Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
Ames Laboratory
Institute for Physical Research and Technology
Iowa State University, Ames, Iowa 50011-3020 U.S.A.

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China and Australia 1998

A letter from the editor

I have recently returned from an extended trip to China and Australia. In China I attended the "'98 Beijing International Exhibition on Rare Earth Development and Applications" and the "International Forum on Rare Earth Technology and Trade". The exhibition consisted almost entirely of Chinese companies displaying their products. The aim of the exhibition was to promote international trade. The "International Forum on Rare Earth Technology and Trade" was opened by Zhou Chuandian, Chairman of the Chinese Society of Rare Earths. Wen Kaiyuan of the State Development Planning Committee discussed current status of the Chinese rare earth industry. Significantly, in order for a joint venture between the Chinese and a foreign company to be approved, the company must not only invest capital but also provide the technology to carry out the manufacturing process. Unlike most scientific conferences, the majority of the talks were actually read with the presenter sitting before a microphone. Simultaneous translation of most papers was provided. Proceedings with papers in Chinese and English were also provided.

Baotou, Inner Mongolia

I visited the rare earth beneficiation plant of Baotou Steel and Iron where they produce rare earth concentrate with 50 and 60 % rare earth oxide (REO). A flotation process is used to separate the concentrate. The process appears very similar to what they use for copper. At the Baotou Rare Earth Institute I toured their Nd-Fe-B magnet production facility. The facility is quite small by U.S. industry standards and mostly employs equipment that was imported from Japan in the late 80's.

The Baiyunebo Mine is the worlds largest rare earth mine. Visiting Baiyunebo requires a special travel permit, which appears to be easily obtained. In order to go to the mine, which is 160 km from Baotou, we had to take the train since the road is under construction. The train takes five hours and goes once a day. We were entertained by the mine director and other officials.

After returning to Beijing I visited Peking University where there is an extensive effort in rare earth chemistry. The General Research Institute for Non-ferrous Metals (GRIMN) is working on applied materials including both superconducting wires and permanent magnets. The questions centered mainly on high temperature superconductors but covered a variety of fields. GRINM includes the China Rare Earth Center for Agriculture Development. China has been using rare earths in agriculture for twenty years and feels that the effects are very significant. Australia is now becoming interested but to the best of my knowledge, no work has been done in the U.S. and there is little acceptance of the Chinese work here.

I visited the Central Iron and Steel Research Institute and viewed the institute exhibition. Every institute here has its exhibition complete with picture of visits by national leaders and showing all the areas in which they are doing work.

Continued on page 2, Column 1 ☛

"Expanded" Negative Thermal Expansion

Negative thermal expansion in $Sc_2(WO_4)_3$ was recently reported by A.W. Sleight et al., and reviewed in *RIC News*, **XXXII**, [3], 1, (1998). Now, the same research group has determined that there is "expanded" negative thermal expansion in $Lu_2(WO_4)_3$ {*J. Solid State Chem.*, **140**, 157-8 (1998)}.

This enhanced decrease in size with increasing temperature is thought to be caused by replacing Sc with Lu, a larger cation. The negative thermal expansion is attributed to transverse thermal motion of oxygen in the Lu-O-W linkages. The motions of the oxygen atoms seem to be correlated to rocking motions of the connected polyhedra. Rocking motions can only occur if the polyhedra undergo shape change during the rocking. The authors think that rigid polyhedra inhibit the rocking motion which, in turn, inhibits negative thermal expansion.

The thermal expansion of $Lu_2(WO_4)_3$ was found to be -6.8 x 10^{-6}/°C as compared to -2.2 x 10^{-6}/°C of $Sc_2(WO_4)_3$. The larger Lu ion causes the polyhedra to expand, which reduces the oxygen-oxygen repulsions within the structure. This facilitates the shape change that is necessary for the rocking motions that are required for negative thermal expansion.

The authors are from the Department of Chemistry and Center for Advanced Materials Research, Oregon State University, Corvallis, OR 97331-4003 USA; Sleighta@ccmail.orst.edu, and expect that another compound, $Ho_2(WO_4)_3$, will exhibit even greater thermal contraction because the Ho^{3+} ion is the largest cation known to exist in this family of compounds. ▲

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Institutes frequently have commercial components and so it is all a very professional public relations effort. I talked with the people working on permanent magnets and they are eager to set up collaboration.

At the University of Science and Technology Beijing, I toured the State Key Laboratory for Advanced Metals and Materials. They have set up a company to make bonded magnets. Most of the operations are done by hand and the number of parts they produce must be fairly small. They said it is the first bonded magnet plant in China.

