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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NASA Contract to Energen

A Massachusetts company has received a US$278,599 contract from the National Aeronautics and Space Administration (NASA) to develop actuators for the Next Generation Space Telescope (NGST). Energen, Inc. will produce actuators that use a Dy-Tb-Fe magnetostrictive alloy. The actuators will provide ground-based operators the ability to control the telescope's reflective surface as well as fine focusing of the optical system. The system will allow precise adjustments to the telescope so that astronomers to obtain the clearest picture possible.

Chad Joshi, President of the company, says that "Energen's magnetostrictive actuators provide superior performance over current actuator technology" and that "We have attained exceptional positioning accuracy, increased stroke and high efficiency under even the most extreme environmental conditions, such as the cold of space". The ability of astronomers to see distant faint objects is directly related to the area and precise geometry of the primary mirror. NGST will have between 6 and 12 times the mirror surface area of the Hubble Space Telescope which will greatly extend our capabilities in visible and near infrared astronomy.

The company develops, manufactures, and markets actuators for precision positioning, robotics and active vibration control based on smart materials technology. For more information, contact Energen, Inc., 17D Sterling Road, Billerica, MA 01862-9876 USA; Tel: 978 671 5400; Fax: 978 670 9876; energen@tiac.net. ▲

Honor Roll

30 Years!

Davison Chemical Division of W.R. Grace & Co., USA

10 Years!

Albright & Wilson Americas, USA
Dept. of Industry, Science and Tourism, Australia
Lockheed Martin Research Corp., USA
North-Holland Physics Publishing (a Department of Elsevier Science Publishers), The Netherlands
Sausville Chemical Co., Inc., USA
Tokin Corp., Japan
Walker Magnetics Group, Inc., USA

This year we wish to honor eight companies for their long and dedicated support. Davison Chemical Division of W.R. Grace & Company becomes the first company in history to support RIC for 30 years. Congratulations!

We wish to express our appreciation and gratitude to all eight companies for their long and continued support. ▲

New Phosphor

A new luminescent inorganic compound, Sr_2CeO_4, has been synthesized by scientists at Symyx Technologies, 3100 Central Expressway, Santa Clara, CA 95051 USA; hweinberg@symyx.com {*Science*, **279**, pp. 837-9, (1998)}. The company prepared the new rare earth phosphor by using combinatorial chemical techniques which included electron beam evaporation and automated masking techniques. The phosphor was identified through parallel screening of more than 25,000 species that were created by automated thin film synthesis.

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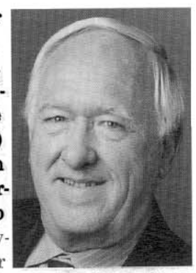
Honorary Professorship



Prof. Dr. Peter Wachter, Solid State Physics Lab. of the Eidgenössische Technische Hochschule (ETH) Zürich, has been awarded an Honorary Professorship from Hunan University, PRC, for his scientific achievements in the field of solid state physics of rare earths. Prof. Wachter is the first to receive this honor from the university, which was conferred by the Laboratory of Condensed Matter Physics, Physics Department, of Hunan University. The university was established 86 years ago and currently has over 10,000 enrolled students.

Dr. Wachter's honorary professorship was earned as a result of his research in rare earth compounds. He has conducted research on magnetooptical properties of rare earth chalcogenides and most recently, the optical properties of rare earth borocarbide superconductors. ▲

☛ *"Phosphor" from previous column*

The strontium cerium oxide phosphor, which emits a blue-white light, is made up of unusual one-dimensional chains of edge-sharing CeO_6 octahedra, with two terminal oxygen atoms per cerium center that are separated from one another by Sr^+ cations. The Sr_2CeO_4 molecule does not emit light from the usual mechanism originating from within the electronic states of a paramagnetic rare earth site, but from ligand-to-metal Ce^{4+} charge transfer mechanism. ▲

APMRC '98

The second Asia-Pacific Magnetic Recording Conference (APMRC) will be held in Singapore on July 29-31, 1998. The conference will cover the mechanical and manufacturing aspects of hard disk drives, and will be hosted by the Data Storage Institute. The technical program will be comprised of six consecutive sessions of 36 invited presentations which will cover the following topics: spindle, bearings, and motor design; HDD/actuator design; servo-control & TMR; HDI tribology / contamination; manufacturing technology; and microactuators.

