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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Search of the Month

The sample search below satisfies a request for information on rare earths that are used in catalysts and catalytic converters that are used in automobiles.

RIC searches utilize the Boolean operand system with "+" = (or), "*" = (and), and "*^" = (and not). Many more citations would have been referenced had we included specific compound/alloys.

RARE-EARTH INFORMATION CENTER LITERATURE SEARCH REPORT
Rare Earths in Automotive Catalytic Converters

(CATALYST + CATALYSIS + CATALYTIC-CONV) * (AUTOMOTIVE + AUTO-EXHAUST + TRANSPORTATION)

There were a total of 1327 documents located and searched from all of the keywords from all years.

TERM	KEYWORDS INDEXED	NUMBER IN REQUESTS
CATALYST	957	78
CATALYSIS	129	3
CATALYTIC-CONV	18	7
AUTOMOTIVE	138	40
AUTO-EXHAUST	59	44
TRANSPORTATION	26	1
**********	83 DOCUMENTS HAVE SATISFIED THIS REQUEST	**********

The above Literature Search Report shows the key words used in the search, the number of times each appears in the data base, and that 83 documents that contain information on rare earth catalytic converters and catalysts used to treat automobile exhaust gases were referenced in the search. More papers can be referenced by specifically requesting the chemical formula of rare earth catalysts used in automotive catalysts.

The cost to receive the Literature Search List from this search, which is a complete listing of all 83 referenced documents, is available for US$170.00. Supporters can receive as many searches as needed for US$300.00 per year (corporate) or US$100.00 (individual).

As an added benefit, supporters receive the 2-page monthly newsletter *RIC Insight* which reports on late-breaking news of rare earths and how these developments may impact the rare earth industry.

We will be happy to conduct a preliminary computer search you with no obligation. Give us a chance to show you how our searchable computer data base system can work for you!

If you would like us to conduct a search for you, please send your request to: Joel Calhoun, RIC, 112 Wilhelm Hall, Ames Laboratory, Iowa State University, Ames, IA 50011-3020 USA; Tel: 515 294 5405; Fax: 515 294 3709; ric@ameslab.gov. ▲

Mag Anisotropy of $SmFe_7$

The magnetocrystalline anisotropy of a new intermetallic compound, $SmFe_7$, has been determined by a research team which was made up of scientists from Japan and China. The team was led by H. Samata {*Jpn. J. Appl. Phys.*, **37**, [6A], 3290-3294 (1998)}. The Sm-Fe compound was grown by the self-flux method and tested the magnetic anisotropy was determined by a torque measurement.

Single crystals of $SmFe_7$ were grown by a self-flux method with excess Sm used as a flux: Sm/Fe at an At% ratio of 65:35 were arc melted under a Zr-gettered Ar atmosphere, then the mixture was placed in a boron-nitride coated Al_2O_3 crucible, which was then sealed in a quartz ampoule. The mixture was then heated and held at 1000°C for 6 hours, followed by cooling from 950°C to 750°C at a rate of 0.4°C/h, then cooled to room temperature after the furnace was de-energized. Interestingly, the resultant single crystal of $SmFe_7$ is in the tetragonal structure, which is analogous to the $R_2Fe_{14}B$ structure that has the boron site absent.

After analyzing the torque curves in the (001) and (100) planes by way of the least mean squares method, the researchers discovered that the tetragonal anisotropy constants K_1, K_2 and K_3 of the $SmFe_7$ sample were -8.7 ± 0.4 x 10^7 erg/cm^3, 1.4 ± 0.3 x 10^7 erg/cm^3, and -2.7 ± 0.1 x 10^6 erg/cm^3 at 293 K, respectively (subsequent magnetization measurements confirmed these results). This reported huge magnetocrystalline anisotropy of $SmFe_7$ exceeds that of $Nd_2Fe_{14}B$ which would make it a likely candidate as a high performance hard permanent magnet material. ▲

Course in Magnetics

A 3-day residential course on magnetism and magnetics will be held March 22-24, 1999, in Sunderland, UK. The course will take place at the University of Sunderland and is intended to be an introductory course on the subject of magnetic materials, with an orientation towards permanent magnetism, including Nd-Fe-B materials. The course will be comprised of eight lectures and two practical sessions.

