Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
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Giant Magnetostrictive Materials

Just about everything you ever wanted to know about magnetostriction is covered in a new book by Goran Engdahl entitled *Handbook of Giant Magnetostrictive Materials*. The book is a fairly thorough treatment of giant magnetostrictive materials, from basic theory and physics to applications. The book contains six chapters and four appendices.

The first chapter is entitled "Physics of Giant Magnetostriction." It covers a wide range of topics from the physical origins of giant magnetostriction to manufacturing processes. Stops along the way include metallurgy and microstructure, crystallography, atomic and magnetic force microscopy images, designing materials, crystalline rare earth alloys, applications, and, of course, TERFENOL-D, among other materials. This chapter includes 85 figures, 50 equations, and 13 tables, all of which serve as excellent illustrative guides to understanding the subject.

The second chapter is devoted to modeling giant magnetostrictive materials. Linear models, finite element modeling, and nonlinear modeling are discussed in detail. Explanations and illustrations of stress and strain, coupling, equivalent circuits, resonance, wave propagation, eddy currents, hysteresis, among others, are included. As is expected, a large number of equations are necessary to explain the topics adequately, and over 230 equations are used throughout the chapter, accompanied by 38 figures.

Chapter 3 covers magnetostrictive design and contains discussions of magnetic, electrical, mechanical, electromechanical, and thermal design. Also included are physical data of TERFENOL-D, magnetic and mechanical operation ranges, 38 figures, and 54 equations.

Two methods of actuator characterization using magnetostrictive materials are presented in Chapter 4. The two methods are time domain methods and frequency domain methods. The discussion is accompanied by 14 figures, 23 equations, and one table. Device applications are covered in Chapter 5, with emphases on sound and vibration sources, vibrational control, direct and indirect motional control, and materials processing. The final chapter discusses the materials, fabrication, and application of giant magnetostrictive thin films.

Four appendices round out the book, with further explanations of eddy currents, impedance, and electromechanical coupling, and also a partial market inventory of material manufacturers and suppliers, system suppliers, consultants, and sources of design software.

Overall, this book is an excellent resource for those who work with magnetostriction in materials and applications. The target audience is mechanical or electrical engineers using magnetostrictive materials in a construction project, but anyone with interest will find lots of useful and interesting information embedded in the pages. The 386-page, hardbound book, ISBN 0-12-238640-X, is available from Academic Press, a Harcourt Science and Technology Company, 525 B Street, Suite 1900, San Diego, CA 92101-4495, USA, www.apnet.com. ▲

New Owner for Treibacher

The parent company of Treibache Auermet, Treibacher Industrie AG change its owner: 100% of Treibacher Industrie A(shares were purchased by the August vo Finck group, a family owned industry hol(ing based in Munich, Germany for over 10 million US$.

The new owner announced that he wi continue the successful policies c Treibacher.

Consequently, Treibacher Auermet, tl Rare Earth company, is continuing i gradual expansion. Its capacity now stan(at 8000 tons per year of rare earths pro(ucts, both chemicals and alloys.

For more information, contact: D Alexander Bouvier, Managing Directc Treibacher Auermet Produktionsges.m.b.F Auer von Welsbachstraße 1, 933 Treibac Austria, Tel: 0043 4262 505-57 Fax: 0043 4262 2898 e-mai alexander.bouvier@treibacher.at, interne www.rareearths.at or www.treibache auermet.com. ▲

In This Issue:

Endohedral Fullerenes

Fullerenes are unique carbon structures, with soccer ball-like cages formed by the carbon atoms that have ample room inside to hold one or more other atoms or ions, including rare earth ions. A recent review article entitled "Endohedral metallofullerenes," by H. Shinohara, was published in *Rep. Prog. Phys.* **63** 843 – 892 (2000), and provides thorough treatment of these materials.

After an interesting historical overview, which covers important events from the discovery of fullerenes in 1985, a short discussion of the endohedral metallofullerenes follows. Many of the endohedral metallofullerenes that have been reported and isolated use rare earth elements as the encaged atoms. The primary focus of this review is on La, Sc, and Y metallofullerenes.