For more information, contact B. Bhushan, Program Co-Chair, APMRC'98, Dept. of Mechanical Engineering, The Ohio State University, 206 West 18th Avenue, Columbus, OH 43210-1107; Tel: 614 292 0651/0171; Fax:614 292 0325; Bhushan.2@osu.edu, or visit the APMRC '98 Web Page at www.dsi.nus.edu.sg/events/apmrc. ▲

China Magnets 1998

The international conference "China Magnets 1998: Supply, Demand, Innovations and Markets for Magnetic Materials in China" will be held October 19-21 at the Friendship Hotel in Beijing, China.

The conference will highlight market trends, new technical developments and emerging business opportunities in the field of permanent magnets and magnetic materials in China. The conference will bring together Chinese permanent magnet manufacturers, raw materials suppliers, magnet and production equipment manufacturers with end users of these materials. Conference speakers will address matters of global supply, demand and pricing of magnets, magnetic materials and finished goods containing permanent magnets, to attendees. New applications of rare earth permanent magnets will appear in the automotive, medical, electronics and production industries.

For more information on "China Magnets 1998", contact Jennifer Winch, Gorham/Intertech Consulting, 411 US Route One, Portland, ME 04105 USA; Tel: 207 781 9800; Fax: 207 781 2150; info@intertechusa.com. ▲

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. ▲

June '98

3rd International Symposium on Metallic Multilayers (MML/EMRS 1998 Symposium)
Vancouver, British Columbia, Canada
June 14-19, 1998
RIC News **XXXIII**, [1], 2 (1998)

July '98

Strongly Correlated Electron Systems (SCES98)
Paris, France
July 15-18, 1998
RIC News **XXXII**, [4], 3 (1997)

Asia-Pacific Magnetic Recording Conf. (APMRC'98)
Singapore
July 29-31, 1998
*This issue

August '98

6th International Symposium on Magnetic Bearings
Cambridge, Massachusetts, USA
August 5-7, 1998
RIC News **XXXII**, [4], 3 (1997)

The 1998 Magnetic Recording Conference (TMRC'98)
Boulder, Colorado, USA
August 17-19, 1998
RIC News **XXXIII**, [1], 3 (1998)

15th International Workshop on Rare-Earth Permanent Magnets and Their Applications
Dresden, Germany
August 30-September 3, 1998
RIC News **XXXII**, [1], 5 (1997)
RIC News **XXXIII**, [1], 3 (1998)

September '98

Tenth International Symposium on Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys
Dresden, Germany
September 4, 1998
RIC News **XXXII**, [1], 5 (1997)
RIC News **XXXIII**, [1], 3 (1998)

7th European Magnetic Materials & Applications Conference (EMMA'98)
Zaragoza, Spain
September 9-12, 1998
RIC News **XXXII**, [1], 5 (1997)

Metallurgy of the XXIst Century: a Step Into the Future
Krasnoyarsk, Russia
September 22-26, 1998
*This issue (p. 3)

October '98

RE Beijing '98
Beijing, China
October 2-8, 1998
RIC News **XXXIII**, [1], 8-11 (1998)
Formerly ***International Forum on Rare Earths: Technology and Trade***
RIC News **XXXII**, [2], 4 (1997)

China Magnets 1998: Supply, Demand, Innovations and Markets for Magnetic Materials in China
Beijing, China
October 19-21, 1998
* This issue

Rare Earths '98
Freemantle, Western Australia, Australia
October 25-30, 1998
RIC News **XXXII**, [2], 5 (1997)
RIC News **XXXIII**, [1], 3 (1998)

Russia Conference

The international conference "Metallurgy of the XXIst Century: a Step into the Future" will be held in Krasnoyarsk, Russia September 22-26, 1998. The conference aims to estimate and substantiate the direction of scientific and technological progress in nonferrous metallurgy, to develop integration of scientific research to conserve resources, and to provide ecological security during the production of nonferrous and noble metals. In addition, the conference will deal with the problems of extraction and reworking of rare earth-containing minerals, challenges in rare earth metal production, and rare earth metal recycling.