For more information, contact Prof. A.G. Clegg, Magnet Centre, University of Sunderland, Priestman Building, Chester Road, Sunderland, SR1 3SD, Tyne & Wear, UK; Tel: 44 191 515 2836; Fax: 44 191 515 2837. ▲

jmw99

The 3rd Joint UK Magnetics Workshop (JMW99) will be held at the University of York, July 5-7, 1999. JMW is geared toward those working in the field of magnetics and magnetic materials in industry, research, and academia. The workshop will cover the topics of low dimensional structures, bulk magnetic materials, information storage, heavy fermions and correlations, modeling, instrumentation/sensors, theory and magnetoresistance, and electrical machines. Those rare earthers who deal with the processing and properties of advanced hard magnetic alloys, magnetic force microscopy of magnetostrictive materials, colossal/giant magnetoresistance, or applications of superconductors to power engineering may be interested in attending.

For more information, contact Margaret Swadling, The UK Magnetics Society, Berkshire Business Centre, Post Office Lane, Wantage, Oxon OX12 8SH, UK; Tel: 44 1235 770652; Fax: 44 1235 772295; ukmagsoc@compuserve.com. ▲

MSM-99

The 1st Regional Conference on Magnetic and Superconducting Materials (MSM-99) will be held September 27-30, 1999 at the Sharif University of Technology, Tehran, Iran. The conference will cover the topics of physics, materials science and application of magnetic and superconducting materials with a major focus on the close relationship of strong correlated electron systems with magnetism. The main fields included in the conference include: production, synthesis, chemistry; microstructure; physical properties; flux dynamics; special magnetism; mathematical modeling; and applications.

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To register for, or to find out more about MSM-99, contact: secretariat, Magnet Research Laboratory, Department of Physics, Sharif University of Technology, P.O. Box 11365-9161, Tehran, Iran; Tel/Fax: 98 21 6019246; msm-99@sina.sharif.ac.ir; www.sharif.ac.ir/~msm-99. ▲

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
RIC News **XXXIII**, [4], 2 (1998)

June '99
IUMRS-ICAM '99
Beijing, People's Republic of China
July 13-18, 1999
RIC News **XXXIII**, [4], 2 (1998)

July '99
3rd Joint UK Magnetics Workshop
York, UK
July 5-7, 1999
*This issue

22nd Rare Earth Research Conference
Argonne, Illinois, USA
July 10-15, 1999
RIC News **XXXIII**, [4], 2 (1998)

Nanotube-99 (nt99)
East Mansing, Michigan, USA
July 24-7, 1999
*This issue

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

September '99
The Third International Conference "Noble and Rare Metals" (NRM-2000)
Donetsk, Ukraine
September 19-22, 2000
*This issue

EUROMAT99
Munich, Germany
September 27-30,
*This issue

Magnetic and Superconducting Materials (MSM-99)
Tehran, Iran
September 27-30, 1999
*This issue

November '99
Magnetism and Magnetic Materials (MMM'99)
San Jose, California, USA
November 15-18, 1999
* This issue

September '01
Rare Earths - 2001
São Paulo - SP, Brazil
September, 2001
RIC News **XXXIII**, [4], 3 (1998)

NANOTUBE-99

The conference and workshop NANOTUBE-99 is dedicated to the science and application of nanotubes of carbon and other materials. The conference will be held in East Lansing, MI, USA from July 24-27, 1999. For more information, contact David Tomanek, Assoc. Professor of Physics, Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824-1116 USA; Tel: 517 355 9702; Fax: 517 353 4500; tomanek@pa.msu.edu; www.pa.msu.edu/conf/nt99/. ▲

NRM-2000

The Third International Conference "Noble and Rare Metals" (NRM-2000) will sum up the results, and cover the current status and strategy of development in the 21st century of noble and rare metals. The conference will be held in Donetsk, Ukraine from September 19-22, 2000 and will cover topics dealing with noble and rare metals including rare earth intermetallic compounds with 3*d*-transition metals for permanent magnets.

For more information, contact Prof. Victor A. Goltsov, Chairman of NRM-2000, Donetsk State Technical University, 58 Artem Street, Donetsk 340000, Ukraine; Tel: 380 0622 910 314; Fax: 380 0622 921 278; goltsov@physics.dgtu.donetsk.ua; www.dgtu.donetsk.ua/nrm.html. ▲

EUROMAT 99

The International Congress on Advanced Materials and Processes is the comprehensive materials event in Europe (EUROMAT 99) and will be held September 27-30, 1999 in Munich, Germany. Topics of interest to rare earthers include: optical and magnetic storage systems, materials for transportation technology, fuel cells, and non-ferrous metals and metals processing, among others. The conference will be accompanied by MATERIALICA, the International Trade Fair on New Materials, Processing and Applications.

