Rare-earth Information Center NEWS

Center for Rare Earths and Magnetics
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Volume XXXV September 2000 No. 3

Ni-MH Batteries Put to Use in New Cars

Ni-MH batteries have been commercially available since 1990. Early work on hydrogen storage alloys, such as $LaNi_5$ and $MmNi_5$, began in the 1970s with the energy crisis that resulted from high oil prices. Microdesigning the composition, surface structure, and microstructure of the metal hydrides resulted in a functional corrosion resistant battery material.

With a 1.5 to 2 times greater energy density, fewer environmental problems, and less resource concerns than Ni-Cd, Ni-MH batteries are more expensive, but with strict disposal regulations for Ni-Cd batteries being enforced, Ni-MH are replacing Ni-Cd in the small rechargeable battery market. By 1997, Ni-MH batteries made up 40% of the small rechargeable battery market, accounting for 25% percent of the sales figures for that market.

The current preparation scheme for Ni-MH batteries is to make the MH electrode from $Mm(Ni,Co,Mn,Al)_5$-based alloy powder pasted on a Ni-plated sheet. The alloy is produced by rapid solidification followed by an appropriate heat treatment and chemical or physical processes to form a Ni-rich surface layer and increase surface area, improving reactivity and corrosion resistance. The Ni electrode is made of spherical $(Ni,Zn,Co)(OH)_2$ powder packed in a foamed Ni or nickel-fiber substrate, then coated with CoOOH. The two electrodes are separated for improving charge retention at high temperature.

Pure electric vehicles (PEV) have been made using Ni-MH batteries. These include models by Toyota, Honda, Mitsubishi,

Continued on page 6

Search of the Month

Ric Database

keywords PERMANENT-M ***AND*** ***keywords*** SPRING

MAGNETIC SPRINGS AND THEIR APPLICATIONS IN HYDRAULIC VALVES ——— 1992 (ND,B,FE) PERMANENT-MAG SPRING VALVE ACTUATOR FORCE APPLICATION

A SMCO5 FIELD DIRECT CURRENT LINEAR MOTOR WITH U-SPRING SUPPORTS ——— 1993 SMCO5 (SM,CO) PERMANENT-MAG DC-MOTOR SPRING DISPLACE-CURRE FREQUENCY

MAGNETIC VISCOSITY ON RECOIL CURVES OF EXCHANGE SPRING MAGNETS ——— 1994 ND2FE14B (ND,B,FE) MAG-VISCOSITY PERMANENT-MAG SPRING MAG-FLD-DEPEND MAGNETIZATION EXCH-COUPLED

MAGNETIC PROPERTIES OF SM-FE-(C,N) MELT-SPUN RIBBONS WITH A LOW SM CONTENT ——— 1994 (SMCFEN) MAG-PROP MELT-SPUN RIBBON COMPOSITION-EF ANNEALING CRYSTALLIZATIO EXCH-INTERACT HYDRIDE COERCIVITY SPRING PERMANENT-MAG NANOCRYSTALLIN X-RAY-DIFFRACT LATTICE-PARAM TEM MICROGRAPH MAG-FLD-DEPEND HYSTERESIS

The search above satisfies a search for references on permanent magnets **AND** springs. Many more citations would have been referenced if other terms were searched for in addition to springs, i.e., if the search was for permanent magnets AND springs OR magnetic bearings.

The database report, which is provided when the search is purchased, includes the keywords used for the search and the bibliographical information of the reference, along with other keywords associated with the reference, for each of the references found. A preliminary search, as shown above, will list titles and keywords of the items that match the request.

The cost to receive a list like this one is $50.00, and includes the reference list for up to 25 matches, and any additional matches are available for $2.00 each. Supporters can receive as many searches as needed for US$300.00 per year for corporate memberships, or US$100.00 for individual memberships.