The major sections of the article include production and extraction, separation and purification, structures, electronic properties, vibrational structures, imaging, magnetic properties, M@C60, and applications. The discussions are very interesting and relatively easy to understand, and include explanations of how it was determined that the metal atoms are endohedral rather than exohedral (outside the cage structure), the location of the metal atoms inside the carbon cage, multiple endohedral atoms, and ESR hyperfine splitting and hyperfine coupling behavior. The figures and tables included add a lot to the understanding of the article.

Potential applications listed include MRI, as contrast agents, and radiochemical medical techniques, as radiotracers. The review outlines more study and application research that can be done, including further investigation of electrical and magnetic properties, increasing production, and development of electronic devices and other applications. The extensive bibliography, of about 275 references, would prove useful for anyone interested in exploring the topic further. ▲

Conference Calendar

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

January '01
The 8th Joint Magnetism and Magnetic Materials (MMM)-Intermag Conference
San Antonio, Texas, USA
January 8-11, 2001
RIC News **XXXV**, [2] 4 (2000)

May '01
The Third International Conference on Hydrogen Treatment of Materials (HTM-2001)
Donetsk, Ukraine
May 14-17, 2001
RIC News **XXXV**, [2] 6 (2000)

June '01
The 4th International Conference on Rare Earth Development & Applications (ICRE-2001)
Beijing, China
June 15-20, 2001
RIC News **XXXV**, [2] 6 (2000)

July '01
International Conference on Dynamical Processes in excited States of Solids (DPC'01)
Lyon, France
July 1-4, 2001
RIC News **XXXV**, [3] 3 (2000)

September '01
Rare Earths' - 2001
São Paulo - SP, Brazil
September 22-26, 2001
Website: http://www.iq.usp.br/geral/congress.html.
RIC News **XXXIII**, [4] 3 (1998)

July '02
The 23rd Rare Earth Research Conference
Davis, California, USA
July 13-18, 2002
RIC News **XXXV**, [2] 4 (2000)

August '02
17th Int. Workshop on Rare-Earth Magnets and their Applications
Newark, Delaware, USA
August 19-22, 2002
*This issue

"*This issue" denotes a news story for this conference is in this issue

ICRE-2001

For those interested in attending ICRE-2001 in Beijing, China, June 15 – 21, 2001, there has been some problem with the e-mail address listed in the June 2000 issue of the RIC News. A new e-mail address that should work better is csre@china.com. Anyone interested in further information on the conference can also contact us at ric@ameslab.gov. ▲

Science in Vietnam

A critical shortage of scientific research literature exists in Vietnam. R. W. McCallum, the director of the RIC, has offered to use the RIC publications to solicit donations of scientific literature. The shortage is so acute that even old conference proceedings are welcome. If you will send a list of books or proceedings you no longer need, he will try to arrange for the shipment of selected items to a central library in Hanoi. There are no funds to support this activity, so he needs to be selective in what he sends. Please send your lists to R. W. McCallum, Ames Laboratory, ISU, 116 Wilhelm Hall, Ames, IA 50011-3020, crem_ric@ameslab.gov. ▲

Newsletter on the Web

The *RIC News* is available on the Web at http://www.external.ameslab.gov/ric . ▲

22nd RERC Proceedings

Volumes 303 and 304 of the *Journal of Alloys and Compounds* (2000) contain the proceedings from the *22nd Rare Earth Research Conference*, held July 10 – 15, 1999, at Argonne National Laboratory in Argonne, Illinois, USA. The conference was attended by approximately 180 scientists from 24 countries.

Ten symposia were held on a variety of topics, in which a total of 83 papers were presented and published in these volumes. Three poster sessions supplemented the symposia, but are not published in these volumes. The symposia topics were environmental chemistry, materials science, coordination chemistry, applied spectroscopy, medicinal chemistry and imaging, physics, spectroscopy and non-linear optical properties, solid state chemistry, solid state electrolytes, and x-ray and neutron scattering. The papers are arranged in sections by topic. The collection of papers as a whole gives an interesting perspective into the area of research in rare earths, from theoretical work to applications.

One highlight of this publication is a write-up on the recipient of the ninth Frank H. Spedding Award. The recipient of this meeting's award was M. Brian Maple, a professor at University of California, San Diego. His biography and a feature paper reviewing the novel electronic states in a variety of f-electron materials are included at the beginning of these volumes.