Contact: EUROMAT Congress Office, c/o Deutsche Gesellschaft für Materialkunde, Hamburger Allee 26, D-60486 Frankfurt, Germany; Fax: 49 69 7917 733; euromat@dgm.de; www.euromat.fems.org. ▲

MMM'99

The Forty-Fourth Annual Conference on Magnetism and Magnetic Materials (MMM'99) will be held at the Fairmont Hotel in San Jose, California, USA, November 15-18, 1999. The conference brings together scientists and engineers interested in recent developments in all branches of fundamental and applied magnetism. Emphasis will be placed on the theoretical and experimental research in magnetism, the properties and synthesis of new magnetic materials, and advances in magnetic technology. The program will consist of invited and contributed papers.

For more information, contact Diane Suiters, Courtesy Associates, 2000 L Street, NW Suite 710, Washington, DC 20036 USA; Tel: 202 973 8668; Fax: 202 973 8722; magnetism@courtesyassoc.com; www.magnetism.org. ▲

High-T_c Pressure Effect

A high-quality film of the superconducting "2-1-4"compound $(La_{1.9}Sr_{0.1})CuO_4$ has been shown to double its critical temperature (T_c) as pressure is increased {*Nature*, **394**, 453-6 (1998)}. The superconducting transition temperature was shown to increase from 25 K to 49 K when the film was grown on a substrate that placed the superconducting film under compressive epitaxial strain. Only moderate increases in T_c have been discovered for other compounds under pressure.

The compressive epitaxial strain results from interfacial interactions between a film and a substrate that possesses slightly smaller atomic spacing. The film is reported to be compressed in the plane of the film but is allowed to expand vertically. The discovery is important in high-T_c superconductors because this "epitaxial strain" technique applied to other compounds could lead to T_c's approaching 200 K. According to the researchers (J.-P. Locquet, et al., IBM Research Division, Zürich Research Laboratory, CH-8803 Rüschlikon, Switzerland; loc@zurich.ibm.com), the highest that the T_c of a superconductor that has been raised by using pressure, is from 133 K to around 164 K. ▲

Operator Techniques in Atomic Spectroscopy

Operator Techniques in Atomic Spectroscopy originally was published as a hard cover edition in 1963 and remains basically unchanged except for the correction of some minor typographical errors. The content of this path-breaking book dealing with the atomic spectroscopy of *f*-elements is now available in soft cover from Princeton University Press.

The whole book is devoted to the rare earths and actinides and contains eight chapters: Classical Methods, Crystal Fields, The *n-j* Symbols, Configurations of Two Electrons, Continuous Groups, Seniority, Fractional Percentage Coefficients, and Configurations of More than Two Equivalent Electrons. The book finishes up with handy appendices which contain Radical Integrals for Hydrogenic Eigenfunctions and The Coefficients $(UL\,|\,U'L'+f)$ and $(WU\,|\,W'U'+f)$.

The new edition was published in 1998 and is available for US$19.95 from Princeton University Press, 41 William Street, Princeton, NJ 08540 USA; pup.princeton.edu.

RIC is grateful for the author of the book and Fifth Frank H. Spedding Award winner, Brian R. Judd, for donating this book to the Spedding Collection held at Iowa State University. ▲

Journal of Rare Earths

Journal of Rare Earths is a quarterly 80-page publication that reports on the science and technology, mining and mineral deposits, chemistry, hydrometallurgy, etc., of rare earth metals, alloys, and compounds. It also provides information on rare earth applications in metallurgy, electronics, chemical industry and agriculture as well as rare earth toxicology, analysis, and physical testing. Each issue includes a bibliography of research published in China with some news on the rare earth industry in China. The annual subscription price is US$140.00.

For more information, contact Jin Zhengai, Editorial Office of Journal of Rare Earths, 2 Xinjiekouwai Dajie, Beijing 100088, People's Republic of China; Fax: 86 10 6201 5019; mnfirgb@public.bta.cn. ▲

Magnetic Properties of Scandium

Interested in the nuclear spin order of single-crystal Scandium metal, Y. Koike and H. Suzuki (Department of Physics, Faculty of Science, Kanazawa University, Kakuma, Kanazawa, 920-11 Japan) have measured the low field magnetic susceptibility of a sample at ultra-low temperatures while in small magnetic fields {*J. Low Temp. Phys.*, **107**, [1/2], 197-208 (1997)}. The measurements were made between 0.1 mK and 10 mK so the metal could be held at the nuclear spin ordered state in order to correlate the spins with the magnetic properties of the electrons.