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

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

In This Issue:

Journal of Alloys and Compounds, vol. 293-295

Volumes 293-295 of the *Journal of Alloys and Compounds* contain the Proceedings of the International Symposium on Metal-Hydrogen Systems – Fundamentals and Applications, Hangzhou, China, October 4-9, 1998. The editor-in-chief is K. H. J. Buschow, with editors G.-Y. Adachi and G. J. Miller and guest editors Q. D. Wang and Y. Q. Lei.

The proceedings are organized into three parts: Fundamentals, Materials, and Applications. Author and subject indices are also included.

The first part includes papers covering six areas of investigation: thermodynamics and phase diagrams; crystal structure and H-ordering; electronic structure and electric, magnetic, and optical properties; H-diffusion, tunneling, trapping, and mobility; surface and interface effects; and reaction kinetics. The crystal structure and H-ordering section includes a subsection devoted to rare earth-based alloys and hydrides. The main emphasis of the publication is on the fundamentals, as this first part is half the length of the book.

The second part includes papers on new metal hydrides, new properties and new phenomena; new methods; thin film, multilayers, and clusters; and nanocrystalline, amorphous, and composite materials. This is the shortest of the three sections, with its emphasis on nanocrystalline and amorphous materials and on thin film, multilayers, and clusters.

The third and final part contains papers that cover a variety of applications of metal-hydrogen systems currently in use and available for further development into future technologies. General areas of discussion are negative electrode alloys, MH-electrodes and H-insertion electrodes; Ni-MH batteries and fuel cells; hydrogen processing of materials; and H2 gaseous, thermal, and catalytic applications. The most lengthy section of this part by far is the first, on electrodes, the majority of which deals with rare earth alloys.

The symposium had 252 participants and 40 others in attendance from 30 countries. Of the 270 abstracts submitted to the symposium, 193 papers were presented. There were 19 invited papers, 66 oral presentations, and 108 poster presentations. A total of 170 papers were selected to be included in the published proceedings, 71 of which deal directly with rare earth materials. Overall, vol. 293-295 provide a thorough overview of the state of research and understanding of metal-hydrogen systems, and anyone interested in the field would find it a valuable resource.

The book is available from Elsevier Science for US$470. For more information, contact the regional office nearest you, which can be found at http//www.elsevier.nl. ▲

Conference Calendar

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

September '00
ICFE'4
Madrid, Spain
September 17 – 21, 2000
RIC News **XXXV**, [1] 3 (2000)

The Third International Conference "Noble and Rare Metals" (NRM-2000)
Donetsk, Ukraine
September 19-22, 2000
RIC News **XXXIV**, [1] 3 (1999)

Permanent Magnet Systems: From Concept Through Commercialization
Atlanta, Georgia, USA
September 25-27, 2000
*This issue

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
*This issue

September '01
Rare Earths - 2001
São Paulo - SP, Brazil
September, 2001
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)

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

Heavy Fermion Semiconductors

Heavy fermion semiconductors, also known as Kondo insulators, are the focus of a new review paper by Peter S. Riseborough, and published in *Advances in Physics* **49** [3] 257-320 (2000).

Kondo insulators are very narrow gap semiconductors that exhibit properties with unusual temperature dependencies. The paper reviews their properties and presents a mode of interpretation in terms of band structure, hybridization gaps, and quasi-particle lifetimes. Doping studies are presented, and theoretical descriptions of the materials using the mean-field approximation and effects of impurities are discussed along with areas of deficiency, and alternate approaches are mentioned.

The majority of the paper is focussed on the properties of the materials. Thermodynamic properties discussed include specific heat measurements, susceptibility measurements, and elastic properties. Transport properties mentioned are electron transport properties and thermal conductivity. The most attention is paid to spectroscopy studies, with optical, tunneling, inelastic neutron scattering, magnetic resonance, and photo-electron spectroscopies as the main areas.

The review requires careful attention to the text as there are few graphs or tables of data. The review cites 352 references, which should enable the interested reader to find detailed discussions on most of the topics covered.