For more information, contact S.V. Grigoryevich, 42 Karl Marx Str., Krasnoyarsk 660049, Russia; Tel: 7 3912 238 650; Fax: 7 3912 238 658. ▲

Partnership Opportunity

Qi Long Enterprise (USA) Inc., a rare earth marketing company, is seeking to develop a partnership program in rare earth and custom-made materials, including advanced technology distribution, with interested parties or individuals. For more information, contact Fan Luo, Sales Manager, Qi Long Enterprise (USA) Inc., 3301 Ocean Park Blvd., #108, Santa Monica, CA 90405 USA; Tel: 310 314 2291; Fax: 310 314 9935; E-mail: qilong@gus.net. ▲

Therald Moeller (1913-1997)

Therald Moeller, 84, died November 24, 1997, in Broken Arrow, Oklahoma. Dr. Moeller was professor emeritus at Arizona University. Moeller received a bachelor's degree in chemical engineering from Oregon State College in 1934 and then earned a Ph.D. in inorganic chemistry from the University of Wisconsin in 1938.

Dr. Moeller authored *Inorganic Chemistry* (1952) which was widely used as a college-level textbook in the 1950's, and *The Chemistry of the Lanthanides* (1963) while he was a professor of inorganic chemistry at the University of Illinois. ▲

Operations Suspended

Molycorp has suspended operations at its separations and specialty plant at Mountain Pass, California, due to concerns about the integrity of the wastewater pipeline. The suspension will reduce output of lanthanide products from the mine by about 50% and a reduction of the 230-member workforce is planned. However, the company will continue to operate the mine in order to produce bastnasite products.

For more information, contact Carl E. Concia, Molycorp, Inc., A Unocal Company, P.O. Box 3398, Wayne, NJ 07470-3398 USA; Tel: 973 942 8332; Fax: 973 942 8335; mcmpcec@mpmoly.unocal.com. ▲

YBM Expands

YBM Magnex International, Inc., recently announced acquisition of the rare earth permanent magnet facilities in Southport and Burscough, England that were operated by Philips REPM. Philips REPM was formerly a subsidiary of Philips Electronics. The facilities will now be operated under the name of Crumax Magnetics, Ltd., as a wholly owned subsidiary of YBM. The company will manufacture high energy permanent magnets and related products.

In addition, YBM is establishing a polymer bonded permanent magnet business in Newtown, Pennsylvania, which is currently under construction. The facility is scheduled to begin production of magnets and magnetic material this fall.

YBM Magnex, Inc. is accepting applications for various research engineering positions, including permanent magnet alloy development, magnet process development, polymer bonded magnet processing, magnet system design, application and manufacturing developments/factory automation.

For more information about the company or to apply for these positions, contact, YBM Magnex, Inc., 110 Terry Drive, Newtown, PA 18940 USA; www.thomasregister.com/ybm. ▲

"Smart Wings"

Etrema Products Inc., manufacturer of the magnetostrictive alloy Terfenol-D®, has been awarded a US$470,000 contract by Northrop Grumman Corp. The contract represents the second phase of a research and development project that is being funded by the U.S. Defense Advanced Research Projects Agency (DARPA). From 1995 to 1997, Etrema received US$260,000 to design and build a prototype of an aircraft wing actuator that uses Terfenol-D®.

The actuator drives a mechanism inside the aircraft wing which allows the wing to change shape in flight. The "smart wing" is designed to make commercial and military aircraft more efficient while in various flight regimes. The project has now progressed to the next higher level, which will address the requirements of aircraft speed, maximum actuation forces, controller development and testing of its Dy-Tb-Fe alloy actuator.

The company's prototype motor has fewer moving parts than conventional motors and should require less maintenance than motors currently used to raise and lower aircraft wing flaps. Another advantage is that the actuator is lighter and may be more reliable.

Also...

Etrema Products Inc. has won the National Institute of Standards and Technology Advanced Technology Program General Competition. The federally funded technology group is honoring the company for the development of its Terfenol-D® magnetostrictive alloys for use in ultrasonic transducers. The award was based on the potential for the positive impact that the company's material will have on the U.S. economy. Ultimately, the creation of thousands of new applications for the material may increase the number of jobs created by the increased demand in Terfenol-D®. ▲

Trading Halted

The Ontario Securities Commission halted trading of YBM Magnex International shares on May 13 for 15 days amid concerns raised by the

Continued on page 8, Column 1 ☛

Magnetism in Metals

The Symposium on Magnetism in Metals took place at the Royal Danish Academy of Sciences and letters in Copenhagen, August 20-26, 1996. The aim of the conference was to bring together a wide group of international experts in the field and to discuss and review recent developments in magnetism research. "Magnetism in Metals" presents 22 papers from the symposium in five sections: Introduction, Rare earths and actinides, Thin films and superlattices, Strongly correlated electrons, and General.