The experiments were carried out at temperatures above 100 μK, the minimum temperature to which one can cool a scandium crystal by nuclear demagnetization of the Cu refrigerator that was used in the experiment. The Scandium sample, although high purity, still contained ppm impurities of magnetic Fe, Cr, Mn, and nonmagnetic impurities of W, Y, Al, and Ce. At low temperatures, a small impurity such as Fe, would have significant impact on the magnetic properties. At low concentrations and temperatures, iron behaves as a Kondo impurity which forms a nonmagnetic singlet state with a conduction electron.

The magnetic susceptibility of the sample in a zero magnetic field was found to increase with decreasing temperature and was discovered to be at a maximum at about 0.5 mK. Below this temperature, the susceptibility decreased until the minimum at 0.2 mK, then it increased again, exposing an obvious anomaly. When an external magnetic field was applied, the maximum susceptibility was shifted toward higher temperatures, and suppressed the value of the maximum susceptibility. This is claimed to be caused by an adiabatic magnetic susceptibility in the magnetic field because the measuring frequency is much shorter than the spin lattice relaxation time. Only in a zero field did it give the same value as the thermal equilibrium ac magnetic susceptibilty.

The anomalous magnetic susceptibilities and anomalous magnetization at 0.5 mK of Sc single crystal was explained by the researchers as a spin glass phenomena of the magnetic impurity in Scandium. ▲

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Blue Phosphor

Field emission displays (FEDs) are essential to providing high-intensity, full color flat panel displays that are readable in sunlight. Portable computers are creating the demand for FEDs which must provide cathode ray tube-type properties in a light weight package. A new phosphor that is a blue-emitting Ce^{3+}-doped $SrGa_2S_4$ compound is reported to have both high luminous efficiency and a fast decay time which would make it an ideal candidate for use in FEDs {*Appl. Phys. Lett.*, **72**, [18], 2226-8 91998)}.

Any phosphor that is to be used in a FED must posses stringent properties in order to be successful: good chromaticity, high luminance, high efficiency, low saturation, and good aging properties while it is operated at the low voltages and high current densities on portable displays. Ce^{3+} - doped thiogallate relies on the 5*d*-4*f* transition for its characteristic blue emission which has a relatively narrow bandwidth due to low electron-phonon coupling energy and a small Stokes shift.

Activator concentrations up to 0.6% Ce were added to $SrGa_2S_4$ by using solid state techniques. A mixed precipitate of precursors were used in the preparation, followed by firing in hydrogen sulfide or carbon disulfide, resulting in a Ce^{3+}:$SrGa_2S_4$ particle size of 7 μm. The phosphor was then excited in a vacuum chamber ($<10^{-8}$ Torr) by an electron gun energized between 100 V and 5 kV. The emission peaked at 450 nm.

The cathodoluminescence properties of the new phosphor include an intrinsic efficiency at 2 kV is 6 lm/W, the critical average current density for required luminance is 9 μA/cm² (94% efficiency), a critical efficiency of 5.64 lm/W, and a figure of merit of 41.5. For more information, contact F.-L. Zhang, Phosphor Technology Center of Excellence, Georgia Institute of Technology, Atlanta, Georgia 30332-0560 USA. ▲

New Phosphors

A new class of phosphor materials that have a promising future in lamp phosphors have been studied to determine their luminescence properties and their resistance to oxidation (J.W.H. van Krevel et al., Laboratory of Solid State and Materials Chemistry, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands). The new phosphors are Ce^{3+} and Tb^{3+}-doped $R_5(SiO_4)_3N$, $R_4Si_2O_7N_2$, $RSiO_2N$, and $R_2Si_3O_3N_4$ (R= Y, Gd, La) materials which have the lattice structures of apatite, cuspidine, wollastonite, and melilite, respectively.

