Rare-earth Information Center NEWS

Volume XXXVI December 2001 No. 4

Turning Windows into Mirrors

The metal-insulator transition in rare earth hydrides, especially yttrium hydrides are intriguing due to the change in optical and electronic properties of the material that occurs. Work on this subject is detailed in "Light-Induced Metal-Insulator Transition in a Switchable Mirror," by A. F. Th. Hoekstra, A. S. Roy, T. F. Rosenbaum, R. Griessen, R. J. Wijngaarden, and N. J. Koeman, *Phys. Rev. Lett.* **86** [23] 5349 – 5352 (2001), and summarized in "Switch-Hitter Materials Tantalize Theorists," by David Voss, *Science* **292** 1987 (2001).

It has been known for some time that certain materials can be doped with hydrogen to change them from metal conductors to clear insulators (called the Mott transition after Sir Neville Mott, who worked on the theory of metal to insulator transitions). This recent work shows that the opposite can also be achieved, and it also tries to provide some clues to the true nature of the metal-insulator transition.

The clear to opaque transition in this case was attained through exposure to UV light and maintaining the material at a controlled low temperature. At the same time the material changed from clear to opaque, the conductivity increased, and the material changed from an insulator to a conductor. This change in yttrium hydride is continuous and is not accompanied by a structural phase transition, as is the case in most Mott-Hubbard systems. It is this fact that may shed light on the critical behavior of such materials. ▲

History of Rare Earths in Postage Stamps, page 4

The Green Challenge

A new yttrium coating has won this year's Presidential Green Chemistry Challenge Award in the designing safer chemicals category. The coating is manufactured by PPG Industries and is used instead of lead in paint primer coats on cars. New cars from Ford, Nissan, or Mitsubishi made in North America currently use the new coating. An article detailing the awards, "Accepting the Green Challenge," appeared in *C&EN* 77 [27] 24 - 28 (2001). Information from this article was also obtained from http://www.epa.gov/opptintr/greenchemistry/presgcc.htm.

The Presidential Green Chemistry Challenge Awards were first given in 1995, and were designed as a competition to promote economical but environmentally friendly chemical products. The awards are administered by the Environmental Protection Agency's Green Chemistry Program, and are operated in conjunction with approximately 20 entities from industry, government, academia, and other organizations. Nominations are accepted in five categories, and the work presented in each nomination must have been carried out in the U.S. in the prior 5-year period. The Awards Program is open to all individuals, groups, and organizations, both non-profit and for profit, including academia, government, and industry.

PPG Industries introduced the first cationic electrodeposition primer in 1976. Their coating technology was put into use throughout the automotive industry, and now almost all automobiles have a primer coat using PPG's technology. Up to now, lead has been used in this process because of its superior corrosion resistance, and lead is very effective for protecting the cold rolled steel which is still commonly used, especially in lower priced vehicles.. And in spite of the known toxicity of lead, it had been allowed up to 1000 ppm in electrodeposited coatings and exempted from stricter regulation because no better substitute was available. PPG has been looking for a replacement for lead for over 20 years, and yttrium coatings are the viable solution. Yttrium coatings had proven to be just as effective in preventing corrosion and provides as smooth a painting surface as lead, and it is a common element in nature, with even more yttrium present in the earth's crust than lead and silver.

Yttrium oxide is not known to pose any health risks or environmental problems, and is nontoxic when compared to lead (this is shown in rats by an LD50 of >10g/kg). It is cost effective because at half the weight of lead, less volatile organic compounds are emitted during application since half the amount relative to lead is used, and no equipment changes are needed to utilize the yttrium coating in PPG's Power-Prime electrodeposition system. The use of yttrium also eliminates the need to use chrome and reduces the need for nickel in the metal pretreatment used on the body of the automobile before the electrocoat. As the new yttrium process is implemented, it will reduce up to 25,000 pounds of chrome and 50,000 pounds of nickel annually, and over the next several years will remove over one million pounds of lead from the electrocoat applications of PPG customers. ▲

RCo_2 Laves Phases

RCo_2 cubic Laves phases have been of particular interest in solid state physics for over 20 years. The reason for their popularity is that the series meets most of the requirements for a true model material. Many of the phenomena associated with these materials are caused by mainly one or possible two dominating mechanisms, which makes modeling of their physical properties possible with fairly simple theory. A recent topical review on the subject, "Physical properties of RCo_2 Laves phases," by E. Gratz and A. S. Markosyan, appears in *J. Phys., Condens. Matter* 13 R385 – R413 (2001).

