



Rare-earth Information Center NEWS

Ames Laboratory

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Springtime in Australia

In early October, two weeks after the conclusion of the 20th Rare Earth Research Conference, the editor was off to Australia to present several talks, including two at two successive one day meetings near Sydney. The first stop in the land-down-under was the beautiful town of Perth in Western Australia.

University of Western Australia

At the University of Western Australia, Nedlands, Perth, I visited primarily with Profs. Robert Street and Paul McCormick and their staff at the Research Center for Advanced Mineral and Materials Processing (RCAMMP). This Center was one of several special research centers established by the Australian Research Council in 1991. RCAMMP is composed of four sections: Minerals and Materials Characterization, Hydrometallurgical Mineral Processing, Solid State Refining, (headed by McCormick) and Materials Development (headed by Street).

The Materials Development Section is mainly concerned with rare earth permanent magnets, but also terfenol, ferrite magnetic materials and the $(Y_xR_{1-x})Ba_2Cu_3O_7$ high temperature superconductor. The Solid State Refining Section is primarily concerned with low temperature mechanochemical processes for refining and alloying of materials. There is close cooperation between the two groups especially with regard to rare earth permanent magnets. Paul McCormick's group is one of the leaders in the area of mechanically inducing chemical reactions at low temperatures, and have prepared rare earth alloys by reducing the rare earth oxide or fluoride with calcium in the presence of iron (or cobalt) or iron oxide (or cobalt oxide) to form the $Nd_2Fe_{14}B$ or $SmCo_5$ permanent magnet alloys at room temperature by mechanical milling. A $SmCo_5$ alloy prepared from SmF_3 with a coercive force of 65.5 kOe is claimed to be the strongest ever reported for a "bulk mag-

netic material magnetized at room temperature".

A two phase mixture of the pure Fe and $Sm_2Fe_{17}N_x$ prepared by mechanical alloying and heat treating, was found to be isotropic with an enhanced Fe remanence (70% of its saturation value) due to magnetic exchange coupling between the nanosize Fe and $Sm_2Fe_{17}N_x$ phases. The material has a magnetic energy product of 26 MGOe, which according to Prof. Street, is ~2.5 greater than that of conventional *isotropic* Nd-Fe-B magnets. Other studies include the time dependent behavior in high coercivity materials, and this has lead to a theory of magnetic viscosity based on the thermal activation of domain processes characterized by a distribution of activation energies. This theory has successfully accounted for many of the observed behaviors of magnetic viscosity and is quite useful in understanding the time dependence of magnetization of materials.

Forum on Rare Earths and Their Uses

The National Science and Industry Forum is a series of meetings sponsored by the

Australian Academy of Science on topics of importance to the science and technology of Australia. The 53rd meeting, which was organized by Prof. R. Street, was devoted to the "Rare Earths and Their Uses". Nine papers were presented at this one day meeting and it included an overview of rare earth uses and applications, rare earth supplies and processing, new high energy permanent magnet materials, optical fibers, use of rare earth permanent magnets in electric motors, magneto-optic storage media, rare earth catalysis, trichromatic phosphors, and products for a rare earth industry in Australia.

Rare Earth '93-Processing and Utilization Workshop

A second one-day meeting was organized by three other Australian organizations to follow-up on the Forum meeting on the next day. This meeting, "Rare Earths '93 Processing and Utilization Workshop" was organized by the Australian Nuclear Science and Technology Organisation

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Season's Greetings
from RIC



(ANSTO), the Department of Industry, Technology and Regional Development, and the Australian Mineral Foundation. The workshop was held at ANSTO, in Lucas Heights, just outside of Sydney. The introductory talk was a brief overview on rare earth high technology applications. This was followed by six brief presentations on: the use of rare earths in organic synthesis, the Olympic Dam mineralogy, processing of radionuclides, refractories for processing molten iron-rare earth alloys, ceria catalysts, and pilot plant scale processing of the Mt. Weld rare earth deposit. After lunch, the attendees toured the Mt. Weld processing pilot plant which is located at ANSTO.

In the afternoon the meeting was divided into two parallel sessions, one dealing primarily with processing and separation chemistry (six papers) and the other with applications, primarily magnetic materials (six papers). The papers in the former dealt with: flotation of monazite, beneficiation of heavy minerals, preparation of $RCl_3(thf)_n$ complexes [thf = tetrahydrofuran], abundance diagrams, kinetics of the extraction of yttrium by mono-2-ethyl-hexyl phosphonic acid mono-2-ethyl-hexyl ester, and the use of radioactive tracers in solvent extraction kinetics. The applications session contained papers on: the $Nd(Ni_xFe_{1-x})Si_2$ system, the iron-rich corner of the Nd-Fe-Ti system, hydrogenation and disproportionation reactions in processing Sm_2Fe_{17} magnets, site occupancy and magnetic interactions in $RCo_{12}B_6$ compounds, ball milling $NdFe(CoZr)B$ permanent magnet powders, and paramagnetic properties of metallic samarium materials.