The *Journal of Alloys and Compounds* volumes 303 – 304 is available from Elsevier Science. For ordering information, contact your nearest regional sales office, which can be found at http://www.elsevier.nl. Orders may also be made by contacting Elsevier Science in the United States at P. O. Box 945, New York, NY 10159-0945, USA, Tel: 1 (212) 633 3730 (or toll free in North America: 1-888-4ES-INFO (1-888-437-4636)), Fax: 1 (212) 633 3680, e-mail: usinfo@elsevier.com, or in The Netherlands at P. O. Box 211, 1000 AE Amsterdam, The Netherlands, Tel: 31 20 4853757, Fax: 31 20 4853432, e-mail: nlinfo-f@elsevier.nl. ▲

Biochemistry of Scandium and Yttrium, Part 2

The second volume of Chaim T. Horovitz's two-part series, *Biochemistry of Scandium and Yttrium*, has recently been published. Part 2: *Biochemistry and Applications* is a compilation of fascinating research on the role scandium and yttrium play in biological processes and how their characteristics can be used in a variety of medical, industrial, and technological applications.

There are four chapters (numbered 7 through 10) in this volume, covering a wide range of biochemical topics. Chapter 7 includes a brief introduction and a discussion of how membranes, cells, organelles, antibodies, tissues, and organs interact with scandium and yttrium.

Chapter 8 deals with the biochemistry and physiology of scandium and yttrium. The first half of the chapter addresses biochemistry in increasingly complex organisms, beginning with a short discussion on cytology and morphology, and moving from there to microorganisms, to plants, to mollusks and arthropods, to fish and birds, to mammals, and finally to humans. The second half of the chapter includes discussions on the roles of scandium and yttrium in nutrition and diet, enzymes and metabolism, membranes and transport, physiological processes, disease, pathology, genetics, immunology, essentiality, and a comparison to other elements.

Toxicology, carcinogenicity, and pharmacology are covered in Chapter 9. Discussions are grouped by organism type, chronic vs. acute effects, organ affected, and the type of effect (including pathologic, genetic, immunological, pharmacological, toxic, and carcinogenic effects). Hazard, occupational, and environmental effects are also presented. The final chapter addresses techniques that use scandium and yttrium and includes lists of specific applications.

The wide scope of the book, along with its extensive bibliographical information, makes it an excellent resource for those interested in how scandium and yttrium affect living systems. The 303-page, hardbound book is available from Kluwer Academic Publishers, Order Department P.O. Box 358, Accord Station, Hingham, MA 02018-0358 USA Tel: (781) 871-6600, Fax: (781) 681-9045, e-mail: kluwer@wkap.com, for US$139.50. It is published as Vol. 13B of the series *Biochemistry of the Elements*, ISBN 0-306-45657-5. For more information, visit http://www.wkap.nl/. ▲

High Tech Materials Website

High Tech Materials, formerly TradeTech L.L.C.'s rare earth and specialty metals division, was purchased earlier this year by Rich Vito. They are announcing their new website and the resumption of the publication of *Elements*, a monthly newsletter devoted to rare earths, specialty metals, and applied technology, now available only in electronic version. Their website is http://www.RareEarthsMarketPlace.com. *Elements* is sent via e-mail to subscribers, and is also available through a password-protected section of the High Tech Materials website.

For more information, contact Rich Vito, High Tech Materials, 1049 Ponderosa Circle, Longmont, CO 80501-3931, USA, Tel: 303-772-0678, Fax: 562-750-0613, e-mail: richvito@RareEarthsMarketPlace.com. ▲

Rare-Earth Magnets Conference

The *17th Int. Workshop on Rare-Earth Magnets and their Applications* will be held August 19 – 22, 2002, in Newark, Delaware, USA. The contact person for this conference is George C. Hadjipanayis, University of Delaware, Newark, DE, USA, Tel: 302-831-2736, Fax: 302-831-1637. So far we have not received any further information, but will publish any information we receive in the future. ▲

Magnetic Ferroelectrics

The topic of multiferroic magnetoelectrics is addressed in an article by Nicola A. Hill in *J. Phys. Chem. B* **104** 6694-6709 (2000). The article, entitled "Why Are There so Few Magnetic Ferroelectrics," is an excellent discussion of the problem.