The first section "Developments in magnetism since the second world war" provides a glimpse of permanent magnets during the past fifty years and a semi-snapshot of rare earths in the same time period. It provides an interesting start to the Symposium, especially to those of us needing a background on the often-neglected topic of post-neolithic permanent magnet history (with apologies to those rare earthers who, it seems to some of us, have been around since the stone age). The next section contains three contributions, but the first: "Magnetic structures of rare earth metals" describes the recent developments in the understanding of the magnetic structures of holmium and erbium metals, and Ho-Er alloys, and the magnetic properties of Ho-Y and Ho-Lu alloys. The section on thin films and superlattices provides a review of recent experiments in lattice mismatch in Ho/Sc, helical order in Dy/Ho, magnetic order in Nd/Pr, and magnetism in mixed hexagonal close-packed/ double hexagonal close-packed (hcp/ dhcp) superlattices. The fourth section provides experimental results in strongly correlated electrons which includes spin dynamics, heavy fermion studies, photoelectron spectroscopy of cuprate superconductors, and magnetism of the high-Tc cuprate oxides $(La,Sr)_2CuO_4$ and $(La,Nd,Sr)_2CuO_4$. Finally, several papers dealing with magnetism in rare earth metals are grouped in the final chapter and deal with conduction electrons in magnetic metals, dilute magnetic alloys, and the results of x-ray magnetic scattering studies.

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The 443-page *Magnetism in Metals* was published in 1997 as Volume 45 of the Royal Danish Academy of Sciences and Letters. It is available for DKK500.00 (US$ 73.00) by contacting the academy, H.C. Andersens Boulevard 35, DK-1553, Copenhagen V, Denmark. ▲

Handbook Volume 24

The 24th Volume of the *Handbook on the Physics and Chemistry of Rare Earths* series is a veritable potpourri of topics concerning the physics and materials science of mostly metallic rare earth materials. The six chapters present an up-to-date, critical review of the formation of amorphous, microcrystalline and quasicrystalline phases by mechanical alloying, rapid solidification and casting, and surface magnetism, electron-spin resonance, exchange coupling in lanthanide-transition metal phases and the magnetic behavior of ternary rare earth stannides, including their crystal structures.

Chapter one, *Surface magnetism of the lanthanides*, reviews the magnetic surface properties of primarily gadolinium films. The discussion includes photoemission spectra, binding energies, surface band structures and surface states, radial charge densities and other properties of metallic Gd. A relationship between the Curie temperature and Gd film thickness is included. The next two chapters (160 and 161 in the series) *Mechanical alloying and mechanically induced chemical reactions* and *Amorphous, quasicrystalline and nanocrystalline alloys in Al- and Mg-based systems* reveal the mechanisms of are earth-alloy production. Chapter 160 covers ball milling, reaction milling, mechanical alloying and mechanical milling, mechanochemical combustion reactions including contamination effects and heat treatments, and the refining of metals and alloys. Chapter 161 reviews the formation, electrical and mechanical properties of binary and ternary rare earth-aluminum alloys (Al-R, Al-R-M where R= rare earth and M= transition metal). The rare earth-magnesium quasicrystals and amor-

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phous alloys, including extrusion and atomization techniques, are described in detail. The next two chapters *Electron-spin resonance on localized magnetic moments in metals* and *Intersublattice exchange coupling in the lanthanide-transition metal intermetallics* focus on ESR , impurities in rare earth metals and systems, and various magnetic properties of rare earth-transition metal compounds. The final chapter *Stannides of rare earth and transition metals* provides comprehensive coverage of binary rare earth-tin, and ternary rare earth-tin-transition metal compounds.

The 600-page hard cover Volume 24 was published in 1997, and in addition to the outstanding quality that we have come to expect from North-Holland publications, comes complete with author and subject indices which make the *Handbook* series such a useful reference tool. The book is available for NLG 475.00 (US$297.00) and can be ordered from the Elsevier Science customer service department nearest you. Customers in Europe should send their orders to: P.O. Box 211, 1000 AE Amsterdam, The Netherlands; Tel:31 20 485 3757; Fax:31 20 485 3432; nlinfo-f@elsevier.nl; in the Americas: P.O. Box 945, New York, NY 10159-0945 USA; Tel:1 212 633 3750; Fax:1 212 633 3764; usinfo-f@elsevier.com; in Japan: 20-12 Yushima 3-chome, Bunkyo-ku, Tokyo 113; Tel: 81 3 3836 0810; Fax: 81 3 3839 4344; E-mail: forinfo-kyf04035@niftyserve.or.jp; Singapore: No. 1 Temasek Avenue, #17-01 Millenia Tower, Singapore 039192; Tel: 65 434 3727; Fax: 65 337 2230; asiainfo@elsevier.com.sg. ▲