After these sessions, a brief panel discussion was held on "Rare Earths Prospects for Australia".

Epilogue

The proceedings of the two meetings will be published, and their availability will be announced in the *RIC News*. It was an enjoyable visit to Australia, to see old friends and make new ones. ▲

NATO-ASI Study Program

The NATO Advanced Study Institute Program has scheduled a two-week course of instruction entitled "Interstitial Alloys for Reduced Energy Consumption and Pollution". The directors of this NATO-ASI summer school are K.H.J. Buschow, G.J.

Long and F. Grandjean. This study program is designed to introduce young engineers and scientists to the field of metal hydrides and interstitial alloys and their role in reducing energy consumption and pollution. Lectures will cover both the preparation and fundamental properties of these alloys and their various applications in energy storage devices. The application

deadline is March 10, 1994.

The course will be held June 12-24, 1994 in Il Ciocco, Castelvecchio Pascoli, Italy. For more information, contact Fernande Grandjean, Institut de Physique, B5, Université de Liège, B-4000 Sart Tilman, Belgique; Tel:32 41 563632; Fax:32 41 562355; E-mail:U2121FG@vm1.ulg.ac.be. ▲

Conference Calendar

* A NEWS STORY THIS ISSUE

May '94

9th International Symposium on Non-Oxide Glasses (Halide Glasses)
Hangzhou, Zhejiang, People's Republic of China
May 24-8, 1994
* This issue

May 24-8, 1994

* This issue

June '94

Interstitial Alloys for Reduced Energy Consumption and Pollution
Il Ciocco, Castelvecchio Pascoli, Italy
June 12-24, 1994
* This issue

June 12-24, 1994

* This issue

International Conference on Nitromagnetics

Honolulu, Hawaii, USA

June 15-17, 1994

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July '94

Eleventh International Conference on Solid Compounds of Transition Elements (SCTE-11)

Wroclaw, Poland

July 5-8, 1994

RIC News, XXVIII, [2] 2 (1993)

August '94

3rd International Conference of f-Elements (ICFE)

Helsinki, Finland

August 1-5, 1994

RIC News, XXVIII, [3] 2 (1993)

Relativistic Effects in Heavy-Element Chemistry and Physics: Electronic Structure Methods for Lanthanides and Actinides

Helsinki, Finland

August 8-9, 1994

* This issue

Strongly Correlated Electron Systems
Amsterdam, The Netherlands

August 15-18, 1994

RIC News, XXVIII, [3] 2 (1993)

International Conference on Magnetism
Warsaw, Poland

August 22-26, 1994

RIC News, XXVIII, [3] 2 (1993)

4th International Symposium on Research in High Magnetic Fields

Nijmegen, The Netherlands

August 29-31, 1994

RIC News, XXVIII, [3] 2 (1993)

14th International Colloquium on Magnetic Films and Surfaces

Düsseldorf, Germany

August 29-September 2, 1994

RIC News, XXVIII, [3] 2 (1993)

September '94

Thirteenth International Workshop on Rare-Earth Magnets and Their Applications and Eighth International Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys

Birmingham, England

September 11-15, 1994

* This issue

1996

21st Rare Earth Research Conference (RERC)

Charlottesville, Virginia, USA

1996

* This issue (See 20th RERC article, page 3.)

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Satellite Meeting

A satellite meeting to the 2nd International Conference on f-Elements will be held August 8-9, 1994 in Helsinki, Finland. The workshop is entitled "Relativistic Effects in Heavy-Element Chemistry and Physics: Electronic Structure Methods for Lanthanides and Actinides" and will compare and evaluate the methods currently available for calculating the properties of atoms, molecules and solids containing 4f and 5f elements. Approximately 25 workshop participants will deliver 40-minute invited lectures and shorter 20-minute presentations.

Those who are interested in participating in the workshop should contact Dr. Michael Dolg, Institute für Theoretische Chemie, Universität Stuttgart, Pfaffenwaldring 55, 70569 Stuttgart, Germany; Tel:49 711 685 4399; Fax:49 711 685 4442; E-mail: cfat1019@servus.rus.uni-stuttgart.de. ▲

Er-Doped Green Laser

There is a growing interest in the production of an all-solid state laser that emits in the visible spectrum. One of the most promising methods known is to utilize upconversion pumping of rare earth-doped crystals or optical fibers with suitable laser diodes. Although erbium-doped crystal lasers emit in the green portion of the visible spectrum, until recently it has only occurred at cryogenic temperatures, which severely limits their applications.

R. Brede, et al. report on the first demonstration of a green erbium-doped crystal laser at room temperature (*Appl. Phys. Lett.*, 63, [6], 729-30 (1993)). The authors excited an Er-doped LiYF₄ (YLF) crystal with a pulsed dye laser which emitted on the ⁴S_{3/2} - ⁴I_{15/2} ground state transition. In studying the fluorescence measurements, it was found that the emitted radiation was polarized parallel to the optical axis. It was also found that with approximately 2% of output coupling, a slope efficiency of 6% was obtained for the Er:YLF crystal. Maximum power output energy of the laser was 30 μJ at a peak power of 600 W. However, repetition rates above 10 Hz showed a rapid decrease in output energy.