The first part of the article, or the first four major sections, provides an introduction to the subject and a discussion of the considerations in explaining the presence, or lack thereof, of magnetoelectric multiferroism. The explanations of ferromagnetism and ferroelectricity are very good; they are well written and easy to understand. The section on multiferroism, which exists when 2 or 3 of ferroelectricity, ferromagnetism, and ferroelasticity are present in the same phase, provides a history and discussion of the requirements for magnetoelectric multiferroism. Considerations in helping to explain the presence of magnetoelectric multiferroism include symmetry, electrical properties, and chemistry. The interaction between these three areas is what finally determines the magnetoelectric multiferroic state, and the necessary interaction is complex and finely balanced.

The second part of the article, or the fifth major section, consists of a detailed discussion of the roles symmetry, electrical properties, and chemistry play in producing magnetoelectric multiferroism in $BiMnO_3$, $LaMnO_3$, and $YMnO_3$, all of which behave slightly different chemically, and all of which evidence magnetoelectric multiferroism. The discussion includes density of states band structures, tight-binding parameter and fitting, Eigenvectors and Eigenvalue for the dynamic phonon matrix, and structure.

An Appendix includes the computations and measurement techniques used to analyze the materials discussed. This helped the flow of the paper. All the technical details are included, but not in the main text of the article, so the arguments presented by the author are not interrupted and can be made more smoothly, while still having the support present in the article.

Overall, this article is very interesting. The author hopes to spark research interest in this area, and this article could be the spark that lights the fire. ▲

Magnetocaloric Materials

A review of magnetocaloric materials was published earlier this year in *Annual Review of Materials Science* **30** 387 – 429 (2000). The review article, entitled "Magnetocaloric Materials," written by K. A. Gschneidner, Jr. and V. K. Pecharsky, offers an overview of the scientific principles of the magnetocaloric effect (MCE) and a compilation of many of the materials already known to exhibit the MCE.

After a brief introduction to magnetic refrigeration, a thermodynamic discussion of the MCE is presented, including discussions on what constitutes conventional MCE behavior and what is anomalous behavior. This section covers the way to determine and characterize the MCE. Anomalous behavior can result from two closely spaced magnetic transitions or by the presence of a low-lying crystal electric field level.

Measurement of the MCE is discussed next. Measurements can be made either directly or indirectly. Direct measurements measure the adiabatic temperature change as a magnetic field is applied and removed. These measurements are usually time consuming, and finely detailed temperature information is difficult to obtain. Error analysis is more difficult with direct techniques, but accuracy is often claimed to be from 5 to 10%, although actual data show a much wider variation. The accuracy of direct measurements is very dependent on the quality of the equipment used in the measurement. Indirect measurements involve calculation of the MCE from magnetization or heat capacity measurements, using the magnetic entropy change and the adiabatic temperature change calculations. The errors in measurements using magnetization are usually in the 20 to 30% range. This is much improved at low temperatures for the heat capacity measurements, but can be as high for near room temperature measurements. The special problem of first order phase transitions is also addressed in this section, and considerations for each measurement method are mentioned.

The last half or so of the article is devoted to materials that exhibit the MCE. The major groups of materials mentioned are lanthanide-based materials, 3d transition metal-based materials, and mixed lanthanide-3d transition metal materials. Summaries for the MCE of many materials within these classes are mentioned.

This article serves as a good introduction to the topic of magnetocaloric materials. The extensive bibliography would well serve anyone looking for more detailed information on the topic. ▲

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Subscribers to the *RIC News* can request to receive their copies via e-mail. This represents a vastly improved time-of-delivery over surface and air mail. In fact, the e-mail version will be available before the print version has even been mailed. It is now available in MSWord, .pdf, HTML, or text-only formats.

To receive the *RIC News* via e-mail, please specify which format you would prefer, and send your e-mail address to: RIC, 112 Wilhelm Hall, Ames Laboratory, ISU, Ames, IA 50011-3020 USA; ric@ameslab.gov. ▲

Industry Notes

❒**NEW ADDRESS:** Stanford Materials Corporation, 4 Meadowpoint, Aliso Viejo, CA 92656 USA, Tel: (949) 362-1746, Fax: (949) 362-1810, e-mail: info@stanfordmaterials.com.