The researchers prepared the materials by solid state reactions at 1500 °C, 1600 °C, and 1700 °C under a nitrogen/hydrogen atmosphere. The Tb^{3+}-doped compounds were prepared at a dopant concentration of 0, 0.32, 1, 3.2 and 10 at% Tb compared to Y. The Gd and La containing materials only contained 5 at% Tb and the Ce^{3+} doping concentration was 5 at% in these silicon oxynitride compounds. Reportedly, the only compound that failed to form was $GdSiO_2N$.

Luminescence studies indicate that the compounds are efficient green-emitting phosphors that should find many applications in industry, medicine, and residential applications. The quantum efficiency, as well as 254 nm absorption, are dependent upon the relative position of the host lattice absorption edge and the Tb^{3+} 5*d* excitation band with respect to each other and with respect to other 254 nm radiation. The Ce^{3+}-doped Y-Si-O-N materials $5d \rightarrow 4f$ emission bands were observed to have increasing crystal field splitting which is observed for higher nitrogen/oxygen ratios. In addition, the Stokes shift decreases for more rigid lattices that have extensive silicon tetrahedral formation.

All compounds possess oxidation resistance above 600 °C and a thermal stability which indicates that they can be used as lamp phosphors. The oxidation increases in the sequence $R_5(SiO_4)_3 < R_4Si_2O_7N_2 < RSiO_2N < R_2Si_3O_3N_4$ which can be explained by the increasing coordination of N with Si which results in a more extended Si network formation. ▲

Australian Scandium Deposit

A new nickel/cobalt source located just southwest of Port Macquarie on the central coast of New South Wales, Australia is reported to also be a major scandium deposit. The discovery of the resource was made by the exploration and mining company, Jervois Mining NL. The deposit was discovered by geophysical survey techniques and drilling the host rock which is made up of laterites underlain by parent serpentinite rocks. The scandium was unexpectedly discovered when a routine analysis was ordered on drill samples to see if any valuable metals were present.

The deposit is reported to contain 12.4 million mt of ore at 1.53% Ni equivalent, which translates into 80,000 mt Ni, 11,000 mt Co, and 500 mt Sc. The discovery led the prospectors to drill additional holes at nearby Houston-Michael North, which indicated that there were several scandium-rich intersections which inferred an additional 40 mt of Sc, making the grade 76 g/mt of ore.

Jervois plans to mine 50-60 mt/yr of Sc during a projected 20-year life of the mine. The company hopes to produce its scandium to satisfy the future demand for Sc-Al alloys and Sc-containing aluminum welding wire. Jervois Mining NL can be contacted via e-mail: jervois@bigpond.com; Tel: 3 9670 3766; Fax: 3 9670 3691. ▲

Rare Earthers

The inventor of the VSM, **Simon Foner**, has been selected to receive the Joseph F. Keithly Award for Advances in Measurement Science. Foner retired in 1995 as associate director and chief scientist of the Francis Bitter Magnet Laboratory at the Massachusetts Institute of Technology. He is being recognized for "the invention and development of the vibrating sample magnetometer and many of its successful applications, and for the innovative development of very high field pulsed magnets".

Ivan K. Schuller will receive the 1999 John Wheatley Award, which recognizes an individual who has promoted the development of physics in developing nations. He earned this distinction for "his dedication to the development of physics at the frontier level in Latin America, China and India; for his efforts on organizing international events and building strong bridges to connect people, ideas, and resources from around the world; and for his results as an imaginative physicist and a close collaborator with young physicists in developing countries". ▲

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Nuclear Waste Storage

The current method for storing radioactive waste is by vitrification, encasing the waste in glass, in order to isolate the waste material from the environment, including leaching from groundwater. However, new methods are under consideration and are the subject of scientific research, such as using ceramic materials to contain weapons-grade plutonium.

At the Nuclear Physics Institute at Orsay, France, researchers are using models derived from naturally-occurring rock that contains the radioactive elements uranium and thorium. To test their model, they prepared thorium phosphate-diphosphate (TPD). Although this compound can not be directly compared to any natural compound, it is well known that thorium is naturally contained in phosphate minerals. Although tetravalent actinide ions of uranium, neptunium and plutonium can be substituted for the tetravalent thorium ion which results in the formation of solid solutions in which the maximum percentage of substitution are 75%, 50%, and 40% respectively. Americium and curium, which form trivalent ions that are larger than those of thorium, cannot be substituted into TPD. This has been simulated with the help of Gd^{3+} ion, which can not be inserted into a solid solution as the tetravalent actinides can, but rather creates a two-phase system of TPD and Gadolinium phosphate. The material can then be contained as ceramic pellets by sintering under 5 mt cm^{-1} pressure, and heating at 1250 °C for 12 h.