A variety of magnetic phenomena that occur in RCo_2 phases are covered in this review. The relation of the magnetic features to the position of the Fermi level is argued to be critical. The properties discussed in the review include magnetic, magnetoelastic, and transport properties of RCo_2 and related compounds, with differentiation made between magnetic and nonmagnetic rare earth elements. Itinerant electron magnetism and spin fluctuation appearance is discussed, including how spin fluctuations influence susceptibility, thermal expansion, and transport phenomena. Specific properties mentioned in the article include electrical resistivity, thermal conductivity, thermopower, magnetoresistance, magnetostriction, crystal structure, and magnetic structure.

Substitutions for both the Co atoms and the R atoms were made for clarification of the interaction between the R and Co sublattices. These helped show the hybridization of the 3d and 4d or 5d bands of the Co and R elements. Metamagnetic transitions in the materials are closely related to this hybridization. The position of the Fermi level in relation to a steep feature in the energy dependence of the density of states causes temperature induced spin fluctuations, which influence many physical properties of the Co Laves phases. The theories drawn from the behavior of the Laves phases are now being applied to other intermetallics with lower symmetry and more complicated magnetic behavior. The discussions throughout the paper are thorough and explain the reasoning behind the theories relatively well. The work is supported by 20 figures, 27 equations, and 72 references.

For more information on this subject, E. Gratz may be contacted at the Institute for Experimental Physics, Technical University Vienna, Wiedner Hauptstrasse 8-10, A-1040, Austria; e-mail: gratz@xphys.tuwien.ac.at. A. S. Markosyan can be reached at Laboratory of Problems for Magnetism, Faculty of Physics, M. V. Lomonosov Moscow State University, 119899 Moscow, Russia; e-mail: mark@plms.phys.msu.su. ▲

Conference Calendar

Note: Reach as many potential conference attendees as possible! Send us your conference announcement and we will publish it here.

March '02

4th Bi-annual School on the Physics and Chemistry of Actinides
and
32emes Journees des Actinides (32JA)
Ein-Gedi, Israel
March 17-22, 2002
RIC News XXXVI, [3] 3 (2001)

June '02

14th International Symposium on Boron, Borides, and Related Compounds (ISBB'02)
St. Petersburg, Russia
June 9-14, 2002
RIC News XXXVI, [3] 3 (2001)

July '02

The 23rd Rare Earth Research Conference
Davis, California, USA
July 13-18, 2002
RIC News XXXV, [2] 4 (2000)
*This issue

August '02

Applied Superconductivity Conference (ASC 2002)
Houston, Texas, USA
August 4-9, 2002
RIC News XXXVI, [3] 1 (2001)

17th Int. Workshop on Rare-Earth Magnets and their Applications
Newark, Delaware, USA
August 18-22, 2002
RIC News XXXV, [4] 3 (2000)
*This issue

July '03

International Conference on Magnetism (ICM'2003)
Rome, Italy
July 27-August 1, 2003
RIC News XXXVI, [1] 4 (2001)

August '03

Scandium Symposium
Oslo, Norway
August 17-23, 2003
*This issue

5th International Conference on f-elements (icfe5)
Geneva,, Switzerland
August 24–29, 2003
*This issue

*This issue denotes that an article on this conference appears in this issue of the *RIC News*. ▲

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Chromatographic Rare Earth Separation

Analysis of the rare earth content of naturally occurring and man-made materials is the focus of a review article that appeared recently in *Separation Science and Technology* **36** [5&6] 1257 – 1282 (2001). The review is "Analytical-scale separations of the lanthanides: a review of techniques and fundamentals," by Kenneth L. Nash and Mark P. Jensen.