❒**GMM:** GanSu Light Industrial Products produces giant magnetostrictive materials for a variety of applications. Contact: Zhu Xiaochun, 386# Ding Xi Road, Lan Zhou, China. Tel: 86-931-8616321-8253, Fax: 86-931-8619024, e-mail: xchunzh@sina.com. ▲

Spin Fluctuations and Superconductivity

Toru Moriya and Kazuo Ueda have written a review article, "Spin fluctuations and high temperature superconductivity," that was recently published in *Advances in Physics* **49** [5] 555 – 606 (2000). Theories of spin fluctuations and how they are related to the characteristics of high-Tc superconductors receive good coverage in this article.

The introduction provides basic information on high temperature superconductivity and the difficulties that have been faced in analyzing spin fluctuations and superconductivity. These difficulties are now being resolved through the development of computers with higher computing power, which are thus better able to handle the many complex calculations required for proper analysis.

Separate discussions of spin fluctuation theory and the anomalous normal state properties of cuprate superconductors follow. The spin fluctuation theory section presents arguments for the preference of self-consistent renormalization (SCR) theory over the random phase approximation (RPA) approach to modeling superconductor behavior. Specific comparisons between phenomenological aspects, quantum critical behaviors, and microscopic theoretical aspects are made. The anomalous normal state properties discussed are the nuclear magnetic relaxation rate, electrical resistivity, the Hall coefficient, spin fluctuation parameters, and optical conductivity.

Next follows the longest section of the paper, on the theory of spin fluctuation-induced superconductivity. Early theories, weak coupling theory, strong coupling theory, the possible interaction between the superconducting and antiferromagnetic phases, a fluctuation exchange approximation, vertex corrections, and application of spin fluctuation theory to other systems are discussed.

The last major section of the paper is a discussion on some of the topics addressed earlier and on the pseudo gap phenomenon. The final conclusion drawn is that spin fluctuation mechanisms are responsible for anisotropic superconductivity in high Tc cuprate and 2D organic superconductors, as has also been determined for superconducting heavy electron systems and Sr_2RuO_4. The only problem that may be encountered is in accounting for the pseudo-gap phenomena, which may be possible by extending the spin fluctuation theories further. ▲

$BaO-Ln_2O_3-TiO_2$ Microwave Dielectric

A review paper covering the work done on a $BaO-Ln_2O_3-TiO_2$ solid solution phase as a microwave dielectric was published in *International Materials Reviews* **43** [5] 205-219 (1998). "Microwave dielectric solid-solution phase in system $BaO-Ln_2O_3-TiO_2$ (Ln = lanthanide cation)," by R. Ubic, I. M. Reaney, and W. E. Lee, presents a good overview of the work done in this area.

Microwave dielectrics are pervasive in the communications world we live in today. Microwave communications are used in cell phones, TV, radio, satellite communications, and radar for police, airborne fire control, airport traffic control, and military applications. Microwave resonators are used to broadcast and receive information in these applications. The properties of the resonator material determine the effectiveness of the resonator. Three important properties are the dielectric constant, the quality factor, and the temperature coefficient of resonance frequency.

After the introductory section that includes the previous information, a history of the development of microwave materials is presented, from the medieval use of lodestones in navigation to barium titanates first developed around 1886, to neodymium titanates around 1970, to barium neodymium titanates that currently receive much research attention. This section also includes phase diagrams and summaries of compounds with crystallographic and dielectric information in the $BaO-Ln_2O_3-TiO_2$ system.

Sections on the composition and crystal structure of the solid solution phase follow. The solid solution in the $BaO-Ln_2O_3-TiO_2$ system is $Ba_{6-3x}Ln_{8+2x}Ti_{18}O_{54}$. The crystal structure is a combination of TiO_6 perovskite-like octahedra arranged similarly to a tetragonal tungsten bronze pattern. Different lanthanides result in slightly different structures for this phase. The discussions on crystal structure in this article are detailed, and include information for several lanthanides.

The final three sections include discussions on the tolerance factor's effect on the temperature coefficient and the effect of dopants, additives, and processing parameters on the electrical properties of the material. The amount of information contained in this article is vast, and is supported by 113 references. It is a good review of an interesting subject, and would be an excellent starting point for anyone considering research in this area. ▲

Correction:

The authors of "Finite-temperature properties of doped antiferromagnets" (reviewed in *RIC News* **XXXV** [3] 7 (2000) are J. Jaklic and P. Prelovsek. ▲

Consultant's Corner

To appear in our Consultant's Corner, any individual, company, or group must be involved in are 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. ▲

Characterization of Ferroelectrics

Research Group Highlight

Characterization of the structural and dielectric properties of ferroelectric ceramics is the subject of several publications authored or co-authored by R. N. P. Choudhary, and which are or soon will be included in the RIC Database. Choudhary has worked primarily with compounds of the ABO_3-type in recent years, with doping, often by rare earths, on either the A or B sites.