The room-temperature lasing of Er-doped Y₃Al₅O₁₂ (YAG) and Lu₃Al₅O₁₂ (LAG) was also observed at a pulsed laser operation of 561 nm. These garnet lasers exhibited inherent instability; yet, the upconversion pumping of the low thresholds looks promising. ▲

20th RERC

The 20th Rare Earth Research Conference (RERC) was held September 12-17, 1993 in Monterey, California, U.S.A. General Conference Chair Herbert Silber and Program Chair Frederick Richardson deserve acclaim for a successful conference. Thanks are also extended to all those who helped make the conference run smoothly. The proceedings are to be published in the *Journal of Alloys and Compounds*.

The 20th RERC was truly an international conference as over 170 of the participants represented 29 countries. Oral sessions of the conference included topics on: Lanthanides in Biochemistry and Medical Diagnostics; Optical Spectroscopic Probes; Rare Earth Energy Level Structures in Optically Opaque Materials; Molecular Lanthanide Chemistry in the Development of New Materials and Reaction Catalysts; Recent Developments in Magnetic and Superconducting Rare Earth-Based Materials; Light Metal Glasses Utilizing Rare Earths; Industrial Applications and Emerging Technologies of Rare Earths; and Comparative Aspects of Lanthanide and Actinide Behavior. Poster Sessions allowed one-on-one discussion opportunities between participants. Among the highlights of the conference were the following.

LeRoy Eyring was presented with the seventh Frank H. Spedding Award. The award is sponsored by Rhône Poulenc and was presented by Lance DeLong, Chair of the Selection Committee. Prof. Eyring received the award for "a highly productive and effective lifetime of research on the thermodynamics and structures of rare-earth oxides and associated phases, illuminating our understanding of the defect solid state".

Of particular interest were papers presented by John A. Barclay (University of Victoria, Canada) on "Magnetic Refrigeration—Both Active or Passive (Cryocoolers)", A. Watson (Nycomed Salutar, Sunnyvale, California) "The Use of Gadolinium and Dysprosium Chelates in Magnetic Resonance Imaging", A. Furrer et al. (Laboratory for Neutron Scattering, Switzerland), "Neutron Spectroscopy in RBa₂Cu₃O_x (R=Ho,Er, 6<7) Compounds" and A. Inoue and T. Masumoto (Tohoku University, Sendai, Japan) "Light-Metal Base Amorphous Alloys Containing Lanthanide Metal".

Many other interesting and important topics were also presented during the conference. Officers of the Rare Earth Research Conference, Inc. gave their approval for the

Continued in next column ☺

9th International Non-Oxide Glasses

The name has changed from halide non-oxide but the "9th International Symposium on Non-Oxide Glasses" carries on the format of the first eight symposia that referred to these glasses as "halides". The 9th Symposium will be held May 24-28, 1994 at Zhejiang University in Hangzhou, Zhejiang, People's Republic of China.

Abstracts that are submitted as quickly as possible after you receive this issue of *RIC News* will be considered. After notification of acceptance, extended abstracts of no more than 6 pages must be submitted by February 20, 1994. Selected papers from the symposium will be reviewed and published in *J. Non-Cryst. Solids*.

The aim of the 9th Symposium is to exchange and circulate information on the science, technology, and applications of halide and non-oxide unconventional glasses. The areas to be covered are: glass synthesis (including purification and analysis of raw materials and glasses), new glass compositions, fabrication techniques, chalcogenide and other unconventional glasses; glass structure (both experimental and theoretical); optical properties; physical and chemical properties, with a focus on durability, aging, impurity analysis, nucleation and crystallization, thermodynamics, kinetics, and magnetic, electrical, thermal and mechanical properties; rare earth-doped glasses and active fibers, fiber amplifiers and lasers, absorption and emission properties; and IR optical fibers, including low loss fibers, telecommunications systems, sensors, and imaging and medical applications.

To obtain further information about the symposium, contact Prof. Chen Quanqing, Dept. of Material Science and Engineering, Zhejiang University, Hangzhou-310027, People's Republic of China. Tel:0571-572242 or -572244; Fax:0571-5123315 or -5171796. ▲

21st Rare Earth Research Conference (RERC) to be held in 1996 in Charlottesville, Virginia, U.S.A. Actual dates of the conference and programs to be presented have not yet been determined. For additional information contact the Conference Chairs: Dr. Frederick S. Richardson, Department of Chemistry, University of Virginia, Charlottesville, VA 22901; Tel:804 924 3905; Fax:804 924 3710, and Mr. James B. Hedrick, U.S. Bureau of Mines, 810 7th St. NW, Washington, DC 20241; Tel:202 501 9412; Fax:202 501 3751. ▲

Fluoride Glass Optical Fibres

Optical fibers made from fluoride glasses are ideal for use in long distance communications systems. Their low-loss properties will enable telecommunications signals to be sent much further than conventional optical fibers without the need for repeaters. *Fluoride Glass Optical Fibres* presents the current state of research and development of heavy-metal glasses and their properties. These exciting materials also transmit visible and infrared energy (from about 0.5 to 5 μm) which opens up many new applications outside the field of telecommunications. Optical fiber sensors, including remote infrared spectroscopy, laser surgery, and fiber lasers are just a few of the latest advances. Several companies from the USA, Europe and Japan are involved in producing commercial instruments based on fluoride fibers, with many more instruments yet to be developed.