YAG Fibers

Small diameter, single crystal $Y_3Al_5O_{12}$ fibers have been grown in an improved edge-defined, film-fed growth process. The process was employed by the Advanced Crystal Products Corp. and Case Western Reserve University under contract for NASA Lewis Research Center, Cleveland, Ohio. Since yttrium-aluminum garnet (YAG) resists creep at high temperatures, fibers made of this material might be useful as high-temperature reinforcements in ceramic matrices {*Adv. Mater. & Proc.*, **152**, [5], 15 (1997)}. ▲

Handbook of Magnetic Materials

Volume **10** of the *Handbook of Magnetic Materials* is composed of topical review articles that deal with the magnetic properties of high-temperature superconductors, rare earth compounds and rare earths with non-magnetic metals, soft magnetic alloys, and the processing of rare earth permanent magnet materials. The four chapters are written by leading authorities in the field who present the information in textual, tabular, and graphic formats.

The first chapter, *Normal-state magnetic properties of single layer cuprate high-temperature superconductors and related materials*, following a review of the theory for the Heisenberg antiferromagnet, covers the experimental techniques used in determining magnetic susceptibility, heat capacity and neutron scattering of these materials. The article reports on the magnetic properties of $Sr_2CuO_2Cl_2$, La_2CuO_4, Nd_2CuO_4, and $(La,Sr)_2CuO_4$. The next chapter, *Magnetism of compounds of rare earths with non-metallic metals* deals with the basic magnetic properties, crystalline electric fields, and exchange interactions of various rare earth binary (RX_{2-6}, R_2X, R_5X_3, R_2X_{17}, RBe_{13} series and R_2Si_3) and ternary (RM_2X_2) compounds (X= Ag, Be, Cd, Cu, Ge, Mg, Ni, Pt, Sb, Zn, pnictides, chalcogenides and others, M= Co, Cr, Cu, Fe, Mn, and others). Chapter 3 mentions soft magnetic materials and the final chapter, *Magnetism and processing of permanent magnet materials*, is split between coverage of ferrites and rare earth permanent magnets. Although discussions of $Nd_2Fe_{14}B$ types predominate, other types, such as Nd-Fe-C, Sm-Co and interstitially modified R_2Fe_{17} and $R_3(Fe,M)_{29}$ (M= Cr, Mo, Si, Ti, V, W, Zr) compounds. Permanent magnet processing techniques are briefly reviewed.

The 668-page hard cover Volume **10** was edited by K.H.J. Buschow and published in 1997. In addition to the outstanding quality that we have come to expect from North-Holland publications, the book comes complete with author and subject indices which make

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the *Handbook of Magnetic Materials* series such a useful reference tool. The book is available for NLG 525.00 (US$329.00) and can be ordered from the Elsevier Science customer service department nearest you. Customers in Europe should send their orders to: P.O. Box 211, 1000 AE Amsterdam, The Netherlands; Tel:31 20 485 3757; Fax:31 20 485 3432; nlinfo-f@elsevier.nl; in the Americas: P.O. Box 945, New York, NY 10159-0945 USA; Tel:1 212 633 3750; Fax:1 212 633 3764; usinfo-f@elsevier.com; in Japan: 20-12 Yushima 3-chome, Bunkyo-ku, Tokyo 113; Tel: 81 3 3836 0810; Fax:81 3 3839 4344; forinfo-kyf04035@niftyserve.or.jp; Singapore: No. 1 Temasek Avenue, #17-01 Millenia Tower, Singapore 039192; Tel: 65 434 3727; Fax: 65 337 2230; asiainfo@elsevier.com.sg. ▲

Gmelin: Optical Spectra of Nd

The Nd^{3+} ion is one of the most important activator ions currently used in solid state laser crystals such as $Y_3Al_5O_{12}$ and $Y_3Fe_5O_{12}$ (YAG and YIG) garnets and are employed by researchers and industry worldwide. Other hosts for the Nd ion include rare earth fluorides, phosphates, molybdates and tungstates (especially CaWO4) and $LiNbO_3$. It was once thought that the only practical use for Nd^{3+}:$LiNbO_3$ was as a laser crystal, but we now know that it can be used in integrated optical devices, such as self-frequency doubled, self Q-switched, and mode-locked lasers. The divalent Nd ion is also interesting, although on a smaller scale than its cousin, Nd^{3+}, but nonetheless has been studied in $KMgF_3$, CaF_2, SrF_2, and BaF_2.

