli and A. Palenzona

"Magnetic properties of intermetallic compounds of rare earth metals," H. R. Kirchmayr and C. A. Poldy

"Magnetostrictive RFe_2 intermetallic compounds," A. E. Clark

"Amorphous magnetic rare earth alloys," J. J. Rhyne

"Crystal fields," P. Fulde

"NMR, EPR and Mossbauer effect: metals, alloys and compounds," R. G. Barnes

"Europium chalcogenides: EuO, EuS, EuSe and EuTe," P. Wachter

"Valence changes in compounds," A. Jayaraman

For more information contact your bookseller or North-Holland Publishing Company, P.O. Box 211, 1000 AE Amsterdam, The Netherlands, or Elsevier North-Holland, Inc., 52 Vanderbilt Avenue, New York, NY 10017, U.S.A.

Liquid Metal Alloys

The magnetic properties of liquid metal alloys is the subject of a review by N. H. March and C. M. Sayers [*Advances in Physics* **28**, 1-47 (1979)]. Rare earth alloys are only briefly discussed while rare earth-transition metal liquid alloys are covered in detail, specifically alloys of La, Ce, and Pr with Co and Ni. Topics include magnetic susceptibility as a function of composition, density of states, partial structure factors and theory. Only two sections of the review are concerned with rare earth materials.

CAST IRON CONTROL

Control of the particles and precipitates formed in cast iron and their effects on the structure of cast iron are the subjects of a paper by W. G. Wilson that was presented at the 83rd Casting Congress of the American Foundrymen's Society, Birmingham, Alabama, May 1979. Wilson has used available thermochemical data, phase diagrams, etc. to develop a systematic method for controlling the precipitates. Copies of the paper may be obtained from Reactive Metals and Alloys Corporation, P.O. Box 366, Route 168, West Pittsburgh, PA 16160.

PHYSICS SYMPOSIUM

An international symposium on the Physics of Actinides and Related 4*f* Materials will be held April 9-11, 1980 at Zurich, Switzerland. Papers on 4*f* materials will be accepted if a relationship to the actinides can be clearly demonstrated. The symposium is open to anyone and will consist of invited and contributed papers dealing with bulk magnetic and related properties, lattice effects, mircoscopic magnetic measurements, electronic structure and associated properties. The application and abstract deadline is January 10, 1980 with papers being due March 10, 1980. The proceedings will be published by North-Holland Publishing Company as a special volume of *Physica B*. For more information contact B. Reihl, Laboratorium für Festkörperphysik, ETH Hönggerberg, CH-8093 Zürich, Switzerland.

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Berzelius' 200th

Photo courtesy of the Swedish National Museum, Dept. of Royal Castles' Collections.

(Editor's note: This is one of a continuing series of articles commemorating the centennials of those scientists who made great contributions to the field of rare earths.)

In addition to being the year in which the first Frank H. Spedding Award was presented and the 100th anniversary of the year in which four rare earths, Sc, Sm, Ho, and Tm, were discovered, 1979 has the further distinction of being the 200th anniversary of the birth of Jöns Jacob Berzelius, one of the founders of chemistry as we know it today.

Born on August 20, 1779, into a humble lifestyle, Berzelius lost both of his parents while he was still quite young. Two individuals, his stepfather Pastor Ekmarck and his natural history school teacher Dr. Hornstedt, instilled in young Berzelius an inquisitiveness and love of nature that was to guide his future development towards science at the expense of his Hebrew and church history studies. In 1802 he graduated with a degree in medicine, but even then most of his free time was spent on his chemistry experiments. His diligence and attention to detail paid off very quickly when, in 1803, Wilhelm Hisinger gave Berzelius a sample of Bastnäs tungsten ore to analyze. Hisinger thought the tungsten ore might contain some of the yttrium earth that Gadolin had discovered in a different ore in 1794. By autumn, both Berzelius and Hisinger were convinced that they had found a new element and named it cerium after the asteroid Ceres. Controversy followed the announcement when it was learned that a German scientist, M. H. Klaproth, had simultaneously made the same discovery, naming it ochroit earth, and Swedish professor Johan Afzelius claimed that cerium did not exist but was in fact a mixture of several known oxides. Berzelius persisted and was able to convince his colleagues of the validity of his discovery which he shares with Hisinger and Klaproth. After a minor stumble (the discovery of Gahnium, later found to be zinc oxide) Berzelius' career was off to the races. Contributions to the science of chemistry include calculation of the atomic weights of many of the elements that were known at that time, definitive work on the combining proportions of the elements, the discovery of selenium and thorium, and perhaps most notable, his system of chemical symbols to describe the elements and their compounds. Perhaps less auspicious but no less useful to the chemist are Berzelius' contributions to the laboratory, which include the desiccator, filter paper, rubber tubing, the wash bottle and the water bath.