Western Australia

In Australia I visited the University of Western Australia, where there are two research groups at the University of Western Australia engaged in work related to my work at Ames Laboratory. The Group of R. Street is heavily engaged in studying hysteresis while P. McCormick is involved in materials preparation. Extensive discussions were held on magnetic measurements, materials preparation and the role of microstructure in magnetic properties.

The primary reason for my visit to Australia was Rare Earths '98. The conference had sessions on Agricultural Applications, Catalysis, Co-ordination Chemistry, Electrical and Electronic Properties, Extraction and Separation Chemistry, Luminescence, Magnetic and Magneto-optical Processes (chaired by traveler), Marketing and Applications, Mineral Characterization, Photophysics & Spectroscopy, Radio Lanthanides in Nuclear Medicine Therapy, Rare Earth Hydrides (batteries), Rare Earth Operations. The conference technical tour visited the site of Rhodia's planned rare earth plant in Pinjarra. The gallium plant at this site was built in the 1980's but has operated for only short periods of time due to an extensive over supply of gallium. The rare earth plant has received environmental approval but construction has been postponed due to the current impact of Chinese rare earth suppliers on the rare earth market. The Western Sands mine is primarily an ilmenite mine producing

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material for titanium pigments. The rare earth-containing monazite is currently separated from the ilmenite and stockpiled. This will serve as the materials source for the Rhodia rare earth plant should it be constructed.

During my trip I enjoyed the outstanding hospitality of The Chinese Society of Rare Earths, the Special Research Centre for Advanced Mineral and Materials Processing of University of Western Australia, an the staff of Rare Earths '98 for which I am extremely grateful.

Sincerely,

R. William McCallum

Conference Calendar

*** A NEWS STORY THIS ISSUE**

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

April '99
29ièmes Journées des Actinides
Luso, Portugal
April 15-17, 1999
* This issue (below)

June '99
IUMRS-ICAM '99
Beijing, People's Republic of China
July 13-18, 1999
* This issue (page 3)

July '99
22nd Rare Earth Research Conference (22nd RERC)
Argonne, Illinois, USA
July 10-15, 1999
* This page (below)

August '99
SCES '99
Nagano, Japan
August 24-28, 1999
RIC News **XXXIII**, [3], 2 (1998)

September '01
Rare Earths - 2001
São Paulo - SP, Brazil
September, 2001
* This issue (page 3)

29ièmes Journées des Actinides

The 29ièmes Journées des Actinides will be held April 15-17, 1999 in Luso, Portugal. The following topics will be covered in the conference: coordination and organometallic chemistry, environmental and solution chemistry, solid state chemistry and physics, preparation and structural characterization of metals, alloys, compounds and solid solutions, electronic and

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magnetic properties, and the theory of chemical and physical effects of the actinides.

For more information, contact Prof. Manuel Almeida, Departmento de Química, Instituto Tecnológico e Nuclear, P-2686 SACAVÉM Codex, Portugal; Tel: 351 1 9550021; Fax: 351 1 9941455; malmeida@itn1.itn.pt; www.itn.pt/jdac/home.html. ▲

22nd RERC

The 22nd Rare Earth Research Conference (RERC) will be held July 10-15, 1999 in Argonne, Illinois, USA. The conference will take place at the Advanced Photon Source Conference Center and Lecture Hall at Argonne National Laboratory. The 22nd RERC will integrate both basic and applied multidisciplinary research that is centered on the *f*-elements. Vanguard research will be featured in invited talks or contributed posters on topics in chemistry, physics, and on the materials, earth, environmental, and biological sciences.

For more information, contact Kay Foreman, Argonne National Lab., Chemistry Division, 9700 South Cass Avenue, Argonne, IL 60439 USA; Tel: 630 252 4364; Fax: 630 252 9289; http://chemistry.anl.gov/rerc. ▲

Latin American Workshop

The proceedings of the III Latin American Workshop, which was held in Mérida, Venezuela in 1995, are entitled *Magnetism, Magnetic Materials and Their Applications.* The proceedings contain 45 contributions dealing with magnetic materials, twelve of which contain information on rare earth compounds and alloys.

Eleven of these papers are in the first section "Fundamental, Techniques and Materials" and include the topics of magnetocrystalline anisotropy in rare earth intermetallics, ferromagnetism vs. Kondo effect in normal and superconducting CeT_yX_{4-y}, magnetic phase transition and magnetocrystalline and anisotropy of rare earth transition-metal alloys, giant magnetoresistance in multilayer and granular magnetic materials, TbFe amorphous thin films, nanophase exchange coupled alloys, exchange interactions in ferrimagnetic rare earth transition metal multilayers, magnetic circular x-ray dichroism, thermomagnetic and x-ray diffraction of Nd-Fe-Ti alloys, electron paramagnetic resonance in La-Ca manganite, and La and Gd doped Ba-M (M= Ba, Fe and Na) hexaferrites.