Rare earth separation on an analytical scale is widely used in a number of areas, including mineral exploration, fundamental geology and geochemistry, materials science, and the nuclear industry. The focus of this review is on chromatographic separation methods in use today.

The analysis of the rare earth content of materials is typically a destructive process. Often, the rare earths as a group are separated from the rest of the sample (the preconcentrated separation) and then are separated and quantified into individual rare earths. Chromatography is a popular method of separation, because of its relatively low cost and high sensitivity, especially when applied to preconcentrated rare earths.

The most successful chromatographic techniques are adsorption and partition chromatography, ion-pair chromatography, cation exchange chromatography, ion chromatography, and extraction chromatography. Capillary electrophoresis has also been used recently, but has not met with a great deal of success yet. Descriptions of the methods used are included in the article, with some comparison of effectiveness, and a few other techniques are mentioned, with reasons why they are considered to be less effective and accurate.

Details on detection methods, such as ICP-AES, neutron activation analysis, methods based on optical properties, and post-column derivatization with colorimetric indicator ligands, are described. Some discussion on chemical reactions and thermodynamics involved in the separation processes is also present throughout the text. Yttrium's behavior in lanthanide analysis also is discussed, with details on the correlation of specific properties of yttrium and other rare earths. The periodicity present in the rare earths is also a factor that affects separation results and receives some treatment in this article. Specific areas of application of the chromatographic separation techniques each receive some space in the article, with discussions tailored to the details of each area.

Chromatographic analysis leaves room for more study. Advances can yet be made in higher sensitivity, and other techniques show promise and can be studied further. The authors believe even the oldest techniques in use are not yet fully understood and can still provide the basis for further study. Several other possible areas of study, such as NMR spectroscopy and UV-visible spectrophotometry/fluorescence, can help improve the interpretations of thermodynamic data. This review is supported by five figures, seven equations, and 81 references. For more information, Kenneth Nash and Mark Jensen can be contacted at the Chemistry Division, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, Illinois 60439-4831 USA. ▲

23rd RERC

The 23rd Rare Earth Research Conference will be held July 13-18, 2002, at the University of California, Davis, California, USA. The conference is billed as an international meeting devoted to f-element science and technology.

According to Susan M. Kauzlarich, Conference Chair, "it will be an exciting cross-disciplinary meeting involving scientists doing research in many different areas. The highlight of the meeting is the Spedding Award." The Frank H. Spedding Award is given at each meeting of the Rare Earth Research Conference for excellence in rare earth research. The conference will begin on Saturday evening with the registration and welcome reception. The lectures, parallel sessions on specialized topics and poster sessions will be held from Sunday, July 14 to Thursday evening, July 18. Abstracts will be accepted beginning mid-December 2001 through January 15, 2002. Registrations are due by June 1, 2002.

The conference is held every 3 years and draws about 180 attendees. There is an award lecture, one plenary speaker each day, and two concurrent sessions. There are also about 150 poster presentations divided into 3 poster sessions. One night of the conference will have a banquet and no evening session. "The banquet dinner will include a private tour and tasting at St. Supery in Napa Valley," said Kauzlarich.

The 23rd RERC is also seeking sponsors for the meeting. They are asking that interested parties consider a tax deductible donation of $500 - $2000 to help pay for travel for invited speakers, to help defer the cost for a graduate student, or to host a social hour at one of the poster sessions. Three to five booths for exhibitors will also be available at $2000/booth.

For more information about the conference or about sponsoring the conference, contact Professor Susan M. Kauzlarich, General Conference Chair and Treasurer, University of California, Department of Chemistry, One Shields Ave., Davis, California 95616 USA, Tel: (530) 752-4756, Fax: (530) 752-8995, e-mail: smkauzlarich@ucdavis.edu. The internet site for the conference is http://www.cevs.ucdavis.edu/Cofred/Public; follow the links under academic conferences. For more information on the Frank H. Spedding Award, contact Lynda Soderholm at Argonne National Laboratory,Chemistry Division, 9700 South Cass Avenue, Argonne, IL 60439. Tel: 630-252-4364, Fax: 630-252-9289, e-mail: ls@anl.gov. ▲