The results of the study shows that corrosion resistance of these ceramic materials to groundwater is at least 10 times better than vitrified waste. For more information, contact Prof. Michel Genet, Radiochemistry Group, Nuclear Physics Institute, University Paris-Sud, 91406 - Orsay, France; genet@ipno.in2p3.fr. ▲

"Next Generation" Plastic Magnets

A new and improved Sm-Fe-N permanent magnet powder and plastic resin composite has been announced by Hitachi Ltd., Japan. The new "plastic magnets" are a contrast to the established Nd-Fe-B powders encased in plastic that replaced traditional cast and sintered permanent magnets that were used in miniature electric motors and electronics applications. Rare earth plastic magnets exhibit greater magnetic strength than ferrite plastic magnets and have much easier formability into complex shapes, and are relatively low in cost. However, most rare earth plastic magnets are of the Nd-Fe-B composition.

There are several advantages to Samarium-based magnetic materials over Neodymium-based magnets, including improved corrosion resistance and damage resistance from high heat, both which eliminates the need for coating surfaces. In addition, Sm-based magnet powders can be produced in a finer grain size, which improves the precision in formed shapes.

The Hitachi method involves a special additive that allows the formation of Sm-based powders in a nitrogen atmosphere. The new Sm-Fe-N powder is less expensive to produce than Nd-Fe-B powder and has magnetic properties close to that of Nd-based powders while having a magnetic strength of 8MGOe, which is still about twice that of sintered ferrite magnets. The company hopes to improve the magnetic strength to 10MGOe by March, 1999, at which time it will make the material commercially available. The targeted market will be in electric motors that operate in elevated temperatures. Hitachi Ltd. hopes for projected sales of US$4,200,000 by 2000. For more information, contact Hitachi Ltd., 4-6 Kanda-Surugadi, Chiyoda-ku, Tokyo 101, Japan; Tel: 81 3 3258 1111; 81 3 3258 5480. ▲

NASA Contract

Energen, Inc. of Billerica, Massachusetts, has been awarded US$171,500 in contracts from the National Aeronautics and Space Administration (NASA). The contracts are for the company to produce manufacturing technology for magnetostrictive materials and to build an apparatus to measure the properties of materials at low temperatures. If the results of the work from these contracts prove successful, then follow-on contracts of US$1,800,000 will follow.

Magnetostrictive materials are a critical component of actuators that are being developed by Energen, Inc., for the Next Generation Space Telescope (NGST). NGST is a US$500,000,000 project which is planned to be launched in 2007 to replace the current Hubble Space Telescope. Magnetostrictive actuators are critical to precision motion control in the harsh environment of space.

For more information, contact: Chad H. Joshi, Energen, Inc., 17D Sterling Road, Billerica, MA 01862-2518 USA; Tel: 978 671 5400; Fax: 978 670 9876; energen@tiac.net. ▲

Adding Mn or Al to $Tb_xDy_{1-x}Fe_2$

Terfenol-D ($Tb_xDy_{1-x}Fe_2$) is well known for its giant magnetostriction and low magnetocrystalline anisotropy, which makes it ideally suited for use in ultrasound transducers and in micromotors. Considerable work has been done on various additions into $Tb_xDy_{1-x}Fe_2$ to reduce the magnetic field that is required to saturate the material. Recently, the addition of Al or Mn was tested to determine their composition effect on the hysteresis and magnetostriction properties of twin-free single crystals of Terfenol-D {*Appl. Phys. Lett.*, **72**, 489-491 (1998)}, [J.H. Wang, Dept. of Physics, Peking University, Beijing 100871, People's Republic of China; jhwang@aphy01.iphy.ac.cn].

Since $Tb_xDy_{1-x}Fe_2$ is anisotropic, crystallographic alignment is needed for maximum magnetostriction. They used twin-free single crystals in the experiment to avoid the pinning of

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Magnequench Opens European Office

Indiana, USA-based Magnequench International Inc. has opened a European office in Tübingen, Germany. The company produces high performance Neodymium-Iron-Boron permanent magnet powder. Its products are used in the production of Nd-Fe-B permanent magnets that are used in devices worldwide. The new office will allow customers access and use of laboratory equipment for magnetic testing and other measurements of magnetic materials.