The latest Gmelin reference publication dealing with the optical spectra of rare earth ions in solid compounds *is Gmelin Handbook of Inorganic and Organometallic Chemistry*, 8th Edition, Sc, Y, La-Lu Series E: Optical Spectra of Ce-Lu, Volume **E2a**: *Optical Spectra of Nd* (the first was *Optical Spectra of Ce and Pr*, Volume **E1**, which was published in 1993). The 284-page hardcover Volume **E2a** was published in 1997 and includes data from literature up to 1995, but more

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recent data have also been included. The Gmelin Handbook series is well known for the wealth of information provided, and this volume is no exception. The book is adequately supplied with tables and includes 141 figures which illustrate primarily the luminescence and absorption spectra of Nd-doped compounds. Nd spectra in solutions are not included in this book, however, certain inorganic laser liquids based on aprotic acid halide solvents, which possess certain advantages over crystals and glasses, are briefly discussed. A 6-page section which contains some experimental results of these solutions is included.

Following two brief sections, one on Nd^{2+} in fluorides and the other on Nd^{3+} in the aforementioned solvents and inorganic liquid neodymium solutions, the book reviews Nd^{3+} in host crystals such as solid H_2O (ice), in alkali compounds such as $LiIO_3$, alkali halides and lithium iodate, and in LiF, Na, K, and Cs halides. The spectra resulting after hydrogenation is reported, as well as the effects of codoping and energy transfer, lifetime and quenching, and the effects of magnetic fields on emission is included. Alkali sulfates and phosphates such as $LiNH_4SO_4$, K_2SO_4, and $NaPO_3$ and alkaline earth compounds are reported which incorporate the Nd ion. Other compounds with a trivalent Nd ion that will interest researchers and engineers alike include alkaline earth aluminates, thiogallates and selenogallates, aluminum silicates, bismuth compounds, various germanium compounds, and others. There has been recent interest in Nd^{3+} in tungsten compounds such as CaWO4 and here the effects of doping and charge compensation, absorption and luminescence spectra, Stark level positions, pressure dependence and laser properties are reported.

The *Gmelin Handbook of Inorganic Chemistry and Organometallic Chemitry*, Volume **E2a**: *Optical Spectra of Nd* can be ordered by contacting the publishers: Springer-Verlag GmbH & Co. KG, Tiergartenstraße 17, D-69121 Heidelberg, Germany; Tel: 49 30 827 87 0; Fax: 49 30 821 40 91; orders@springer.de. The cost is DM 1,690.00 (US$1,056.25) per copy. ▲

Sc-Al Alloys

Sc Addition

The use of scandium in aluminum alloys for the aerospace industry was pioneered on a wide scale by the Soviet aircraft manufacturers. For years, their fighter and military aircraft utilized the advantages of the superior strength and lighter weight that scandium-aluminum alloys offered. One explanation for this was that the material was readily available to them at a lower cost than it was to western aircraft manufacturers at the time.

The advantages of scandium/aluminum alloys begins with metallurgy. Scandium is a potent agent when added to aluminum because its ability to refine grain size, inhibit crystallization, increase plasticity, enhance fatigue resistance, and provide greater strength to the alloy. In fact, scandium provides the highest increment of strengthening per atomic percent of any alloying element when it is added to aluminum {*Acta. Metall. et. Mater.*, **42**, 2285-90 (1994)}. When Sc-alloy is used in welding, the resulting weldment exhibits reduced hot cracking susceptibility {pp. 1222-6 of *Alumitech '97*, Atlanta, Georgia, USA, May 19-23, 1997 (1997)}.

New Products

Easton Sports, Van Nuys, California, is using scandium in it's new line of sports equipment, which includes baseball bats. The new bats are made of extruded Sc-Al alloy tubing which is welded to the handle. The alloys allow the walls of the bat to be 5% thinner, yet are stronger and lighter than the company's previous model. Other companies are developing consumer products that utilize the benefits of scandium aluminum alloys such as golf clubs, tennis rackets, welding wire, bicycles, and automobiles. In addition, the U.S. aircraft industry is exploring the benefits of scandium in its structural alloys, and boat hulls that are less prone to corrosion may be produced in the near future.