Fluoride Glass Optical Fibres presents work from both an academic and commercial viewpoint, including ways to convert these glasses into fibers and their uses in industry. Following an introduction on perspectives and overview of research in fluoride glasses, the book elaborates on: properties of fluoride glasses, propagation in optical fibers, manufacture of infrared fibers, measurement of intrinsic losses, extrinsic absorption and scattering, measured losses in fibers, mechanical properties, and applications. Lanthanum and yttrium fluoride glasses are the main focus, as well as others that contain cerium, dysprosium, gadolinium, praseodymium, and other rare earths.

The book was written by P.W. France, M.G. Drexhage, J.M. Parker, M.W. Moore and S.F. Carter and J.V. Wright. Five of the chapters were written by P.W. France and another chapter was co-authored by J.M. Parker and P.W. France.

The 256-page hardcover book *Fluoride Glass Optical Fibres* contains 107 figures, 35 tables of information, and 468 references. The book was published in 1990 and is available for \$100.95 US in the U.S.A. and \$121.00 US elsewhere. To order, write to: CRC Press, Inc., 2000 Corporate Blvd. N.W., Boca Raton, FL 33431 USA. In the U.S.A.: Tel: 800 272 7737; Fax: 800 374 3401; outside the U.S.A.: Tel: 407 994 0555; Fax: 407 998 9114. ▲

YTTERBIUM, atomic number 70, was discovered by J.C.G. Marignac in 1878 and is obviously named for the town of Ytterby.

SCES '92 Proceedings

The proceedings of the International Conference on Strongly Correlated Electron Systems (SCES '92), which was held September 7-11, 1992 in Sendai, Japan, is now available. The proceedings contains 311 papers by 308 scientists from 16 countries who participated in the Sendai meeting. Altogether, 332 papers were presented at the conference including 41 invited papers.

About three quarters of the papers are related to *f*-electron systems and one quarter are dedicated to CuO_2 layered high- T_c superconductivity. Several papers are related to exotic organic metals that exhibit strong electron correlations and even superconductivity. Five Symposia were held in the following fields: new types of Kondo states, two impurities and Kondo states; very low-carrier-concentration heavy fermions; weak magnetism and heavy-fermion superconductivity; Fermi surface and Luttinger theorem; and electron-phonon interaction in strongly correlated systems.

The five symposia are further divided into eleven chapters, two of which are entitled "Cerium and Ytterbium Compounds" containing 57 papers, and "Other Rare Earth Compounds" which contains another 12 papers. These two chapters alone contain research results on magnetic and electrical properties, heavy-electron behavior, thermodynamic and transport properties, thermoelectric power, magnetovolume and magnetoelastic effects, thermal expansion studies, heat capacity and resistivity, as well as other properties of rare earth systems.

The proceedings of the International Conference on Strongly Correlated Electron Systems is published as Volumes 186-8 of *Physica B*, (1993) by Elsevier Science Publishers B.V. The cost to receive the 1100-page book is Dfl.1194.00 (~\$662.00 US). Order from the publisher, P.O. Box 1991, 1000 BZ Amsterdam, The Netherlands, Tel: 31 20 586 2911; Fax: 31 20 586 2623. ▲

Workshop and Symposium on Permanent Magnets

The Rare-earth Information Center still has a limited supply of the proceedings of both the Twelfth International Workshop on Rare Earth Magnets and Their Applications, and the Seventh International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth Transition Metal Alloys.

The cost of the two-volume set is \$150.00

REM XIII

The Thirteenth International Workshop on Rare-Earth Magnets and Their Applications and the Eighth International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth Transition Metal Alloys will be held in Birmingham, England in September, 1994. The Thirteenth Workshop will be held from Sunday, September 11-14, while the Eighth Symposium will take place one day only, on Thursday, September 15, 1994.

The Workshop and Symposium are a series of biennial meetings designed for physicists, chemists, materials scientists, and mechanical, chemical and electrical engineers working in the field of rare earth-transition metal magnets and their applications. The Workshop will occupy three days and will concentrate on the processing, characterization and applications of rare earth magnets. The Symposium on Anisotropy and Coercivity will be held immediately after the Workshop and will concentrate on the more fundamental aspects of the solid state physics and materials science of rare earth-transition metal alloys and magnets. Abstracts need to be sent to the organizers of the conference by January 14, 1994 and authors that are requested to submit papers will be contacted by February 25, 1994.

This will be an outstanding opportunity for companies to advertise their products and services to an international audience. The Technical Exhibition will be held over the length of the conference and will enable company representatives to make new contacts and to open new markets for their products/services.