Newsletter on the Web

A paperless alternative to receiving an electronic form of the *RIC News* via e-mail is to access our website: http://www.ameslab.gov/ric, where current and previous issues of the *RIC News* are available, along with general information about the Rare-earth Information Center and a list of our sponsors. ▲

History of Rare Earths on Postage Stamps

Fathi Habashi
Department of Mining, Metallurgical, and Materials Engineering
Laval University, Quebec City

Postage stamps are excellent means of communication. They are created by artists and they have artistic value. They are used every day and can be found everywhere. Although it took over 200 years to discover and isolate the rare earths and the industry was established as a mature industry, there are only few stamps available that tell its story.

Figure 1

The story started in 1751 when a new mineral discovered in Sweden and described by the Swedish chemist Axel Cronstedt which he named as the heavy stone from the Bastnäs mine. In 1784 another Swedish chemist Tobern Bergman recognized the existence of an unknown earth in this mineral, but it was not until 1804 that the Swedish chemist Berzelius (1779-1848) (Figures 1 and 2) and independently the German chemist Martin Klaproth isolated this new earth and called it cerium oxide, naming the mineral "cerite" in honor of the newly discovered small planet ceres. Because Berzelius is also recognized as the first to use letters instead of symbols for the chemical elements, a stamp issued by Grenada in the Caribbean showing the chemist and the letters for the elements (Figure 3).

Figure 2

In 1788 a Swedish mineral collector by the name Axel von Arrhenius (1757-1824) discovered a remarkably heavy black stone in the feldspar quarry at Ytterby on the outskirts of Stockholm. The properties of this mineral were described by the Finish chemist Johan Gadolin (1760-1852) (Figure 4) in 1794 who simply referred to it as the "new stone"; he suspected in it the presence of an unknown earth to the extent of about 38%. Finland at that time was ruled by Sweden. This discovery was confirmed a year later by the Swedish chemist Anders Ekeberg who called the new earth "ytter earth". In 1801 Klaproth confirmed this discovery and named the mineral in which the ytter earth occurred "gadolinite" in honor of Gadolin who first analyzed the mineral. The Gadolin stamp was issued by Finland in 1960 on the occasion of the 200th anniversary of his birth.

Figure 3

Figure 4

Carl Auer von Welsbach (1858-1929), an Austrian chemist and industrialist (Figure 5), appears on two stamps. Educated at Vienna and Heidelberg, he conducted research on the rare earths. He showed that the oxide didymia was composed of two oxides of metals which he named praseodymin and neodymium. He invented the incandescent gas mantle and was the first to start a rare earth industry based on monazite sand. India has a large deposit of monazite sand from which the rare earths are separated on an industrial scale. Figure 7 gives a view of the plant.

Figure 5

Figure 6

A book published recently in Canada gives enlarged colored replicas of about 900 stamps in all areas of mining and metallurgy. The present article shows a small selection from this work.

Figure 7

Reference

F. Habashi, D. Hendricker, and C. Gignac, *Mining and Metallurgy on Postage Stamps*, Metallurgie Extractive Quebec, Sainte Foy, Canada 1999. Distributed by Laval University Bookstore "Zone", Quebec City G1K 7P4. ▲

Feedback?

See something in the *RIC News* that you'd like to comment on? Have something of interest to the rare earth community? We welcome your feedback and input! Send any letters to the editor, comments on the *RIC News*, or submissions you would like considered for publication to the *RIC News*, 116 Wilhelm Hall, Ames Laboratory, Iowa State University, Ames, Iowa 50011 USA, e-mail: ric@ameslab.gov. We look forward to hearing from you! ▲

Magneto-optical Recording

Magneto-optical (MO) recording is one of several different optical recording techniques used today. Others include CD, CD-ROM, CD-RW, and DVD. CD-RW and MO methods are the only two that can be rewritten, but their mechanisms of data storage are completely different. MO is magnetic, while CD-RW depends on a change between crystalline and amorphous material states. MO recording is the subject of a topical review entitled "Magneto-optical recording," by S. Tsunashima, and published in *J. Phys. D: Appl. Phys.* **34** R87 – R102 (2001).