The value of these materials is in their applications. They are used in transducers, computer memory and displays, light valves, electro-optical modulators, oscillators, sensors, hydrophone devices, and pyroelectric detectors. Choudhary is one of the people searching for new compositions that could serve in device applications.

The primary focus of Choudhary's work is the preparation of single-phase samples and subsequent structural and electrical evaluation of those samples. The methods Choudhary employs in sample preparation are thoroughly described in each publication. Methods used include solid-state reaction and sol-gel processes. Details are included as to the constituent materials sources, process chemical sources, mixing methods, and heat treatments.

Characterization details are also included, such as the specific measurement instrument used and the analysis method employed. Structural information often includes a comparison between calculated and observed XRD peak positions along with the associated Miller indices, cell parameters, crystal structure, density, particle size, and SEM images showing the microstructure of the material.

Dielectric properties often included are dielectric constant as a function of temperature or frequency, dielectric loss tangents, the temperature of the maximum dielectric constant, the Curie temperature, activation energy, conductivity or resistivity, diffusivity, and a discussion of the diffuse nature of the electronic phase transition. Explanations of how the composition of the material affect these properties are also included.

Some of the specific compositions studied in Choudhary's papers include:

$Pb(Li_{0.25}Nd_{0.25}W_{0.5})O_3$,
$Pb_{0.9}(La_{1-z/3}K_z)_{0.1}(Zr_{0.53}Ti_{0.47})_{0.975}$,
$Pb(Li_{0.25}Gd_{0.25}W_{0.5})O_3$,
$Pb(Li_{0.25}Sm_{0.25}Mo_{0.5})O_3$,
$[Pb_{0.92+(z/1-z)}La_{0.08}]_{1-z}[Zr_{0.53}Ti_{0.47+(z/1-z)}]_{0.98(1-z)}O_3$,
$Pb_{0.9}(La_{1-z/3}Na_z)_{0.1}(Zr_{0.53}Ti_{0.47})_{0.975}O_3$,
$Pb(Li_{0.25}Eu_{0.25}Mo_{0.5})O_3$,
and $Ba_5RTi_3Nb_7O_{30}$ (R = rare earth element)

among many others. Some of the recent publications by Choudhary can be found in *Materials Chemistry and Physics* **58** 204-211(1999), *Journal of Materials Science Letters* **18** 345-348 (1999), *Materials Letters* **39** 318-323 (1999), *Indian Journal of Pure & Applied Physics* **37** 476-481 (1999), and *Materials Science and Engineering* **B60** 31-39 (1999). ▲

News from Japan

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

The Nikkei Sangyo Shinbun, September 28, 2000: Hino Motors Ltd. has developed a fuel-efficient hybrid diesel truck, in cooperation with Toyota Motor Corp. The hybrid engine uses Hino's diesel engine and Toyota's hybrid system and catalytic converter for diesel engines. The NiMH battery used is the same as in the Toyota Prius. The hybrid system works to optimize drive and power generation for locomotion and also incorporates an energy recovery system. The company plans to have it on the market by the end of 2003.

The Japan Times, September 29, 2000: Toyota Motor Corp. is adding to its hybrid vehicle lineup with the hybrid Estima minivan, which will be available in Japan sometime next spring. Other models planned include mini, luxury, and medium-class vehicles and trucks. The Prius sedan has been available in Japan since December 1997.

The Japan Times, October 4, 2000: The U. S. Environmental Protection Agency ranked the Honda Insight as the most fuel-efficient automobile among 2001 models marketed in the United States. The Toyota Prius was ranked second. Both vehicles use the hybrid gasoline-electric engine. The Honda Insight averages about 61 mpg and the Toyota Prius gets about 52 mpg, both numbers are for city driving.