For more information, contact Professor I.R. Harris, Chairman, REM XIII, School of Metallurgy and Materials, The University of Birmingham, Edgbaston, Birmingham, B15 2TT UK, Tel: 44 21 414 5165; Fax: 44 21 471 2207; E-mail: E.B.Deer@met.bham.ac.uk. ▲

US, or \$75.00 US for either volume alone. For ordering information check page 7 of the September 1, 1993 issue of the RIC News, or contact the Rare-earth Information Center, Institute for Physical Research and Technology, Iowa State University, Ames, IA 50011-3020, USA; Tel: 515 294 2272; Fax: 515 294 3709. ▲

Digital Recording

High density digital magnetic and magneto-optic storage devices are widely used in audio, video, data processing technology, and computer systems. As the application of these materials expand, the demand for increased information storage densities and capacities will lead to the need for new materials to satisfy stiffer requirements. The materials engineering of high density storage media demand high signal-to-noise ratios and the design of sophisticated read and write heads. Perhaps most important, magnetically-stored information must be recovered after years of storage.

These stringent requirements demand the collective efforts of many disciplines: organic, inorganic, and solid state chemistry, metallurgy, solid state physics, electrical and mechanical engineering, and systems analysis. Experts in these areas have produced 21 papers which make up chapters in the new book *High Density Digital Recording*. The first chapters introduce the reader to the fundamental concepts and units in magnetism and magnetic recording and magnetic properties of thin-film recording media. Over half of the chapters deal with the preparation, characterization, and application of rare earth and rare earth-containing materials. For example, V.G. Harris, W.T. Elam, and N.C. Koon report on the structural origins of magnetic anisotropy in amorphous non-s-state rare earth-transition metal films. These magneto optical films are the active layer material that makes this type of recording possible. The authors present experimental results of extended x-ray absorption fine spectra structure (EXAFS) and modeling analysis of Tb-Fe amorphous films with strong perpendicular anisotropy. Kerr rotation tables of Tb-Fe-Mn, Tb-Fe-Ni, Tb-Fe-Pr, Tb-Fe-Gd, and Tb-Fe-Ho alloys used in magneto optical recording are included. Cross-sectional drawings of typical magneto optical films and disks are also included.

The book is an excellent source of information for scientists working with magneto-optical materials and should help interested persons keep abreast of the latest developments in this field.

High Density Digital Recording, edited by K.H.J. Buschow, G.J. Long, and F. Grandjean, was published in 1993 and is available for Dfl 380.00 (\$250.00 US, £153.00). The 604-page book can be ordered in the U.S.A. and Canada from Kluwer Academic Publishers, 101 Philip Drive,

Selected Topics in Magnetism

In recent years, studies in magnetism have included exciting new concepts such as the Rudermann-Kittel-Kasuya-Yosida (RKKY) interaction, virtual bound state, Kondo effect, spin glass state, Kondo lattices, spin fluctuations, valence fluctuations, heavy Fermion state, magnetic ordering of nuclear moments and, most recently, magnetism of high- T_c superconductors. *Frontiers in Solid State Sciences, Selected Topics in Magnetism* is the second of a series of nine volumes to be published concerning topics in solid state science.

The book contains 12 chapters contributed by 25 authors and is edited by L.C. Gupta and M.S. Multani. The chapters include: Spin Fluctuations in Heisenberg Magnets; Dynamic Critical Phenomena and Excitations in Quasi-Periodic Systems; Quenching of Spin Fluctuations by High Magnetic Fields (Ce, Sc, Y, and Lu compounds); Kondo Effect and Heavy Fermions; Magnetic Interactions in Correlated Electron Systems; High Pressure Investigations; Hall Effect in Heavy Fermion and Mixed Valence Systems (Ce compounds); Magnetic Properties of Uranium Based 1-2-2 Intermetallics; Inelastic Magnetic Excitations in Anomalous Rare Earth Intermetallics (Ce, Sm and Yb systems); Neutron Scattering Studies of Magnetic Properties of Actinide Systems; Magnetic Properties of Heavy Fermion Systems as Studied by μ SR Spectroscopy (Ce and Yb compounds); Re-entrant and Insulating Spin Glasses and; Nuclear Magnetism in Metals and Alloys. The final chapter reveals electronic and nuclear magnetic ordering data for PrNi₂. The book will be of interest to scientists and academicians alike who work in the field of magnetism.