Basic physics and current technologies of MO recording are presented in the review. Several materials suitable for MO recording are addressed, with the focus of the treatment on rare earth-transition metal films. Limitations of storage density are discussed, with new techniques allowing recorded domains on the order of several tens of nanometers (versus a few hundred nanometers), and thus more densely recorded media.

The review is organized into five sections plus conclusions. The introduction draws the reader into the article with a general description of MO recording technology. This is followed by the physics section, which introduces the principles of MO recording and readout. This explains the mechanisms of recording and readout. MO recording is a thermomagnetic process, and raises the temperature of the recording media to a level closer to the Curie temperature. At this temperature it is easier to change the direction of magnetization because of the lower magnetization and coercivity of the material at the elevated temperature. Readout utilizes the Kerr effect.

Recording materials are treated in the third section of the review. Seven criteria are given for MO recording materials, with an eighth (efficient, low-cost production) added to make the material practical for wide use. Rare-earth transition metal amorphous alloys receive a lot of attention, especially RE-Fe and RE-Co materials. Also discussed are exchange-coupled films and metallic multilayers. Several graphs and diagrams help highlight magnetic properties of the materials discussed. Next is a section on high-density recording. Issues addressed include resolution of readout and ultimate recording density. The discussion is insightful and really explains the limitations to density issues. A glimpse of what is yet to come is provided in the section on future recording techniques. The focus is on near-field recording and hybrid recording. Both techniques sound very interesting, and could be exciting developments in the field.

The article as a whole is informative and interesting. The points made are well supported by one table, nine equations, 24 figures, and 43 references. For more information, S. Tsunashima can be contacted at Nagoya University, 464-8603 Nagoya, Japan, e-mail: tsunashi@nuee.nagoya-u.ac.jp. ▲

Scandium Symposium, icfe5

A Scandium Symposium is planned in Oslo, Norway, August 17-23, 2003. The schedule is currently set as follows: registration and social functions on August 17, scientific program on August 18-19, and an excursion on August 20-23. The tentative excursion itinerary includes several stops to mineral deposits and mining museums.

The *5th International Conference on f-elements* is scheduled for August 24-29, 2003, in Geneva, Switzerland. We do not have further details on this conference at this time, but will publish them when they become available. ▲

SAMARIUM, atomic number 62, was discovered by Lecoq de Boisbaudran in 1879 and was named after a Russian mine official, Colonel M. Samarski.

Rare Earth Economics

The Eleventh Edition of Roskill's *The Economics of Rare Earths and Yttrium*, copyright August 2001, is now available. It provides an update to the information in the Tenth Edition from 1998.

The focus is economics, so production, imports and exports, pricing, and markets are a large part of the report. However, in explaining these aspects, some information about what makes rare earths unique comes out. Almost all aspects of rare earth materials are mentioned somewhere in this report.

The major sections of the report include occurrence and reserves, mining and processing, world production of rare earths, production of rare earths by country and company, world consumption, consumption by end use, international trade, and rare earth prices. While minute details are not given in every area, information that is available is included. Apparently some information is closely guarded as proprietary, and was not released from the companies involved.

Reading this report really provides considerable insight into the world of rare earths. The text is well written, and the section on consumption by end use clearly demonstrates how prevalent rare earths are in day to day life. Just about every, if not every, application that uses rare earths is mentioned. Many countries (36 total) involved in production of rare earths are mentioned, some in greater detail than others, with a laundry list of companies and the extent of their rare earth involvement for many countries. Not only is the current state of rare earth economics presented, but an analysis of the future of the rare earth industry is also included.

The entire report is 236 pages long, with 77 tables and 22 figures presented in the text. It also includes a 47- page appendix containing 130 tables of international trade statistics. While the table of contents is very detailed, there is no separate index or list of references, though a few references are cited in the text.