Sc-Al Alloy Licensing

Ashurst Technology, Ltd., Hamilton, Bermuda, has licensed its patented AlSc Alloys and AlSc-based products, such as tubing for bicycle

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frames, shock absorbers and handlebars to Easton Sports for use in its Sc7000 alloy bicycle frame tubing and accessories. The Sc-Al alloys are reported to be 50% stronger than conventional aluminum alloys currently used in bicycle frames, yet are up to 12% lighter {*Adv. Mater. & Proc.*, **152**, [5] 14 (1997)}. Since 1993, Ashurst Technology has been 34% owner of the huge Zhoti Vody mine in Ukraine, which is the only known primary scandium mine. ▲

Treibacher Celebrates 100th

Carl Auer von Welsbach, the Austrian chemist who discovered Lutetium and was the first to separate Neodymium and Praseodymium, also invented the incandescent gas mantle, the lighter flint, and the incandescent electric lamp that had a metal filament. The chemist turned industrialist in Vienna and in 1898 moved his operations to Treibach, Austria. The new company was named Treibacher Chemische Werke AG, and in 1993 was reorganized into Treibacher Industrie AG with Treibacher Auermet Producktionsges. m.b.H. as a 100% subsidiary. The company has a well established rare earth business which includes: nickel metal hydride alloys and other vacuum alloys; rare earth oxides and compounds for the glass, catalyst, ceramic and the electronics industry; rare earth metals and alloys, including mischmetal; and lighter flints.

The company will celebrate this milestone by involving its employees in intense training and education. For more information, contact: Dr. Otto Bohunovsky, Treibacher Auermet Producktionsges. m.b.H., Auer von Welsbachstraße 1, 9330, Treibach, Austria; Tel: 43 4262 505 411; 43 4262 2898; tau@treibacher.at. ▲

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H Storage in $LaNi_{5-y}Sn_y$

The intermetallic compound $LaNi_5$ possesses exceptional hydriding characteristics because of its ability to absorb as many as 6 hydrogen atoms per formula unit when placed in a 2 bar H_2 atmosphere at room temperature. This allows the solid alloy to store much more hydrogen than can be contained by liquefying hydrogen under pressure. Hence, it has received much attention by researchers in order to develop an efficient hydrogen storage alloy (the $LaNi_5$ phase is also used in metal hydride battery electrodes).

The interest in hydrogen storage alloys lies in the advantages of hydrogen as a fuel source; it is abundant, nearly inexhaustible, environmentally benign, and relatively easy to utilize. However, for utilization as hydrogen storage materials, alloys must possess not only excellent hydrogen absorbing characteristics, but also excellent *dehydriding* characteristics so that the fuel may be extracted from the storage material. Unfortunately, the ability of $LaNi_5$ to act as a hydrogen storage alloy tends to decrease due to thermal degradation from the hydriding-dehydriding cycles. One method to alleviate this problem is the substitution of Sn for Ni in the crystal lattice structure of the $LaNi_5$ to form $LaNi_{5-y}Sn_y$.

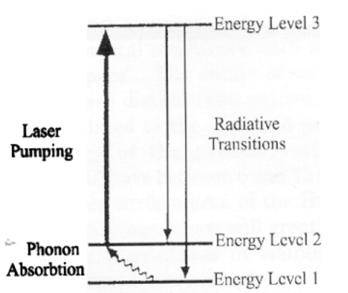
Recent research by a team led by J.M. Hughes, Department of Geology, Miami University, Oxford, OH 45056 USA {*Int. J. Hydrogen Energy*, **22**, [2/3], pp. 347-9 (1997)} was conducted on the phase $LaNi_{4.8}Sn_{0.2}$ to determine the positional disorder of the phase due to Sn substitution. Their single crystal studies indicate that although the established crystal structure of the compound appears to be correct, Sn substitution creates disorder within the crystal structure, leading to a decrease of La-Ni(c) interatomic distances by at least 0.2 Å. It is this positional disorder which may be the key to decreased thermal degradation of the alloy. Although further tests should determine more precisely the mechanism responsible for the disorder, the $LaNi_{4.8}Sn_{0.2}$ phase has shown to have greater resistance to degradation even after thousands of hydriding-dehydriding cycles. ▲

Optical Refrigeration?