The 441-page book was published in 1993 and is available for \$75.00 US (£47.00) by ordering from the World Scientific Publishing Company. In the U.S.A. contact the publishers at: 1060 Main Street, River Edge, NJ 07661 USA; Fax: 201 487 9656; Tel: 201 487 9655/800 227 7562; in Europe: 73 Lynton Mead, Totteridge, London, N20 8DH, England; Fax: 44 81 4463356; Tel: 44 81 4462461; in India: 4911, 9th Floor, High Point IV, 45 Palace Rd., Bangalore 560 001, India; Fax: 91 812 344593; Telex: 0845-2900 PCO IN. ▲

Norwell, MA 02061, U.S.A., elsewhere; Kluwer Academic Publishers Group, P.O. Box 322, 3300 AH Dordrecht, The Netherlands. ▲

Powder Processing of High T_c Oxide Superconductors

Powder Processing of High T_c Superconductors and Their Properties, edited by A.C. Vajpei and G.S. Upadhyaya, presents properties and aspects of processing these materials under one cover. Although powder processing of ceramics is an established technology, it is of particular importance when applied to superconductors. This book explores the perspectives and practice of powder processing routes towards control and optimization of the microstructure and other important properties of high T_c materials.

After a brief introduction, the second chapter presents information including tables, diagrams, and figures on the classification, crystal structure, and bonding of YBa₂Cu₃O₇ (YBCO) ceramic oxide superconductors. The conditions under which these materials are formed are reviewed, as well as, their phase equilibria. Chapter three reviews the methods and processes needed to prepare these powders, including the solid state reaction method, methods based on solution routes, and the vapor phase continuous process to produce submicron YBCO powder.

The next chapter describes crystal structure characterization of oxide superconductors by chemical and thermoanalytical studies. The last two chapters discuss properties of high T_c superconductors. Granulometry and diamagnetic properties are then reviewed, including powder shape forming techniques, sintering and post sintering treatments, and other manufacturing methods. Many factors influence the various properties of these ceramic materials, such as substitution of elements in the compound and compositional variations. In addition, the effect and dependence of many other variables in the processing of YBCO, and other superconductors are explained. Some other properties that the authors included are: contact and mechanical properties; chemical stability and passivation behavior; the dependence of diamagnetic properties on temperature, magnetic field and pressure; and radiation induced effects.

The 338-page *Powder Processing of High T_c Superconductors and Their Properties* was published in 1992 as volumes 75 and 76 of *Key Engineering Materials* by Trans Tech Publications. The book is available for Sfr 220.00 (~\$146.00 US) by contacting the publisher: P.O. Box 100, Hardstrasse 13, CH-4714 Aedermannsdorf, Switzerland; Fax: 41 62 72 10 58. ▲

Advanced Material Resources Ltd.

Advanced Material Resources Limited (AMR) has announced a joint venture with Chinese rare earth producers in Jiangyin, Jiangsu Province. The facility is one of the most modern and advanced rare earth facilities that produce high value separated products in China. AMR will invest \$3.1 million in return for a 60% interest in the venture. Under the terms of this joint venture, AMR will have the right to purchase 100% of the production of the facility, which is 300 tons of rare earth oxide equivalent, for export.

AMR also reports a second venture involving 70% interest of the facility at Yixing, Jiangsu Province. This \$5.04 million investment will be used to build the largest rare earth plant in China to process ion absorption clays from southern China. AMR will purchase 100% of the production from this facility. A third joint venture with a production facility in Shandong Province is currently on schedule, according to AMR.

AMR is also working on a joint venture agreement with Beijing New Precision Alloy Company, which is a wholly owned subsidiary of Central Iron and Steel Research (CISRI), which is a part of the Chinese Ministry of Metallurgical Industry, the largest mining group in China. This facility will produce materials for rare earth permanent magnets from a new production facility. AMR will own 60% of this joint venture. For more information contact Mr. Peter V. Gundy, Advanced Material Resources Limited, Standard Life Centre, Suite 810, 121 King Street West, Toronto, M5H 3T9, Canada; Tel:416 367 8588. ▲

Dresser Retires

Jim Dresser, Manager of Special Products for Rhône-Poulenc's Phoenix plant since 1989 and manager of Metal Products at the same plant for Research Chemicals Division of Nucor Corporation from 1965 to 1989, retired from the company December 1, 1993. He served for over 30 years producing, fabricating and selling rare earth metals and alloys. Jim is grateful for the opportunity to be a part of the development of rare earths. He and his wife, Mary, look forward to travel, golf, skiing, grand parenting, and volunteer work for years to come. Mr. Dresser adds, "this should be enough to fill the void left by my withdrawal from the rare earth arena". RIC wishes him well in his retirement. ▲

Baotou Research Institute of Rare Earth

Ms. Hu Yulin, Deputy Director of Baotou Research Institute of Rare Earth (BRIR), was promoted to Director early this year. She fills the position left by Mr. Ma Pengqui, when he was assigned Chief Engineer of Baotou Steel & Rare Earth Company.

Ms. Hu has worked extensively in the field of rare earths. In the 1960's, she headed a group which investigated the process for preparing high purity Y_2O_3 , Nd_2O_3 and Gd_2O_3 using an ion-exchange process. In the late 70's, she studied the rare earth extraction process for preparing La_2O_3 , CeO_2 , Pr_6O_{11} , Sm_2O_3 , Eu_2O_3 and Gd_2O_3 . In the 1980's, she acted as Vice Director of Research and Management Department of BRIR, and then later as Deputy Director.