This is a fairly thorough review of the heavy fermion semiconductors, with emphases on $Ce_3Bi_4Pt_3$ and FeSi, which were selected for how well they fit within the standard model and whether they have gaps large enough to be observed with spectroscopic studies. Some discussion is also included on CeNiSn and CeRhSb, which were at one time considered heavy fermion semiconductors, but which have since been reclassified as semimetals. ▲

Newsletter on the Web

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

1st Annual Conference on Permanent Magnet Systems

The First Annual Conference on Permanent Magnet Systems, entitled *Permanent Magnet Systems: From Concept Through Commercialization*, will be held September 25-27, 2000, in Atlanta, Georgia. This conference will bring together permanent magnet systems designers, developers, and manufacturers; permanent magnet manufacturers; raw materials manufacturers; processing, testing, magnetizing, and manufacturing equipment producers, and users of permanent magnet systems.

The conference session schedule includes many presentations that should prove interesting. There is a panel discussion devoted to NdFeB magnets scheduled the final day of the conference, and several of the presentations in the concurrent sessions mention NdFeB in their titles. Many presentations on the applications of permanent magnets will take place, and the keynote session will include four topics that seem especially interesting and pertinent. The optional pre-conference workshops also should provide insight into magnet and magnetic systems design.

For more information, visit their web site at www.goradv.com or send e-mail to gorham@goradv.com, or contact Victoria Grant, Gorham Conferences, 211 Mosher Road, Gorham, ME 04038 USA, Tel: 207-892-5445, Fax: 207-892-2210. ▲

DPC '01

The International Conference on *Dynamical Processes in Excited States of Solids* will be held July 1-4, 2001, at the Université Claude Bernard Lyon 1, France. DPC is a cross-disciplinary meeting for scientists interested in theoretical and experimental aspects of the dynamics of excited states in condensed matter in physics, chemistry, life sciences, and material sciences.

Emphasis is on the underlying fundamental aspects, common to all of the above fields, in the areas of dynamics of highly excited states of solids; energy transfer and exciton dynamics; electroluminescence; electron-photon interaction and phonon dynamics; photoinduced large amplitude motions, cooperative motions, and phase transitions; quantum optics; coherent and nonlinear spectroscopy, ultrafast phenomena; and spectroscopy of nanoscale and single nano objects.

For information, you may contact the conference secretariat at: Chantal Iannarelli, Congrès Scientifiques Services, 2 Rue des Villarmains, F- 92210 Saint-Cloud, France, Tel: 33 (0)1 47 71 90 04, Fax: 33 (0)1 47 71 90 05, e-mail: c2s@club-internet.fr. The scientific secretariat may be contacted at: Marie-France Joubert, LPCML< UMR 5620 CNRS, Université Claude Bernard Lyon 1, Bât. 205, 43, Boulevard du 11 novembre 1918, F- 69622 Villeurbanne cedex, France, Tel: 33 (0)4 72 44 83 39, Fax: 33 (0)4 72 43 11 30, e-mail: joubert@pcml.univ-lyon1.fr. Or, visit their web site at http://pcml.univ-lyon1.fr/DPC01/welcom.html. ▲

Rare Earths/Specialty Metals Business Taken Over By High-Tech Materials

High-Tech Materials of Longmont, Colorado, acquired the rare earths and specialty metals business of TradeTech, LLC, of Denver, Colorado, in March. This transaction includes all materials trading, consulting, and information services related to rare earths and specialty metals, including the publication *Elements*, a monthly newsletter dedicated to rare earths and specialty metals. TradeTech will continue its consulting and information services for the international nuclear fuel industry. For more information, contact: Treva E. Klingbiel, TradeTech, LLC, Tel: 1 (303) 573-3530, Fax: 1 (303) 573-3531, e-mail: mail@tradetech.com, or Richard J. Vito, High-Tech Materials, Tel: 1 (303) 772-0678, Fax and Voice: 1 (562) 750-6013, e-mail: kartrace@gateway.net. ▲