Magnetism, Magnetic Materials and Their Applications is available for US$86.00 from World Scientific Publishing Co. Pte. Ltd., Farrer Road P.O. Box 128, Singapore 912805, Republic of Singapore; Tel: 65 382 5663; Fax: 65 382 5919; in North America, contact the company at 1060 Main St., River Edge, NJ 076661 USA; Tel: 201 487 9655; Fax: 201 487 9656; in Europe, 57 Shelton St., Covent Garden, London WC2 9HE, England; Tel: 44 171 836 0888; Fax: 44 171 836 2020. ▲

IUMRS-ICAM '99

The Fifth IUMRS International Conference on Advanced Materials (IUMRS-ICAM '99) will be held June 13-18, 1999, in Beijing. The conference will include the following topics: separation chemistry and technology of individual rare earth oxides in high and ultra-high purity, rare earth permanent magnet materials, giant magnetic materials and magneto-optic

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materials, luminescence, phosphors and lasers, hydrogen storage alloys and their applications, application of rare earths in glasses and ceramics, catalysis, agriculture, medicine, and industry, and coordination and solid chemistry of lanthanide compounds.

For more information, contact Prof. Chunhua Yan, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, People's Republic of China; Tel: 86 10 62754179; Fax: 86 10 62755926; E-mail: chyan@chemms.chem.pku.edu.cn; www.chimeb.edu.cn/meeting/e_mrs.thm. ▲

Handbook of Magnetic Materials

The *Handbook of Magnetic Materials* Vol. **11** is the latest of this prestigious series that not only assists those who wish to be introduced to the field of magnetism, but also serves as a reference for those actively involved in scientific research and instruction. The 732-page book was published in 1998 and presents comprehensive reviews in four chapters, about the latest research and technological developments in physics, chemistry, and materials science. Each chapter includes extensive descriptions in graphical and tabular form that support the text.

Out of the four chapters in Vol. **11**, two deal with rare earth materials. Chapter 3, "Magnetism of Permanent Magnet Materials and Related Compounds as Studied by NMR" begins with a general review of rare earth permanent magnet materials by providing a short history of the development, as well as their associated energy products and magnetic properties. There then follows a description of the mechanism of NMR, resonance of specific elements in compounds as it applies to $R_2TM_{17}A_x$ (R= Nd, Sm, Y, Gd, Er and Tb; TM= Fe and Co; A= N, C, and H). Sm-compounds such as Sm_2Fe_{17} powders and their nitrides that contain niobium are also covered, as well as results of these measurements taken under high pressure. Other rare earth perma-

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Rare Earths - 2001 Brazil

"Rare Earths - 2001 Brazil" will feature basic and applied multidisciplinary papers on the applications and research on rare earths. The conference will be held in Sáo Paulo, Brazil, and will cover the following rare earth topics: environmental, toxicology, biomedicine, analytical, solution, and coordination chemistry, materials science, spectroscopy, luminescence, phosphors, lasers, minerals, extraction and separation, physics, metallurgy, and valence fluctuation, and applications. The conference is scheduled to take place in September, 2001.

For more information, contact REs - 2001 - Brazil, IQ-USP/, Caixa Postal 26077, CEP 05599-970 Sáo Paulo, SP-Brazil; Tel/Fax: 55 11 818 3876; Fax: 55 11 815 5579; E-mail: RE2001@quim.iq.usp.br; www.iq.br/geral/congress.html. ▲

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nent magnet materials are reported, including $R_2Fe_{14}C$, $R_2Fe_{14}BH_x$, $RFe_{12-y}M_yN_x$ (M= Mo, Ti, and V), and RCo_5.

Chapter 4 reviews neutron scattering from rare earth intermetallic compounds, the determination of crystal field interactions, crystal fields in amorphous lanthanide alloys, and theoretical aspects of crystal fields in lanthanide intermetallics. Inelastic neutron scattering experiments on RX (X= Bi, P, As, Ag, Zn, Cu and Sb), RBe_{13}, RX_3 (X= Sn, Pb, In, Mg, Pd, Tl, Al, and Ga), RPd_2X (X= Sn, In), $RInAg_2$, and RMo_6X_8 (X= Al, Ni, Fe, and Co) are reported. Some of the other binary compounds that are included are: RNi_5, RCu_6, RCu_5, RCu_2, RAl_3, RGa_2, and RAg_2. The chapter also includes a description of how inelastic neutron scattering is complimentary to other modern and conventional experimental techniques.