We congratulate Ms. Hu in her accomplishments and wish her well as Director of BRIR. ▲

CONCORD Revives ELEMENTS

CONCORD has resumed publication of its *Elements* magazine in an expanded format that includes applied technology, in addition to rare earths and specialty metals. *Elements*, published bi-monthly, will be a trade journal that will provide insights into the development and conduct of global trade in those featured fields. Each issue promises to include reports on international market activities: in-depth features on emerging technologies; the latest word on tariffs, duties and taxes; and a variety of special reports and updates on the economics, production and application of rare earths, specialty metals and applied technology.

Subscription price for the newsletter is \$495.00 US per year. For more information, contact Becky Clark, Circulation Manager, Concord Information Services, Three Park Central, Suite 1000, 1515 Arapahoe Street, Denver, CO 80202 U.S.A.; Tel:303 899 4503; Fax:303 899 5611. ▲

The Kondo Problem to Heavy Fermions

The behavior of magnetic impurities metals presents problems that have challenged condensed matter theorists since the 1950's. Cambridge University Press offers Cambridge Studies in Magnetism, Vol. *The Kondo Problem to Heavy Fermions*, by Alex Hewson, which presents the concepts and techniques, developed over the past thirty years that meet this challenge. It will be useful to researchers in this field how the theories presented in the book apply to the interpretation and evaluation of experimental results.

After introducing basic theoretical models, the author describes Kondo's explanation of the resistance minimum. The non-perturbational approach is needed to predict low-temperature behavior, since Kondo's perturbational calculations break down in this temperature region. To solve this "Kondo problem", A. Hewson surveys many-body techniques, scaling, the renormalization group, Fermi liquid and Bethe ansatz. The book also deals with special techniques for N -fold degenerate models for rare earth impurities and compares theoretical predictions with experimental results. The ten chapters are Models of Magnetic Impurities; Resistivity Calculations; The Kondo Problem Renormalized Group Calculations; Fermi Liquid Theories; Exact Solutions and the Bethe Ansatz; N -fold Degenerate Model I, and II; Theory and Experiment; and Strongly Correlated Fermions.

The Kondo Problem to Heavy Fermions was published in 1993, and will interest experimental and theoretical condensed matter physicists. The 425-page hardback book contains 175 line diagrams and 392 references. To order, send £52.50 (\$100.00 US) to: Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, UK; Tel:0223 325970; Fax:0223 325959. ▲

MINTEQ International

On page 6 of the September issue of the *RIC News*, we erred in mentioning that the company offers building materials, ceramics, paints, glass, metal alloys, and rare earths. Actually, MINTEQ International Inc. is a research and technology-based company which provides a wide range of mineral,

mineral-based and synthetic mineral products used primarily in the manufacture of paper and steel. They also produce them for building materials, polymers, ceramics, paintings, glass, lead alloys, rare earth metals, and other industries. ▲

K-M Dismantles RE Plant

Kerr-McGee Chemical Co. has filed a plan with the Illinois Department of Nuclear Safety for the final closure and dismantling of its former 43-acre rare earths plant located in West Chicago. In addition to producing rare earth materials, the plant also manufactured thorium for use in lamps and thorium nitrate, much of which was sold to the Atomic Energy Commission. The latest plan involves removing the remaining structures and excavating radioactive wastes and soil.

The project is expected to be completed in four years at a cost of more than \$100 million. The initial shipment of contaminated materials to a permanent disposal site in Clive, Utah is expected to be made in July 1994. The cleanup will allow the site, which has been closed since 1973, to be converted to beneficial use. ▲

More Scandium

Hunan Research Institute of Rare Earth Material reports that it produced about 100 kg of scandium metal in 1992, and that this output could be increased if required [*China Rare Earth Information*, No. 30, August, 1993]. The company produces 99.999% scandium metal and the export of the metal and its compounds are increasing yearly. Also, Panzhihua Iron and Steel Company in Sichuan Province has received the capital necessary to build a scandium metal production line. ▲

RE Extractive Metallurgy

A comprehensive report entitled "Extractive Metallurgy of Rare Earths" by C.K. Gupta and N. Krishnamurthy appeared in *International Materials Reviews*, 37, [5], 197-248 (1992). This excellent review provides information on the following topics: world rare earth resources and production; ore processing and separation of individual rare earths; reduction, refining, and ultrapurification of rare earth elements; methods for rare earth materials analysis; and rare earth applications.

The review begins by identifying the rare earths and providing a brief history into their discovery. The authors also give relative and crustal abundances of the rare earths and their distribution in ores and minerals. A world map is included that shows the locations and identifies the major rare earth resources with their associated minerals. World rare earth production figures show each major country and the annual tonnage recovered for exports and domestic use.

Companies and researchers will be interested in the flow sheets that describe the step-by-step methods of separation processes: physical beneficiation; heavy mineral processing; chemical treatment; selective reduction; fractional crystallization; and solvent extraction. The authors have included these flow charts to show the separation processes for the major rare earth minerals: xenotime; bastnasite; monazite; and euxenite, which is a nice touch. Some thermodynamic data is given for selected oxides, and a section on the preparation of rare earth metals by the metallothermic reduction of the chlorides, fluorides and oxides is included. Electrolytic preparation of rare earth alloys by electrolysis is reviewed including a brief history of the electrolytes and cathodes used in this process.