For more information, contact Dr. Bernd Grieb General Manager, Magnequench Europe, Vor dem Kreuzberg 18, D-72072 Tübingen, Germany; Tel: 49 (0) 7071 400 635; Fax: 49 (0) 7071 400 641. ▲

Change of Address

The New York office of Metal Mining Agency of Japan has moved. They can now be reached at: 120 W. 45th Street, Suite 901, New York, NY 10036; Tel: 212 869 0639; Fax: 212 869 0205. ▲

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magnetic domain walls, which allows maximum magnetostriction at the lowest possible magnetic field.

The compositions that were investigated were $Tb_{0.27}Dy_{0.73}(Fe_{1-x}Al_x)_2$ and $Tb_{0.5}Dy_{0.5}(Fe_{1-x}Mn_x)_2$. Without substitution ($x$ =0), the maximum magnetostriction under 3 kOe was 1600 ppm and 815 ppm for Al and Mn, respectively. Both compositions decrease magnetostriction. When Al was added, the saturation field decreased from 1.1 kOe to 500 Oe when x was increased to 0.15, which decreased corresponding magnetostriction to about 400 ppm. When Mn was added, negative magnetostriction was observed at room temperature while under zero prestress, due to the rotation of domains 109.5° away from the crystallographic axis. While under compressive stress, a large magnetostriction of 2160 ppm with a saturation field of 900 Oe can be obtained, making it a promising material for future applications. ▲

Rare View Mirror

Rare earth-doped glass used in motor vehicle headlights reportedly not only improves color saturation and rendition, but also reduces glare {*RIC News*, **XXXIII**, [4], 6 (1998)}. This is accomplished when Nd_2O_3 filters out some of the yellow light produced by the hot incandescent filament. This produces a color-corrected light which results in decreased glare from the source. The inventor of this "new" technology has now applied this property of Nd-doped glass to vehicle rear-view mirrors.

Although rare earth oxide-doped glass reduces glare produced from lights from a variety of vehicles such as ships, trains, motorcycles and aircraft, it is in automobiles where this application shines. An obvious and long-known hazard has existed when a larger vehicle with higher-mounted headlights follows a smaller vehicle during periods of darkness. The headlight height from buses, sport utility vehicles, and trucks, as measured from the pavement, ranges from 36 inches to 39 inches, which corresponds to the height of rear windows and side-mounted and rear-view mirrors. To exacerbate the problem, cars have gotten shorter while trucks and sports-utility vehicles have gotten taller and more numerous on roads. The Society of Automotive Engineers (SAE) estimates that when headlights are the same height as the mirror, glare becomes 10 to 20 times worse.

Mr. Daniel Karpen, the inventor of the Nd-doped glass in headlights and mirrors, claims that the new technology in rear view mirrors not only decreases glare, but also improves color rendition, color saturation, color contrast of the viewed object and improved depth perception. The cost to implement this new technology for a light duty motor vehicle is estimated to be from US$1.00 to $3.00 per vehicle. If the automobile industry would adopt this new technology and the Nd-doped glass performs as stated in the patent, this would be a true quantum leap in safety for the motoring public. For more information, contact Daniel Karpen, Professional Engineer & Consultant, P.C., 3 Harbor Hill Drive, Huntington, NY 11743 USA; Tel: 516 427 0723. ▲

Cerium in Automobile Catalysts

A well-tuned engine still produces many pollutants caused by the incomplete combustion of the fuel. Exhaust gas mixtures contain by volume 1-2% CO, 500-1,000 ppm unburned hydrocarbons, and several thousand ppm NO_x. When hydrocarbons and NO_x escape into the atmosphere, they react photochemically and then condense on particulate matter to form visible air pollution, smog. Carbon monoxide, though not a component in smog, is an important toxin. Catalytic converters that reduce these three byproducts of combustion are referred to as three-way catalysts. The goal of the automotive catalytic converter is to remove all of these pollutants before they are forced out of the tailpipe.

Catalytic converters that depend on rare earth compounds are essential in converting pollutants from automotive engine emissions to relatively benign products. These devices are an integral part of all automobile exhaust systems manufactured since the mid-1970's (in the U.S.A. as a result of the 1970 Clean Air Act). They are durable and dependable especially when one considers the severe operating environment that they are subjected to. They must perform through rapid temperature fluctuations, an enormous number of on-off cycles, and vibration and shock that would shake apart any other chemical reactor. As government regulations reflect the mood for cleaner air and more stringent vehicle emissions standards, automotive catalytic converters must become more efficient. A recent paper reviews the state of the industry and research that is being conducted to improve catalytic converters {*C & EN*, **77**, [4], 36-44 (1999)}.