NEWS FROM JAPAN

New Fuel Cells Achieve High Output Density at Low Temperatures

Researchers at the National Industrial Research Institute of Nagoya and Nagoya University have jointly developed a new type of solid oxide fuel cells (SOFCs), as reported in the *Nikkan Kogyo Shibun* published June 16. A single-chamber fuel cell design, where the anode and cathode are exposed to the same mixture of fuel and air, was applied to a SOFC constructed of yttria-stabilized zirconia (YSZ), a Ni-based anode, and a perovskite cathode. However, this design must operate at 1223 K to achieve sufficient ionic conduction.

Cation-doped ceria compounds, especially samaria-doped ceria (SDC), have greater ionic conduction that YSZ in an oxidizing atmosphere, and n-type semiconducting behavior in a reducing atmosphere. The partial pressure of oxygen gradually becomes lower as the operating temperature decreases, suggesting that the SDC can be used under fuel cell conditions, as long as it operates at extremely low temperatures. The combination of the low operating temperature with the single-chamber design has been demonstrated as a successful SOFC design.

Smallest NiMH Battery

Matsushita Battery Industrial Co. has begun mass-production of slimmer and lighter type NiMH batteries than AAA size, the first of its kind. These batteries are expected to be exported initially to European markets for use in mobile phones. The batteries are available in two models of different dimensions and capacities. Reported June 21 in the *Kagaku Kogyo Nippoh*.

Chinese Rare Earth Prices Surge

Chinese exports to Japan, which account for 70% of Japan's imports, have increased in price significantly since the end of last year. Government controls of Chinese exports are likely to cut production in China by 20-30%. These cuts, accompanied by increased Japanese demand for rare earths for magnets and rechargeable batteries, have driven up prices by as much as 100% or more. Information from the July 5 issue of *Nihon Keizai Shinbun*.

MQI Begins Operations in China

Magnequench International Inc. is producing a NdFeB powder, MQP, for making bonded magnets in its new plant in Tianjin City, China. Magnet manufacturers have begun to be sent samples from the new plant, and MQI plans to have produced 500 tons of the powder by the end of the year. Full-scale shipments to manufacturers are scheduled to begin by the end of August. The new plant is located on a site adjacent to Nd suppliers, thus reducing costs. About 80% of the market for MQP is expected to be in Japan. ▲

Lanthanum Quits Periodic Table of Elements

STOCKHOLM, SWEDEN—The world of chemistry was shaken Monday by lanthanum's announcement that the popular 57th element will quit Transition Group IIIb of the periodic table at the end of the summer. "I have nothing but good things to say about my time with the periodic table," said the ductile, silvery-white metal, speaking from the site of its discovery by Carl Gustav Mosander in 1839. "Nevertheless, I will be stepping down after Labor Day to focus on my own earth-metal solo projects." Rumors of a longtime feud with molybdenum and the constant demands of lens manufacturing are believed to be behind the departure.

--From the June 7, 2000 edition of *the ONION* **36** [21] (2000), www.theonion.com ▲

Monte Carlo Models

A recent review article by A. Lyberatos, "Monte Carlo models of the magnetization reversal in thin films with strong perpendicular anisotropy," was published in volume 33 (2000) of the *Journal of Physics D: Applied Physics*. This article offers an overview of Monte Carlo models, simulations, and algorithms used to describe the magnetization reversal in thin films of Tb-Fe-Co amorphous alloys, ultra-thin Au/Co/Au magnetic films, CoPt-alloy films, and CoNi/Pt and Tb/Fe multilayers. Magnetization reversal in these materials is of interest due to potential applications in magneto-optic recording media, and also to the possible integration of magnetic elements with semiconductor microelectronics.