4th RE-Co Workshop

The *Proceedings of the Fourth International Workshop on Rare Earth-Cobalt Permanent Magnets and Their Applications,* held May 22-24, 1979 at Hakone National Park, Japan, are now available as a 450-page paperbound volume for $25.00, plus $6.00 per copy for overseas delivery from the Society of Non-Traditional Technology, Kotohira Kaikan Bldg. No. 2-8, 1-Chome, Taranomon, Minato-ku, Tokyo 105, Japan. Residents of the USA, Canada and Mexico may obtain copies for $25.00, plus $3.00 postage from the Magnetics Laboratory, KL-365, University of Dayton, Dayton, Ohio 45469. Forty-seven articles outline electrical applications, medical applications, magnetic bearings and other mechanical devices, magnetic properties, magnetic aftereffects, structure and coercivity and permanent magnet materials.

e: Key Elements: d^9-, d^{10}-, $d^1..d^3$-, f-elements, edited by K.-H. Hellwege and A. M. Hellwege has been published by Springer-Verlag (1976). The cloth-bound volume is 739 pages in length and costs $278.00 (DM680).

Data is arranged in tables and includes the chemical formula, space group, lattice constants, number of formula units per unit cell, density, structure type, scope of structural determination, the method used and references. Oxo-compounds of scandium, yttrium, and the lanthanides (La-Lu, except Pm); hydroxo-compounds of scandium, ytterbium and lutetium and flurooxo-compounds of cerium are included. This volume also contains data for similar compounds of Cu, Ag, Au, Zr, Cd, Hg, the actinides, Ti, Zr, Hf, V, Nb and Ta.

24th MMM Proceedings

The proceedings of the 24th Annual Conference on Magnetism and Magnetic Materials, November 14-18, 1978, Cleveland, Ohio, edited by J. J. Becker and J. C. Bonner, has been published by the American Institute of Physics in the *Journal of Applied Physics* **50,** 1551-2464 (1979). Over 40% of the 320+ articles are concerned with rare earth materials. Topics covered include metallic glasses, amorphous rare earth-transition metal alloys, anisotropy and magnetostriction of crystalline and amorphous materials, spin glasses, electronic structure, exchange interaction, critical behavior, superconductivity, magnetic structure, transport, insulators, semiconductors, neutron scattering, hydrides, garnets, magnetic domains, bubble materials, intermetallic compounds, hard magnetic materials, phonon-magnon interaction and microwave devices.

nent magnet alloys; low-samarium (Ce-based R-Co-Cu and $MMCo_5$) magnet materials; flexible, plastic-bonded R-Co permanent magnets; new standards in commercial magnet applications; the situation of R-Co magnets in Japan; applications in electrical machines of medium to large power ratings and virtually zero-powered magnetic bearings for high-vacuum operation; and methods for chemical and physical analysis of powdered R-Co magnets and alloys. An appendix contains phase diagram data for binary and ternary alloys between the rare earths La, Ce, Sm and MM and the transition metals Fe, Co and Cu.

Copies can be obtained by writing to: Th. Goldschmidt Prod. Corp., 175 Main Street, White Plains, NY 10601, U.S.A.

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O. P. Srivastava is studying the transport mechanisms in ZrO_2:R_2O_3 systems in order to obtain a high temperature solid electrolyte, which may have application as solid superionic conductors.

The encouragement, active interest and help provided by Prof. N. K. Sanyal, Head of the Physics Department, University of Gorakhpur and SIDA, Sweden, are the keys to the success of our work.

TOXICITY

A review concerned with new aspects of the toxicity of the rare earths has been compiled by P. Arvela [*Progress in Pharmacology* **2,** [3] 69-112 (1979)]. A brief mention of the physical and chemical properties, natural occurence and applications of the rare earths is made. Topics covered more extensively include metabolism, distribution, excretion, acute and chronic toxicity, effects as calcium antagonists, effects on microsomal drug metabolism, secretory processes, interaction with mitochondria and the effects of other agents on the toxicity of the lanthanides. The rare earths were found to be essentially nontoxic when taken orally due to limited intestinal absorption. However, inhalation of rare earth particles is hazardous to the lungs. Two hundred and thirty references are cited.