The Nihon Keizai Shinbun, October 5, 2000: Sanyo Electric Co. has agreed to buy out Toshiba Battery Co.'s NiMH battery plant in Takasaki, Gunma Prefecture, by the end of March 2001. This will make Sanyo the largest world producer of NiMH batteries, with an estimated 60% market share. Toshiba will stop producing NiMH batteries and will focus instead on lithium-ion batteries.

The Nikkan Jidosha Shinbun, October 19, 2000: Honda Motor Co. will market a new version of the Honda Insight beginning in mid-2001. The new version of the Insight will have a continuously variable automatic transmission instead of the manual transmission currently in place. It is expected the new model will reach gas efficiencies of about 50 mpg for city driving.

The Japan Times, October 22, 2000: General Motors Corp. has achieved its mileage goal, of 80 mpg, in its Precept prototype. The engine and motor design differs from most hybrid vehicles currently on the market, as it uses a three-cylinder diesel engine and two electric motors: one that powers the front wheels, and another attached to the diesel engine that acts as another electric motor and a generator. It will not be on the market soon, however, as it is still much more expensive to mass-produce than regular vehicles.

The Nikkei Weekly, November 13, 2000: Mitsubishi and DaimlerChrysler are teaming up to develop small, lightweight fuel-cell vehicle mass production within four or five years. Fuel cells produce electricity by combining hydrogen and oxygen and are seen as the ultimate in clean alternatives to internal combustion engines. Some industry analysts predict fuel cells will power 25% of vehicles by 2020. ▲

Rare-earth doped polymer waveguides

Contributed by Albert Polman

Polymer-based optical waveguide amplifiers offer a low-cost alternative for inorganic waveguide amplifiers. Due to the fact that their refractive index is almost similar to that of standard optical fibers, they can be easily coupled with existing fibers at low coupling losses. Doping the polymer with rare-earth ions that can yield optical gain is not straightforward, as the rare-earth salts are poorly soluble in the polymer matrix.

A recent study {Ph.D. Thesis of L.H. Slooff, Utrecht University, The Netherlands, ISBN 90-393-2537-5} focuses on two different approaches to dope a polymer waveguide with rare-earth ions. The first approach is based on organic cage-like complexes that encapsulate the rare-earth ion and are designed to provide enough coordination sites to bind the rare-earth ion and to shield it from the surrounding matrix. Optical properties of Er-doped organic polydentate cage complexes are described, showing clear photoluminescence at 1.54 mm with a bandwidth of 70 nm, the highest reported for an erbium-doped material so far. The luminescence lifetime is very short (~1 ms) due to coupling to vibrational overtones of O-H and C-H bonds. Due to this short luminescence lifetime, high pump powers are needed for optical gain in a waveguide amplifier based on these complexes. The pump power can be reduced if the Er is excited via a highly absorbing lissamine sensitizer, which is covalently bonded to the complex. This highly absorbing sensitizer makes standard butt-end coupling of the pump light into a waveguide amplifier impractical. The pump power can be used more efficiently by using a novel coupled waveguide system, which employs gradual evanescent field coupling between parallel pump and signal waveguides.

An alternative approach to make a rare-earth doped polymer wave-guide is by combining the excellent properties of SiO_2 as a host for the rare-earth ion with the easy processing of polymers. Using a base-catalyzed sol-gel synthesis, silica colloidal spheres with a diameter of 340 nm were grown, and the luminescence properties of the spheres, implanted with Er up to concentrations of 1.0 at.% were studied. The Er shows a very long luminescence lifetime of 17 ms. This long luminescence lifetime is partly due to the low local optical density of states (DOS) in the free standing silica colloids. Calculations of the DOS are described for thin films as well as the spherical colloids. By comparing the calculation with experimentally probed decay rates, radiative and non-radiative components in the decay of Er are determined. Optical gain calculations are performed for a colloid/polymer waveguide, and predict a net gain of 8.7 dB at a pump power of 30 mW, for a 15-cm long waveguide. Such a length can be rolled up on an area of 16 mm^2.