Overall, this is an informative report and should serve as a useful tool for anyone requiring detailed information about the economics involved with rare earths. *The Economics of Rare Earths* (11th edition, 2001) is available for US$2400 (£1200, ¸1945) from Roskill Information Services Ltd., 2 Clapham Road, London SW9 0JA, England. Tel: +44 (0) 20 7582 5155, Fax: +44 (0) 20 7793 0008, e-mail: info@roskill.co.uk. ▲

News From Japan

Our thanks to Kensuke Shimomura for the content and translations for this section.

The Japan Times, August 23, 2001: Aisin AW Co. will begin shipping its gasoline-electric hybrid engine system to Ford Motor Co. in 2003 for use in sports and multipurpose vehicles. Aisin AW is a subsidiary of Aisin Seiki Co. and is partly owned by Toyota Motor Corp. The engine system is to be used in Ford's Escape Hybrid Electric Vehicle that will be marketed in 2003. The system being provided to Ford is smaller than the one used in Toyota's Prius.

The Nikkei Weekly, August 27, 2001: Sumitomo Special Metals Co. will start producing miniature high-performance permanent magnets in China next April. These magnets will be used in cellular phones, audiovisual equipment, and other communications and electronics products. Initially about 20 million neodymium magnets will be produced monthly, for use in microspeakers of cell phones and CD player pickups.

Osaka Gas Co. Press Release, August 27, 2001: Osaka Gas Co. and Sanyo Electric Co. have entered into an agreement to jointly develop a 1 Kw residential polymer electrolyte fuel cell (PEFC). The collaboration is expected to speed the commercialization of residential fuel cells.

The Nikkei Weekly, September 3, 2001: Samsung Electronics Co. will start making code division multiple access (CDMA) cellular phones and communications equipment in China. Production began in September. The new production facility is located in Tianjin. Samsung will begin by producing 300,000 cellular phones in the first year, and gradually increasing production after that. Samsung is hoping to capitalize on a recent decision by China Unicom to start CDMA service in China.

Honda Press Release, September 4, 2001: Honda R&D Co., Ltd. and Stanford University have created electricity-producing miniature fuel cells. Details of the joint research were presented at the Electrochemical Society meeting, September 2-7 in San Francisco. The joint research focus is the development of technologies for manufacturing fuel cell components, like ultra-thin gas channels made by silicon micromachining and electrolytic membranes made using thin-film processing technology. Honda's goal is to establish the foundation for miniature fuel cell technology by 2003.

The Nikkei Weekly, September 10, 2001: Mitsui & Co., Osaka Gas Co., and U. S. fuel cell maker H Power Corp. are teaming up to develop a home-use cogeneration system. The planned system will produce 500 watts generated from fuel cells that use hydrogen from propane gas and recycled waste heat discharged during power generation. A small cogeneration system will be developed by mid-2002. The system is expected to be used primarily as a backup during power failures and for daytime lighting.

The Nikkei Weekly, September 10, 2001: Honda Motor Co. will release a hybrid version of the Civic compact car in December. It will be Honda's second hybrid, after the Insight, and offers fuel efficiency less than the Insight, but more in line with Toyota's Prius. The cost of the hybrid Civic will be slightly higher that the regular Civic.

The Nikkei Weekly, September 17, 2001: Sales of hybrid cars are expanding, as evidenced by the popularity of Toyota Motor Corp.'s Estima Hybrid. Toyota set sales goals at 1000 units per month, but in the two months since its release 7000 orders have been made. The minivan's popularity is due in part to a lower tax rate on hybrids and government subsidies available to those that qualify, along with the vehicle's quiet ride and low fuel consumption, which cuts fuel costs in half. Factory production is currently limited to 1000 vehicles per month, but plans are in the works to increase production. Toyota's Crown Hybrid was released in August and is also seeing good sales. Toyota plans to increase its overall hybrid production of all three of its hybrid models to 300,000 units annually by 2005.

The Japan Times, October 18, 2001: Suzuki Motor Corp. and General Motors Corp. have agreed on a collaboration to develop fuel-cell technology for small cars. The two companies have worked together in the past and are renewing their strategic alliance with a new focus.