Volume **11** includes a comprehensive author and subject index, and is edited by K.H.J. Buschow. The Tome is available for NLG 550.00 (US$316.00). To order, contact Elsevier Science, P.O. Box 945, New York, NY 10159-0945 USA; Tel: 212 633 3730; Fax: 212 633 3680; usinfo-f@elsevier.com; Elsevier Science, P.O. Box 211, 1000 AE Amsterdam, The Netherlands, Tel: 31 20 485 3757; Fax: 31 20 485 3432; nlinfo-f@elsevier.nl. ▲

Volume on Oxides

Oxides: Phase Transitions, Non Stoichiometry, Superconductors is **Vols. 155-156** of Key Engineering Materials (1998) which considers some new aspects of the physics and chemistry of oxides.

Of the 14 contributions in the book, three deal with rare earth compounds: 1) Nanometric amorphization of oxide materials under dense electronic excitation: swift heavy ion irradiations; 2) The structure principles and their consequences for the anion-deficient fluorite-related oxides of the higher rare earths; and 3) Magnetoelectric phenomena in R_2CuO_4 rare-earth cuprates. The papers report on the resistivity of Ca-doped $Y_3Fe_5O_{12}$ thin films, phase diagrams, crystal and surface structure, and diffraction patterns of rare earth oxides. The last rare earth-containing review deals primarily with the magnetic-field effects of tetragonal antiferromagnetic Gd_2CuO_4, Sm_2CuO_4, and Nd_2CuO_4 - the parent compounds of high-T_c superconductivity. The magnetic properties and phenomenological considerations of these cuprates, which indicates spontaneous structural distortion within the CuO_2 planes. All of the papers contain the latest information on their respective topics and provide glimpses of applications and potential applications of these materials.

To order your copy of the 476-page **Volumes 155-156** of Key Engineering Materials, contact Trans Tech Publications Ltd., Brandrain 6, CH-8707 Uetikon-Zuerich, Switzerland; Fax: 41 1 922 10 33; ttp@ttp.ch; http://www.ttp.ch. The cost of the book is CHF225.00 (US$172.00). ▲

Rhodia Rare Earths

Rhodia Terres Raras S.A. has moved its corporate headquarters from Paris, to the main production facility located in La Rochelle, France. The management, sales and markets departments, and sales administration will be in involved in the move. Rhodia now employs approximately 500 people at La Rochelle.

The new address is: Rhodia Terres Raras S.A., Z.1. 26, rue Chef de Baie, 17041 La Rochelle Cedex, France; Tel: 33 0 5 46 68 34 56; Fax: 46 68 33 44. ▲

High-T_c Review

High-Tc Superconductivity 1996: Ten Years after the Discovery is part of the NATO ASI Series, is a review of the major contributions toward the development of high temperature superconductors since their discovery in 1986. This Series presents to us the background and history of high-temperature superconductivity research and the contributions to the field through 1996. There are 24 papers contained in the book which is divided into 5 chapters.

The Series starts out with the introductory paper "The discovery of HT_c superconductivity and its circumstances" by none other than the cofather of the art, J.G. Bednorz. This is a good review for those who want to be reminded of how the discovery was made and should be mandatory reading for those neophytes who aspire to participate in this field of study. Chapter 2 deals with *s* and *d* wave symmetry components and theory aspects of high-T_c superconductors. The next chapter deals with novel two-dimensional ABO_3 perovskites such as $LaTiO_3$, $PrTiO_3$, $CeTiO_3$, and $NdTiO_3$; the classification of layered cuprates and oxycarbonates; high pressure crystal growth and properties of $Y_2Ba_4(Cu,O)20$; non-toxic superconductor materials; and the noncuprate layered perovskite superconductor $(La,Sr)_2CuO_4$. Chapter 4 reviews the phase separation, electronic inhomogeneities and related problems with the La- and Y-cuprate system. The final chapter reviews the current status of technical applications of high-T_c superconductors, such as fault current limiters, power transmission lines, transformers, current leads, NMR tomography, turbogenerators and motors, fusion magnets, and NMR spectrometry.