A detailed description of the qualities an effective model must possess is presented at the beginning of the article, along with a rationale for the validity of using Monte Carlo models, which neglect domain wall details. A comparison and correlation between different Monte Carlo models is the primary objective of this paper, a goal that is attained in the remainder of the paper.

Cell models are presented for both homogeneous thin films and inhomogeneous films. Demagnetization energy calculations, energy change calculations, lattice effects on domain growth, and Monte Carlo simulations for thin films are all presented in the discussion on homogeneous thin films. Pinning is the emphasis in the section on inhomogeneous films, with an extensive presentation and discussion of micromagnetic and mesoscopic models of pinning by defects of low wall energy, and a shorter discussion of pinning by defects of high wall energy. Discussions of a Monte Carlo method with an energy barrier, Monte Carlo simulations, magnetic viscosity simulations, hysteresis loop simulations, domain avalanche simulations, and simulation of the effects of a dispersion in coercivities are all presented as part of the low wall energy section.

Ising models and the relationship between Ising models and micromagnetic models follows. Comparisons are made for homogeneous thin films and inhomogeneous films, with the latter accomplished through both a random-field Ising model and a random-bond Ising model. Finally, a section

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Alexandr Kamarzin

Alexandr Kamarzin, whose scientific activity was fully dedicated to investigations on rare earth compounds, died on April 10, 2000, in Novosibirsk, Russia, at the age of 65. After completion of Chemical Technological Mendeleev Institute in Moscow in 1958, Alexandr Kamarzin bound up his activity with the development of Inorganic Chemistry Institute of Siberian Branch of Russian Academy of Sciences in Novosibirsk. Since 1989, he was head of the Laboratory of Synthesis and Crystal Growth of Rare-Earth Compounds. He is the author of more than 150 papers and patents on methods of synthesis and characterizations of rare earth sulfides, oxysulfides, pure rare earth metals and intermetallics, as well as hydrides and borides.

With respect to rare earth sulfides, he has developed the hypothesis of radical (LnS)+ construction of Th_3P_4-type Ln_2S_3 sulfides, and considered the participation of (LnS)+ ions in chemical reactions. He was the first to prepare large (centimeter) scale transparent stoichiometric monocrystals of Ln_2S_3 crystals, grown in sulphur vapor.

Alexandr Kamarzin did much for the development of research on rare earths in Russia; the development of international scientific cooperation, organizing international seminars on rare earth compounds in Novosibirsk; and participating as a true scientific partner to the development of rare earth sulfides applications. ▲

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relating the domain structure and the thin-film material properties is presented.

Overall, this article is a good review of Monte Carlo models. The paper includes one table, eight figures, and 61 equations, and cites 86 references, all of which help clarify and illustrate the main points of the article. ▲

Corrections:

- The e-mail address for information for *ICRE-2001* should be CSRE@263.net.
- The correct e-mail address for Dr. Yuriy Paderno (Consultant's Corner, *RIC News* **XXXV** [1] 5) should be paderno@ipms.kiev.ua.

Consultant's Corner

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

- **AScI Corporation-Environmental Testing Laboratory**: Contact Christopher Gross, Analytical Chemist, 4444 Airpark Boulevard, Duluth, MN 55811, Telephone: 218-722-4040, Fax: 218-722-2592, e-mail: etl@ascicorp.com, URL: http://www.ascicorp.com. ▲ Areas of expertise: Analysis of rare earth metals, oxides and alloys; also other materials such as ceramics, quasicrystals, magnetic materials, dielectric alloys and others. Methods employed: instrumental (ICP-AES, GFAA, UV/VIS, EDXRF, inert gas fusion, combustion) for the determination of impurities as well as nominal composition. Also classical methods such as colorimetric, titrimetric, pyrohydrolysis, and hot vacuum extraction.