The Japan Times, October 18, 2001: Toshiba Corp. and Matsushita Electric Industrial Co. are planning two joint ventures to begin in April. One venture will merge liquid crystal display (LCD) production and development. The aim of their other joint venture is to streamline CRT operations. Both ventures will increase cost efficiency through mass production.

The Nikkei Weekly, October 29, 2001: A new ceramic material has been reported by a National Institute for Materials Science laboratory. The new material can elongate like metal when heated and pulled. The plasticity of the materials opens the door to applications of ceramics in engine parts and turbine blades. The materials is a composite of 40% zirconia, 30% alumina, and 30% spinel. The components are mixed and sintered using conventional methods, but the mixture prevents the growth of large crystals, thus reducing fractures between the crystals of the material during heating and deformation. ▲

Consultant's Corner

To appear in our Consultant's Corner, any individual, company, or group must be involved in rare earth or rare-earth-related consulting activities. Just send us the appropriate information: contact name, company name, mailing address, Tel/Fax number(s), e-mail, web address, and areas of expertise.

We would like to update our information as much as possible, so if you have submitted your information in the past but have something that has changed, if you are new to rare-earth consulting, or if it has been a while since you have had any of your information published in the *RIC News*, please resubmit your information: Tel: (515) 294-2272, Fax: (515) 294-3709, e-mail: ric@ameslab.gov. ▲

Rare Earth Ore in China

A brief summary of the characteristics and distribution of rare earth resources appears in *Light Metals* **2001** 1159 – 1165 (2001). The review is called "Beneficiation of Rare Earth Ore in China," and is written by Ruan Chi, Shengming Xu, Guocai Zhu, Jingming Xu, and Xin Qiu.

The major topics of the review cover the characteristics of Chinese rare earth resources, beneficiation and extracting technologies of bastnasite, beneficiation of coastal beach sand, mixed rare earth ore of bastnasite and monazite, ion-absorbed rare earth ore, and other types of rare earth ores. China has the largest reserve of rare earth resources in the world, followed by the former Soviet Union, The United States, Australia, and India. China's reserves make up about 63% of the total world reserves. While the reserves in China are large, they are not necessarily the best quality ores, and it can be costly to produce usable rare earth materials from the ores available.

Several different separation techniques are presented in the review, and the discussion is often organized by location of the ore. The effectiveness of each technique is reported, along with some interpretation as to whether each particular method is cost effective or not. Several areas where technological advances would make production more effective are given.

Overall, the review gives an interesting perspective into the rare earth industry in China. The article is accompanied by 33 references. While written in English, there are some grammatical or syntactical problems that make understanding the real meaning of what is being said a little difficult, but in general the ideas are clear.

For more information, the authors may be contacted at the Institute of Nuclear Energy Technology, Tsinghua University, Beijing, China 102201.▲

Sm^{150} is used to determine the age of rocks, and Sm^{153} is utilized in the radiation therapy of cancer tumors.

SEARCH OF THE MONTH

Ric Database Report

keywords bubble ***AND*** ***keywords*** DOMAIN

Document Number ***Article***

199017170 MODELING DOMAIN BEHAVIOR IN MAGNETO-OPTIC RECORDING
PERLOV;CM DELLA-TORRE;E BIRECKI;H
J. APPL. PHYS. 67, 4444-6 (1990)
1990 APPLICATION BUBBLE CELL COERCIVITY COMPUTER DOMAIN DOMAIN-WALL FILM MEMORY MODEL RECORDING RELAXATION-PHE REVIEW SATURATION TBCOFE TEMP-DEPENDENC

199103670 CLASSIFICATION OF HARD DOMAINS IN GARNET BUBBLE FILMS
NIE;X-F TANG;G-D NIU;X-D HAN;B-S
J. MAGN. MAGN. MATER., 95, 231-6 (1991)
1991 BLOCH-LINE BUBBLE DOMAIN DUMB-BELL FILM GARNET

199219730 SELF-SHRINK OF THE FIRST KIND OF DUMBBELL DOMAINS IN GARNET BUBBLE FILMS
NIE;XF TANG;GD HAN;BS
J. MAGN. MAGN. MATER., 104-107, 307-8 (1992)
1992 BUBBLE DOMAIN DUMB-BELL GARNET R SHRINKAGE