High-Tc Superconductivity 1996: Ten Years after the Discovery appears as Series E: Applied Sciences - **Vol. 343** of the NATO ASI Series on applied sciences. The 596-page hard cover book was published in 1997 and is available for NLG 435.00 (US$256.00) by contacting Kluwer Academic Publishers, P.O. Box 322, 3300 AH Dordrecht, The Netherlands;

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Diffusion in Silicon

Rare earth researchers and scientists who require a solid background in the diffusion of rare earths in silicon will find *Diffusion in Silicon - 10 Years of Research* a valuable source of information. The 560-page book presents a thorough treatment of the subject, covering a full decade of progress in the understanding of diffusion in silicon. The book is divided into two sections: the first section contains 13 in-depth reviews that provide information on the most important areas (sans rare earths); the second section is made up of 300 pages of extended abstracts on the subject of which four deal with Er, Pr, Sc, and Yb.

Bulk diffusion of Er in Si is covered in five abstracts that deal with concentration profiles, effect of trapping, and the effect upon defects. Temperatures from 77 K to 1500 K are explored as the diffusion of the Er ion in SiO_2 are reported. The sole abstract concerning the diffusion of Pr in Si in the temperature range 1373 K to 1523 K reports a positive temperature dependence of Pr diffusivity from 10^{-13} to 1.5 x 10^{-12} cm^2/s. Diffusion of Sc was accomplished by depositing ^{46}Sc-labelled chloride and was measured at a depth of 0.35 mm and was shown to increase from 1.4 x 10^{-13} to 1.9 x 19^{-12} cm^2/s as temperature increased from 1373 K to 1523 K. The final abstract reports the results of Yb bulk diffusion qualitative data/qualitative observations and ion implantation.

Diffusion in Silicon - 10 Years of Research was published in 1998 and is available from Trans Tech Publications Inc., Post Box 699, May Street, Enfield, NH 03748 USA; Tel: 603 632 7377; Fax: 603 632 5611; ttp@ttp.net; www.ttp.net (North and South America); others contact: Trans Tech Publications Ltd., Brandrain 6, CH-8707 Uetikon-Zuerich, Switzerland; Tel: 41 1 922 10 22; Fax: 41 1 922 10 33; ttp@ttp.ch; www.ttp.ch. The cost for the soft cover book is US$272.00 (CHF360.00) plus shipping. ▲

Fax: 31 78 654 6474; Tel: 31 78 639 2392; services@wkap.nl; in the USA: 101 Philip Drive, Norwell, MA 02061 USA; Fax: 617 878 0449; Tel: 617 871 6300; kluwer@wkap.com. ▲

Ferroelectric $YMnO_3$

Ferroelectric thin films for metal-ferroelectric-semiconductor field effect transistors (MFSFET) are interesting because they can be used in non-volatile random access memories (RAM). A recent study by T. Yoshimura, et al. {*Appl. Phys. Lett.*, **73**, [3], 414-16 (1998)} reports that $YMnO_3$ thin films, deposited on a Si-substrate, exhibit hysteresis, capacitance-voltage properties, and ferroelectric polarization switching properties that may save electrical power while decreasing memory cell size.

The scientists prepared $YMnO_3$ films on a *p*-type Si substrate, which exhibited a 1 Ω cm resistivity, by using a pulsed-laser deposition technique. To prepare the sample, sintered ceramic pellets of $YMnO_3$ were used as targets. The silicon substrates were boiled in ethanol for 5 minutes, then rinsed with pure water, followed by a 5 minute soak in HNO_3 for 30 seconds, then dipped in a HF solution for another half-minute. The substrate temperature was held at 830 °C during the preparation process. A 2 nm buffer layer between the film and the substrate was Y-Mn-O of unknown stoichiometry.

The film's dielectric properties were measured using Pt electrodes, as was the hysteresis, which exhibited a clockwise rotation, indicating a ferroelectric switching behavior. The Pt electrode made up the metal constituent in the Pt/Y-Mn-O/Si structure. The material was discovered to have a memory window 1.1 V, a dielectric constant of 27.8 with a dissipation factor of 0.035. An apparent down-side of the experiment indicated that the memory retention properties of the material is poor, which is probably due to the compensation of remanent polarization by a positive charge on the Silicon surface. However, it has been shown that $YMnO_3$ films on a Silicon substrate can be used as ferroelectric RAMs with a MFSFET structure.

For more information on this study, contact Norifumi Fujimura, Department of Applied Materials Science, College of Engineering, Osaka Prefecture University, 1-1 Gakuen-cho, Sakai, Osaka 599-8531 Japan; fujim@mtl.osaka-u.ac.jp. ▲

Letter to the Editor

Dear Editor,

I am enjoying the RIC News continuously. Thank you.

As for the latest issue, Vol.**33**, No.3, of it, I found, however, that the expression of Dy, I believe, is "inappropriate," now one of the world-famous words. At the third column of page 4, 5 lines from the bottom, you use "by Dysprosium's high price." It should be "by dysprosium's high price," if I am right.