The original limits for pollutants in 1970 were set at 1.5 g/mile for hydrocarbons, 15 g/mile for CO, and 3.1 g/mile for NO_x. These limits were reduced in 1990 to be 0.25 g/mile for hydrocarbons, 3.4 g/mile CO, and 0.4 g/mile for NO_x. This not only put tremendous pressures on catalytic converter manufacturers to produce increased performance converters, but

Continued in next column ☛

by 1996, the devices were expected to last longer than 100,000 miles.

Catalytic converters are porous ceramic bricks (monoliths) that are coated with catalyst metals and a variety of support, additive, and stabilizer materials. An important component of catalytic converters are the oxygen-storage materials which keep fuel-to-air ratios at their stoichiometric value, about 14.6 by weight. They accomplish this by providing oxygen to the gas mixture during fuel-rich cycles, and absorbing oxygen in the fuel-lean cycles.

CeO_2 works best because of its ability to provide oxygen for thorough hydrocarbon and CO oxidation during periods when the engine is running rich. When the engine is running lean, Cerium is oxidized to Ce^{4+} which stores oxygen. When the fuel-rich cycle begins, Cerium is able to change oxidation states reversibly from Ce^{4+} to Ce^{3+}, providing oxygen for chemical reactions in the catalyst. However, when the exhaust temperatures exceed 850 °C pure cerium oxide in the catalyst suffers irreversible losses in its ability to store oxygen. This is due to sintering, which causes smaller particles to bond to each other and form larger particles, decreasing surface area and lowering the number of active sites available for catalytic reactions. Therefore, the Ceria is stabilized with zirconia to enable the oxide to withstand high temperatures. Pure Ceria reacts only on the surface, whereas zirconia-stabilized Ceria enables oxygen liberation-absorption throughout the material. An observation of three-way catalytic converters indicates that the addition of Cerium to a catalytic monolith allows for the decrease in the amount of precious metals such as Pd, Pt, and Rh used to achieve improved catalysis. ▲

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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).

199900020

PEREYRA;R ZUKJAS;E
Transformation behavior of Cerium
Advanced Materials & Processes, **155**, [2], 29-32 (1999)
1999 CE METAL
PHASE-DIAGRAM PHASE-TRANSFOR MICROGRAPH
TRANSFORMATION TRANSFORM-PRES TRANSFORM-TEMP
COOL-RATE-EFF

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. ▲

James W. Cunningham (1921 - 1998)

James W. Cunningham, a native of Tennessee, earned his BS in chemistry, with honors, from Murray State College in Kentucky. In 1946 he joined Owens Corning Fiberglas, Newark, Ohio, as a chemist. While at Owens Corning, he pioneered the use of spectroscopy for metallurgical analysis. Later, he headed chemistry laboratories for Cannon-Muskegon Corporation and Cameron Iron Works.

Rare earthers will remember Jim as the General Manager of Research Chemicals, a division of Nucor Corporation which was later purchased by Rhône-Poulenc. He worked for Research Chemicals for 25 years, and after his retirement, remained active by joining the board of directors, and also by serving as director and member of the Audit Committee for Nucor for seven years. ▲

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Since the December issue of the RIC News went to press, we have received support from 4 new family members and renewed support from 15 other organizations.

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ETREMA Expands

ETREMA Products, Inc., of Ames, Iowa, is planning a US$16 million expansion to increase production of its magnetostrictive alloys and "smart" material, Terfenol-D. The U.S. Navy uses Terfenol-D in sonar systems, but it has other uses as well, such as in aircraft wing flap motors, and for clamps on semiconductors.

The company is expected to add 67 new employees to produce more of the magnetostrictive alloy, and will complete a 20,000 square foot addition to its production facility this year so that it can develop new products and smart materials. Another phase of expansion will be completed in 2001, which will put the size of the company's production and administrative facility to 90,000 square feet. The company continues to work on expanding markets worldwide for its products.

ETREMA Products, Inc., 2500 North Loop Drive, Ames, IA 50010 USA; Tel: 515 296 8030/800 327 7291; Fax: 515 296 7168 ▲

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