The section entitled "Purification of Rare Earth Metals" will be of particular interest to those who want a concise and to-the-point description of these processes. Melting temperatures, vapor pressures, and various processes for the purification of the individual rare earth metals including zone refining, electrorefining and electrotransport illustrate how pure and ultra-pure RE metals are produced. For permanent magnet producers, the section on the preparation of rare earth alloys provides both a description of the production of samarium-cobalt (Sm-Co) and neodymium-iron-boron (Nd-B-Fe) permanent magnet materials by

ETREMA Dedicates Building

ETREMA (Edge Technologies Rare Earth Magnetostrictive Alloys) Products Inc., has opened a new "World Class" manufacturing facility in Ames, Iowa. ETREMA is a world leader in the production and quality of TERFENOL-D, a giant magnetostrictive alloy that has found uses in sonar transducers and miniature linear motors. Applications range from micropositioning vibration control, and laser optics for aerospace, medical, and petroleum and geophysical exploration.

The 10,800 square foot facility was named "McMasters Systems and Research Center" in honor of O. Dale McMasters, who was mainly involved in developing the technical processes for the manufacture of directionally solidified polycrystalline, and also single crystal TERFENOL-D. Ceremonies took place October 13, 1993 and included a guided tour of the production facilities. The McMasters Systems and Research Center is highly automated which will increase production, cut production costs and make batch-to-batch performance more consistent. For information on products and services, contact Jody R. Zahn, ETREMA Products, Inc., 2500 North Loop Drive, Ames, IA 50010 USA; Tel: 515 296 8030 or 800 327 7291; Fax: 515 296 7168. ▲

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several methods and flow charts detailing each process. For Sm-Co, reduction diffusion and coreduction processes are shown; for Nd-B-Fe, the Ronson, Santoku, Molycorp, Ames, Comurhex, General Motors, and Goldschmidt processes are illustrated.

To determine the chemical composition of the impurities in separated rare earths and purified metals and alloys, the available methods of analysis are reviewed.

"Applications of Rare Earths" gives a brief but comprehensive breakdown of traditional uses of rare earths, and also applications to the latest technological breakthroughs which utilize these materials, including fluoride glasses, optical waveguides, laser glass, high-temperature superconductors, permanent magnets, and hydrogen storage materials.

The 52-page "Extractive Metallurgy of Rare Earths" is recommended for those needing a background in the processes and procedures of preparing rare earths from minerals and ores and in purifying their metals and alloys. The paper contains 476 references, 19 tables and 35 figures. ▲

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O. Norman Carlson 1920-1993

O. Norman Carlson, 72, an Iowa State University emeritus professor, died September 10 from cancer. He was internationally known for his work on high purity rare earth metals, phase equilibria, and mass transport in solids. He was the author of more than 120 papers, two books and several chapters of various books. His final works were phase diagrams of the oxygen-yttrium system and the "Purification of Refractory Metals by Solid State Refining" which were published in 1990.

After receiving his bachelor's degree in 1943 from Yankton College, Yankton, South Dakota, Carlson went to work for the Manhattan Engineering Project at Iowa State College until 1945. After earning his doctorate in 1950, he joined the faculty of chemistry at the college and Ames Laboratory. He was appointed chairman of the newly formed department of metallurgy and chief of the metallurgy division of Ames Laboratory in 1961. In 1966, he returned to teaching and research duties and retired in 1987, when he was designated an emeritus professor and continued to work as an associate and consultant at Ames Laboratory.

Carlson was a member of the Metallurgical Society of AIME and the American Chemical Society, and was elected a fellow of the American Society for Materials International in 1991. He was also a longtime member of Sigma Xi and an emeritus life member of Phi Kappa Phi honorary societies.

RIC extends our condolences to his family and friends. ▲

New Category

RIC announces a new category of support - the INDIVIDUAL SUPPORTERS. This category has been set up for those persons who wish to help RIC promote the rare earths, through its publications and to provide information on these materials when requested.

An Individual Supporter will receive the full benefits of a corporate membership - subscription to our monthly newsletter *RIC Insight*, free literature searches, and a yearly listing in the *RIC News*, unless they wish to remain anonymous. The minimum level of support is \$100.00-US. Checks should be made payable to the "RIC Newsletter Fund" and sent to the Rare-earth Information Center, Institute for Physical Research and Tech-

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Supporters 1993

Since the September issue of the RIC News went to press, RIC has received support from 7 new family members, and renewed support from 24 other organizations. The supporters from the second quarter of fiscal year 1994 who wish to be listed, grouped according to their appropriate category, and with the number of years that they have contributed to the Center in parentheses, are listed below.

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RIC welcomes our first Individual Supporter, Mr. Norton Jackson, from Erindale, Australia. ▲

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