Best regards,

Katsuhisa ITOH, Mr.
General Manager for Technical Collaboration, Technology Dept.
Sumitomo Light Metal Ind., Ltd.
1-12, 3-chome, Chitose, Minato-ku
Nagoya 455-8670, Japan

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katsuhisa_itoh@mail.sumitomo-LM.co.jp

Dear Katsuhisa ITOH:

Thank you for your kind comments concerning the *RIC News*. We are happy that you enjoy reading our newsletter.

Your observation about the correct use of "dysprosium" is correct. However, to add emphasis, we have chosen to use upper case letters when mentioning rare earths. This we attempt to do consistently not only with rare earths, but with rare earth compounds and alloys as well *i.e.* "Neodymium-Iron-Boron" vs. "neodymium-iron-boron" and "Dysprosium-Terbium-Iron" vs. "dysprosium-terbium-iron" alloys. Perhaps it is a self-justification of our own interests, and others like us, that we emphasize the subjects of our study. And since the main theme of the *RIC News* is the Rare Earths, we take every opportunity to stress their importance.

Sincerely,

R. William McCallum

New Magnets and Processes

Strong magnets

Sumitomo Special Metals Company Ltd., is producing two new rare earth-containing permanent magnet grades that have improved magnetic properties, one of which is claimed to be the world's strongest permanent magnet. This new magnet grade is known as Neomax 50 and has a magnetic strength of 400 kJ/m^3, which is about 4% greater than Neomax 48. The company's other new product, Neomax 48BH, features a high resistance to loss of its magnetic strength at high temperatures while exhibiting a maximum coercive force of 875 $kA\ m^{-1}$, which is about 27% greater than Neomax 48.

Both new materials use Nd, Sm, and other rare earth elements, along with improved crystal grain orientation, in order to improve performance. Total production of both new magnetic materials is about 10 mt per month.

Ni plated magnets

Neodymium-iron-boron resin bonded (plastic) magnets need to be coated in order to prevent corrosion of the alloy powder in the composite. To prevent corrosion of these materials, polymer coatings are often used because traditional electroplating techniques are inadequate due to the insufficient electrical conductivity of the plastic magnet.

Sumitomo has introduced a new dry plating process that coats plastic magnets with metallic nickel improves durability, allowing greater ease of washing, reduced coating thickness and greater control of coating thickness, and higher mechanical strength over polymer coatings. Another advantage of the electrically conductive Ni coating over polymer coatings is to prevent static buildup of dust particles. The new plating process facilitates precision and cleanliness during production which will improve rotational speeds in motors which use the magnets. Nickel coatings also permit multiple layers, as well as other metal coatings which further increase durability.

Sumitomo Special Metals Company Ltd., 4-7-19 Kitahama, Chuo-ku, Osaka 541, Japan; Tel: 81 6 220 8821; Fax: 81 6 075 961 4410. ▲

Roskill Report 1998

The Economics of Rare Earths & Yttrium, 10th Edition, is the latest from the firm that provides market information on rare earth concentrates, compounds, metals, and alloys. This latest report analyzes the world wide rare earth industry and presents it in 9 sections: Introduction, 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 in Rare Earths, and Rare Earth Prices.

Among the interesting and enlightening facts revealed in the report, is that 60% of the world's rare earth production was supplied by the People's Republic of China, Japanese imports of Chinese rare earths is expected to have decreased in 1998 (the first time in ten years), and overproduction of some rare earths may present a glut of these commodities. Automobile exhaust catalysts remain the largest single market for rare earths, accounting for 46% of US consumption, and Nd-Fe-B permanent magnets, which represented a US$900,000,000 market in 1997, is expected to show a solid 15% per year growth to 2000.

Of the rare earth market studies and reports that we have seen in recent years, this work devotes more pages, 99, to comprehensively cover applications and consumption of rare earths. The major market niches listed in the report include: catalysts, glasses, metallurgical applications, permanent magnets, phosphors (including cathode ray tubes and lamps), ceramics (sensors, fuel cells, and engineering ceramics, among others), lasers, superconductors, optical fibers, nuclear uses, pigments, magnetostrictive alloys, jewelry, fertilizers, and rare earth hydrides (batteries and heat pumps). Additional information is included on electron microscopes, microwave applications, magnetic refrigeration, medical, and other uses. Some less important but interesting applications of rare earths are explored in textiles, cement additives, mirrors, lubricants, propulsion jets, geology, and solar energy systems.