It has been common practice in industry for years to use lasers to "burn through" a variety of materials ranging from metals, alloys and composites, to organic tissue. However, the idea to use laser light to actually cool a substance was first proposed in 1950, based on principles submitted as early as 1929, shortly following the discovery of anti-Stokes fluorescence {*Mat. Sci. Forum*, **239-241**, 501-04 (1997)}.

The concept has now been proven, at least in the laboratory, by researchers at Los Alamos National Laboratory. The experiment dealt with cooling Yb^{3+}-doped fluoro-zirconate glass optical fibers *in vacuo* from 298 K to 282 K by using a laser. The test began when the scientists radiated a continuous wave titanium-sapphire laser on a spot ~50 µm in diameter on the face of the fiber {*Phys. Rev. Lett.*, **78**, [6], 1030-3 (1997)}. As a result, the temperature of the glass decreased by 16 K.

The mechanism of optical cooling, the luminescent cooling of a solid in this experiment, begins with an ion with two excited levels, such as Yb^{3+} in glass, which yields a three-level optical cooling scheme (see figure, below).



A three-level optical refrigerator

Laser light of photon energy $E_L=E_3-E_2$ pumps an atom from energy level

Continued in next two columns

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2 to level 3. A radiative deexcitation moves the atom either to level 2 or to the ground state, level 1. If the atom is moved to level 2, the emitted photon has the same energy E_F as the absorbed laser photon and the system is unchanged. However, when the fluorescing photon (E_F) carries away energy $E_F=E_3-E_1>E_L$, there is a net shift of an excitation from level 2 to level 1. The thermal population of level 1 and 2 are then forced out of thermal equilibrium, which is restored when the atom jumps from level 1 to 2 by absorbing a photon of energy $E_P=E_2-E_1$, which decreases the thermal energy of the glass, resulting in a temperature decrease.

The success of the experiment has led to the establishment of the Los Alamos Solid-State Optical Refrigerator (LASSOR) {pp. 681-86 of *Cryocoolers 9*, R.G. Ross, Ed., Plenum Press, New York (1997)}. The Los Alamos team suggests that since optical refrigeration occurs on an atomic scale, the LASSOR could be constructed using a multitude of designs and sizes, depending on the desired application. They offer the possibility that three-level optical cooling LASSORs could provide 10-100 W capacity for cooling large mirrors, while smaller milliwatt models could be used for cooling small electronic components.

Optical refrigerators could have distinct advantages, because they would be vibration-free since there are no moving parts and their lifetimes would be measured in years since the limiting factor would be the durability of the diode laser. The cooling efficiency, operating temperature, and power density of a particular device would depend on the atomic properties of the cooling element.

Additional information on the LASSOR program can be found at: http://sst.lanl.gov/~edwards/cooling.html. ▲

RIC Database

The total number of documents referenced in our system is now over 95,000. 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).

199800830

MOMMER;N HIRSCHER;M CUEVAS;F KRONMULLER;H
Influence of the microstructure on the desorption kinetics of single- and multiphase LaNiFe alloys
Journal of Alloys and Compounds., **266**, pp. 255-9 (1998)

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. ▲

Velmer A. Fassel (1919-1998)

Velmer A. Fassel, 78, of Rancho Bernardo, California, died of cardiac arrest on March 4, 1998. Dr. Fassel was an integral part of the Manhattan Project during World War II while he was conducting research at Iowa State College, now Iowa State University (ISU), Ames, Iowa. While at ISC, he helped develop the uranium enrichment process for the production of pure uranium metal.

Following World War II, he continued his studies and earned his Ph.D. in physical chemistry in 1947. Two years later, Dr. Fassel joined the faculty in analytical chemistry at ISU. He later became a group leader in the continuation of the scientific research from the Manhattan Project which then evolved into the Ames Laboratory of the U.S. Department of Energy.

Dr. Fassel's scientific career was devoted to basic and applied studies of chemical analysis, and was well known for his pioneering work on developing inductively coupled plasma mass spectroscopy (ICP-MS). His system is now the world's industrial and research standard used in elemental trace analysis. ▲

☛ *YBM Halt Continued from page 3*

company's auditors. However, the trading halt was not expected to affect on the company's continuing operations or reported financial position.

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Since the March issue of the RIC News went to press, RIC has received support from 9 new family members and renewed support from 22 other organizations and individuals. The supporters from the third quarter of the 1998 fiscal year who wish to be listed, grouped according to their appropriate category, and with the number of years that they have contributed to the Center in parenthesis, are listed below.

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