199229780 HIGH-SPEED MAGNETOOPTICAL SPATIAL LIGHT MODULATORS
CHERVONENKIS;AYA KIRUKHIN;NN RANDOSHKIN;VV AYRAPETOV;AA
FIZ. NIZK. TEMP. 18, SUPP. S1, PP. 435-8 (1992). ADVANCES IN MAGNETO-OPTICS II, PROC. 2ND INTL. SYMP. MAGNETO-OPTICS, ISMO '91, KHARKOV, UKRAINE
(LUYBIFEGAO) 1992 BUBBLE COMPOSITION DOMAIN FARADAY-ROTAT FILM IMAGE LIGHT-TRANSMIS MAG-ANISOTROPY MAG-OPT-PROP MAGNETIZATION MAGNETO-OPTIC MODULATION NEEL-TEMP THICKNESS VELOCITY

Friday, November 09, 2001 ***Page 1 of 1***

This search above satisfies a request for information on bubble domains since 1990. Many more citations would have been referenced if other years had been included in the search.

The Database Report, as shown above, is sent when the search results are purchased, includes full reference information: our document number, title, authors, bibliographic reference, and keyword list. The preliminary search report, which is provided when the search is requested as an evaluative tool, includes the keywords used for the search, the title of the article, and the other keywords associated with the reference, for each of the references found.

The cost to receive the full report for this search is US$50.00. The minimum cost for any search is US$50.00, which includes the reference list for up to 25 matches, and any additional matches are available for US$2.00 each. That means that if a search turns up 30 matches, the full report would cost US$60.00. Supporters may receive as many searches as desired for US$300.00 per year for corporate memberships, or US$100.00 for individual memberships. For other support levels available, see "December 2001 Supporters" on page 8.

As an added benefit, supporters receive a 2-page monthly newsletter, the *RIC Insight*, that reports on late-breaking news of rare earths and how these developments may impact the rare earth industry. Supporters can also have space on our website, providing additional exposure for their company and links to their own webpages.

If you would like us to conduct a search for you, please send your request to: Angela O'Connor, RIC, 112 Wilhelm Hall, Ames Laboratory, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515-294-5405; Fax: 515-294-3709; e-mail: ric@ameslab.gov. If you would like to become a supporter of the RIC, send your name, address, telephone, fax, e-mail address, and your desired level of support to the above address or to LaVonne Treadway, RIC, 116 Wilhelm Hall, Ames Laboratory, Iowa State University, Ames, IA 50011-3020 USA, Tel: 515-294-2272; Fax: 515-294-3709; e-mail: crem_ric@ameslab.gov. ▲

REMXVII

As noted in a previous issue of the *RIC News*, the *17th International Workshop on Rare Earth Magnets and Their Applications* is to be held at the University of Delaware, Newark, Delaware, USA from August 18-22, 2002.

The Workshop is part of a series of biennial meetings designed to bring together scientists and engineers in industry, government, universities, and research institutes from different backgrounds to review the current understanding of rare earth magnets and their applications and to exchange ideas and information. Concentrations will be on the practical aspect of fabrications, processing, and applications, as well as the fundamentals of rare earth transition metal alloys and their magnetic hysteresis behavior. The technical program will consist of invited and contributed talks and posters. Abstracts are to be submitted before January 31, 2002. Registrations are due before July 10, 2002.

For more information on this conference, contact the Chairman, George C. Hadjipanayis, Department of Physics and Astronomy, University of Delaware, Newark, DE 19716 USA, Tel: (302) 831-2736, Fax: (302) 831-1637, e-mail: hadji@udel.edu. The website for the conference, which also includes more detailed abstract and conference program information, is http://REM02.physics.udel.edu. ▲

December 2001 SUPPORTERS

Since the September issue of the *RIC News*, we have received support from two new family members and renewed support from 25 other organizations and individuals.

The supporters from the fourth quarter of the 2001 fiscal year who wish to be listed, grouped according to their appropriate category, and with the number of years that they have contributed to RIC in parenthesis, are listed below.

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