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The 282-page *Economics of Rare Earths & Yttrium*, 10th Edition was published in 1998. The textural descriptions in the report are supported by 182 tables and 22 figures that help to illustrate the complexities of this relatively small, but essential, aspect of modern industry and international trade. The market study is available by contacting: Roskill Information Services, 2 Clapham Road, London SW9 OJA, UK; Tel: 44 171 582 5155; Fax: 44 171 793 0008; www.roskill.co.uk. The cost is US$1,700.00 but *RIC News* readers can receive a **10% reader's discount** by quoting ref: RICNEWS98. ▲

Atomized Nd-Fe-B Powder

The Idaho National Engineering and Environmental Laboratory (INEEL), located in Idaho Falls, Idaho, is producing Nd-Fe-B magnetic powders by an atomization process. The laboratory claims that the improved process gives the permanent magnet material superior behavior during manufacture as well as enhanced magnetic properties than those produced by previous methods.

The atomization process, now licensed to GAPowders, Idaho Falls, involves spraying molten alloy to create microscopic droplets that quickly cool into fine spherical particles. Since cooling rate is essential in determining microstructure, and magnetic properties improve with an increasingly fine structure, a faster rate of cooling is desired for optimal properties. Research has shown that by adding small amounts of titanium and carbon to the melt, quenching is facilitated during melt spinning. Using this technique, the INEEL researchers were able to perfect a new, commercially viable route for manufacturing isotropic Nd-Fe-B powders. Atomized powders have many improved properties than do those produced by melt spinning.

GAPowders have entered into a partnership with Magnequench International Inc. for production-scale development and distribution. For more information, contact Charles Sellers, INEEL, P.O. Box 1625, Idaho Falls, ID 83415-3695 USA; Tel: 208 526 1693; Fax: 210 526 5034; www.ineel.gov. ▲

RE-Doped Glass

Although the majority of inventions and discoveries dealing with rare earths are contributed by institutional and corporate researchers, there are still a few privateers that provide us with substantial results from their initiative. One example is described in US Patent # 5,548,491 "Color corrected motor vehicle headlight" that is based on the color-specific absorption characteristics of Neodymium oxide.

Mr. Daniel Karpen, the inventor, has designed a system for vehicle headlights that filters out certain portions of the spectra that is produced by the hot filament in incandescent light bulbs. The system is based on the optical properties of Nd_2O_3 which improves the color rendition and contrast of objects in low light conditions. The oxide-doped glass accomplishes this by filtering out excessive yellow light. Too much yellow light decreases the eye's ability to discern the differences in the color of objects while they are illuminated by an incandescent bulb.

According to the inventor, there are many potential applications of the color-correcting properties of Nd_2O_3-doped glass, not only in headlights in automobiles, aircraft, and rail transportation systems, but in rear view mirrors and windshields which will decrease the glare from light sources, such as headlights from other vehicles. Automobile drivers, in particular, could benefit from this new technology since elimination of excessive yellow light lessens eyestrain that currently results from the light that is emitted from the headlights of oncoming traffic during hours of darkness.

One distinct advantage of the new Nd-doped glass is that it would allow a higher-Wattage bulb to be used in vehicles without increasing eyestrain from the lights of opposing motor vehicles. This could improve safety as better contrast of objects under increased illumination at night would allow the operator of a vehicle more time to react to potential hazards in transportation and navigation.

For more information, contact Mr. Daniel Karpen, 3 Harbor Hill Drive, Huntington, NY 11743 USA; Tel: 516 427 0723. ▲

Magnetic Field Viewing Film

The ability to visually see DC magnetic field patterns provides advantages to manufacturers in the area of quality control, researchers in magnetic field analysis, and educators in illustrating the behavior exhibited by magnetic fields. Magne-Rite, Inc. provides a flexible film that allows the user to visually determine the static magnetic fields of hard and soft permanent magnets, as well as the accompanying magnetic fields associated with current-carrying wires. The company's viewing film is possible through a process that employs the micro-encapsulation of colloidal nickel which gives the paper-thin plastic film its flexible nature. The film allows the viewing of magnetic fields without the need for bulky, rigid magnetic field viewing devices.

In order to produce the films, a slurry of colloidal Ni particles that are engulfed within gelatinous membranes is prepared. A 2 mil coating of the slurry is then applied to the 5 mil-thick plastic film and allowed to dry. After drying, the nickel particles maintain their freedom of movement within the gelatinous membranes. When a DC magnetic field is applied to the bonded film, the Ni particles congregate in alignment with the magnetic flux lines that emanate from the magnetic source, which show up as a dark image on the film. Once the film is removed, the particles are free to move about their cells, which erases the image. The film is sensitive enough to show magnetic fields as low as a few gauss. The company claims that this film is particularly useful in identifying changes in magnetic polarity.