The Ph.D. thesis as well as copies of separate published articles on the topic are available on the website of the FOM-Institute for Atomic and Molecular Physics, Kruislaan 407, 1098 SJ, Amsterdam, The Netherlands; www.amolf.nl. For more information contact Prof. A. Polman; polman@amolf.nl. ▲

Search of the Month

Ric Database

keywords 1999 ***AND*** *keywords* HYDRIDE ***AND*** *keywords* battery

Effect of Al in Mm(NiCoMnAl)5 on the performance of the sealed MH/Ni cell ———1999 MM HYDRIDE BATTERY PRECIPITATION (MMALCOMNNI) MM(ALCOMNNI)5 H-STORAGE ALLOY

Hyrogen economy in the future ———1999 H HYDRIDE BATTERY REVIEW ENERGY

Manufacturing process, electrochemical properties and structure of MI (NiMnTiCo)5 hydrogen storage alloys ———1999 H-STORAGE ELECTROCHEM HYDRIDE INDUSTRY PRODUCTION BATTERY ALLOY CHARGE-DECHAR COMPOSITION X-RAY-DIFFRACT MORPHOLOGY

Effects of a surface treatment on electrochemical characteristics of nn-stoichiometric hydrogen-adsorbing alloys for nickel-metal hydride secondary batteries ———1999 MM ALLOY MM(ALCOMNNI)5 (MMALCOMNNI) SURFACE COMPOSITION-EF XPS AQ-SOLUTION ELECTROCHEM BATTERY HYDRIDE

Magnetic properties of the La(Ni-M)5-H system ———1999 MAG-PROP LA(CO,NI)5H LA(FE,NI)5H LA(MN,NI)5H (LACOHNI) (LAFEHNI) (LAHMNNI) (LA,H,NI) BATTERY MAGNETIZATION TEMP-DEPENDENC HYDRIDE

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The search above satisfies a search for references from 1999 on hydride AND battery. Many more citations would have been referenced if other terms or other years were also included, i.e., if the search was for (2000, 1999, 1998, 1997, OR 1996) AND (hydride OR h-storage) AND battery.

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Luminescence in Sr_2CeO_4 compounds

R. Sankar and G. V. Subba Rao have written an article on luminescence that recently appeared in *Journal of The Electrochemical Society*, **147** [7] 2773 – 2779 (2000). The article, "Eu^{3+} Luminescence, $Ce^{4+} \rightarrow Eu^{3+}$ Energy Transfer, and White-Red Light Generation in Sr_2CeO_4," covers some interesting topics in luminescence.

Sr_2CeO_4 was discovered to exhibit blue luminescence. Excitation with UV light, cathode rays, and x-rays all produce luminescence in this material, and it has been established as an efficient blue-white phosphor material. Sankar and Subba Rao set out to determine what effect, if any, Eu^{3+} would have on the luminescence characteristics of Sr_2CeO_4. This article reports the synthesis, characterization, and luminescence properties of pure and doped Sr_2CeO_4.

Doping was done for both the Sr- and Ce- sites. Compounds investigated were Sr_2CeO_4, $(Sr,La)_2(Ce,Eu)O_4$, $Sr_2(Ce,Eu)O_4$, and $(Sr,Eu)_2CeO_4$. The experiments performed for this article confirmed Sr_2CeO_4 as a blue phosphor, and compared its properties to other standard blue phosphors. $(Sr,La)_2(Ce,Eu)O_4$ was shown to exhibit luminescence in the blue-white to red-white range. $Sr_2(Ce,Eu)O_4$ also exhibits luminescence in the blue to red range. $(Sr,Eu)_2CeO_4$ and $(Sr,La)_2(Ce,Eu)O_4$ are each efficient red phosphors under different excitation wavelengths.

The paper also includes a discussion on the energy transfer mechanism in Eu-doped Sr_2CeO_4. The comparable behavior between these compounds and Eu-doped Y_2O_3 that is the standard material shows that Eu-doped Sr_2CeO_4 may be a viable alternate materials for luminescence applications. ▲

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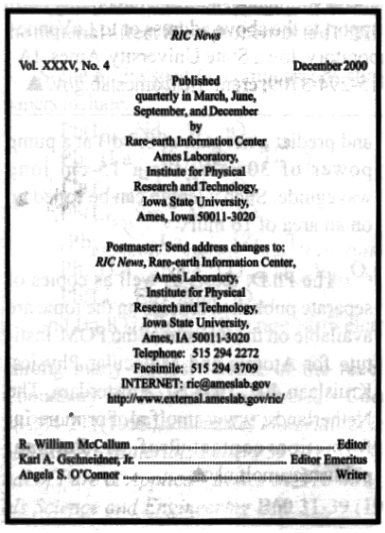

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