The 0.006 inch-thick film is green in color and is available in 12 and 18 inch rolls, and 12 inch by 12 inch sheets. The greatest advantage of these films lies in their ability to conform to magnetic surfaces with high degrees of convexity and concavity and cut to a desired size.

For more information, contact Peg Esgaté, Magne-Rite Inc., 425 Park Avenue South, New York, NY 10015 USA Tel: 212 779 2882; Fax: 212 685 0393. ▲

Australian Rare Earth Newsletter

The *Australian Rare Earth Newsletter* (*AREN*) is a forum for topical news on Rare Earths with a particular focus on Australia. It provides for Australian and overseas individuals and companies to access timely information in such areas as: research and development, resources, mining and processing, rare earth products and services, and commercial activities and developments.

AREN is edited by Marcus Richardson and Norton Jackson and is published by the Australian Mineral Foundation (AMF). AMF provides training and information services and is funded by Australia's minerals and petroleum industries. The free newsletter is available on-line at: http://www.ozemail.com.au/~marcusr/aren. ▲

ERES Newsletter

The European Rare-Earth and Actinide Society (ERES) publishes a four-page newsletter two-to-three times per year which contains information dealing with rare earth research, book reviews, conferences of the inner transition elements, and general information on the rare earths and actinides. Contributions dealing with any topic of interest to the *f*-element community are welcome and should be sent to the editor, Jean-Claude G. Bünzli either by mail or through their website: http://www.unil.ch/eres. The organization can be contacted, and subscriptions requested, by contacting the *ERES Newsletter*, Université de Lausanne, Institut de chimie minérale et analytique BCH, CH-1015 Lausanne, Switzerland. ▲

RIC Database

The total number of documents referenced in our system is now over 100,000. The documents are stored as citations in the RIC data base and represent books, journal articles, government, company, and laboratory reports, patents and theses which contain information on rare earth metals, their alloys and compounds. A typical citation from a search contains the author(s) name(s), title of paper or contribution, reference line, and keywords that we have assigned to the citation after we have reviewed the document (see below).

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COOMBS;TA CAMPBELL;AM GANNRY;I
LO;W TWARDOWSKI;T DAWSON;B
Superconducting bearings in flywheels
Mater. Sci. Eng., B53, [1-2], 225-8 (1998), International Workshop on the Processing and Applications of Superconducting (RE)BCO Large Grain Materials, Cambridge, UK 1997
1998 APPLICATION SUPERCONDUCTOR MAG-BEARING
(YBACUO) LEVITATION FLYWHEEL

The minimum cost to receive the results of a computer search is US$50.00 (for 25 citations and US$2.00 for each citation over 25 per search). However, many organizations become supporters which allows them to not only receive as many searches as needed for one year, but as an added benefit, they receive the monthly two-page newsletter *RIC Insight*. *RIC Insight* provides a provocative view into recent developments of rare earth science and technology and how these may impact the rare earth industry. The cost to become a supporter is US$100.00 for an individual, or US$300.00 for a corporate membership.

Send requests to: Rare-earth Information Center, 112 Wilhelm Hall, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515 294 5405; Fax: 515 294 3709; ric@ameslab.gov. ▲

INEEL Contractor

Lockheed Martin Idaho Technologies Company (LMITC) has elected not to rebid the contract to operate the Idaho National Engineering and Environmental Laboratory (INEEL) for the U.S. Department of Energy (DOE) which expires September 30, 1999. LMITCO will spend the next year improving site operations, carrying out the long range plan, and facilitating the transition to a new contractor.

The DOE is seeking competitive offers for the management and operations contract of the laboratory. The contact is Brad Bugger, Idaho Operations Office, 785 DOE Place, Idaho Falls, ID 83401-1562; Tel: 208 526 0833; buggerbp@inel.gov; www.inel.gov ▲

The Rare Earths

The Rare Earths is the latest booklet of the Popular Science Series published by Shokabou, one of the major science textbook publishers in Japan. They have dedicated their latest book to the history and scientific and industrial developments of rare earths metals, alloys, and compounds.

It was written by Prof. Yasuo Suzuki whom graciously provided a copy to us. The book is printed in Japanese. We have dedicated the book by keeping it in the RIC collection in the memory of Prof. Spedding.

We thank Prof. Emeritus Yasuo Suzuki for his contributions to the field of rare earths and for a copy of this fine book. ▲

1999 Supporters

Since the September issue of the RIC News went to press, we have received support from three new family members and renewed support from 38 other organizations.

The supporters from the first quarter of the 1999 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 in the next column.

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