- **Liyang Founder Rare Earth Co. Ltd**: Contact Dr. Damon F. Cheng, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, China, Tel: +86 10 62754179, Fax: +86 10 62754179, e-mail: fxcheng@lyfounder-re.com, URL: www.lyfounder-re.com. ▲ Areas of expertise: marketing, supplies, separation of individual rare earth, and Simulation and Optimization for Rare Earth Countercurrent Extraction.

- **Quant Corporation**: Contact David C. Marshall, 400 Travis Lane, Unit 28, Waukesha, WI, USA, Telephone: 262-513-1900, Fax: 262-513-5960, Toll Free: 800-216-9474, e-mail: quant@execpc.com. ▲ Area of expertise: 34 years experience in the chemical analysis of rare earth elements in magnet metallic alloy, and battery materials using classical wet-chemical techniques and state-of-the-art instrumentation (ICP-OES, etc.).

- **Dr. Matvei Zinkevich**, Institute of Solid State and Materials Research Dresden, P. O. Box 27 00 16, D-01171 Dresden, Germany, Telephone: +49 351 46 59 685, Fax: +49 351 46 59 452, e-mail: m.zinkevich@ifw-dresden.de, URL: http://w32n4mz.ifw-dresden.de. ▲ Areas of expertise: Rare earth transition metals compounds: synthesis and crystal structure investigations; Phase diagrams of alloy systems with rare earths: experimental studying and computational thermodynamics.

Honorary Doctorate Awarded

Dr. Renata Reisfeld was awarded the designation of Doctor Honoris Causa at the University of Bucharist in November 1999. She has many achievements in physics and quantum chemistry, including work with crystalline and amorphous luminescent systems and systems doped with transitional elements. Her work has addressed problems in basic science and in a wide array of applications, including lasers, phosphors, scintilators, and solar energy convectors.

She has been on the editorial board of several prominent journals, and has published hundreds of scientific papers. She co-authored a book, *Lasers and Excited States of Rare Earths*, published by Springer Verlag in 1977. Much of her work is focussed on the spectroscopy of rare earths in glasses, including theoretical modeling, characterization, and practical applications.

Dr. Reisfeld is currently a professor at the Hebrew University of Jerusalem, where she is actively involved with scientific cooperation between scientists of Israel and Romania. ▲

Endohedral Structures

Endohedral structures are based on carbon fullerenes that encapsulate other atoms or molecules. The most well known fullerene is C_{60}, but larger molecules exist, such as C_{70}, C_{76}, and C_{84}, with the larger fullerenes having lower symmetry than C_{60}. The spheroid structure of these molecules encloses a volume amply large to contain other atoms or small molecules in the interior of the fullerene. An article published in *Uspekhi Fhzicheskikh Nauk* **170** [2] 113-142 (2000), and in English in *Physics-Uspekhi* **43** [2] 111-137 (2000), offers an overview of endohedral structures.

The article begins with an introduction of fullerenes that gives the reader a good sense of the work done on this molecule since the 1985 discovery of C_{60}. The Nobel Prize for Chemistry in 1996 recognized this discovery as one of the most notable scientific advances of the 20th century. The development of a method to produce fullerenes in macroscopic quantities in 1990, synthesis of carbon nanotubes, and the development of endohedral fullerenes were important steps in the growth of the field, with endohedral structures being a significant example of artificially designed structures. In endohedral metal fullerenes, all or part of the valence electrons of the metal are transferred to the outer surface of the fullerene molecule. This fills existing electron vacancies and imparts chemical properties unique to endohedral fullerenes, which are different from both empty fullerenes and individual metal atoms.

The first major section of the article discusses the methods of production and purification of endohedral fullerenes. Several methods are presented, including laser sputtering, an electrical arc method, a gaseous method, ion implantation, and a section on "other methods," which include nuclear and radiation methods not in wide use. A subsection on extracting endohedral fullerenes from a fullerene soot is also presented.

A section on the structure of endohedral fullerenes includes discussions on NMR, PMR, electronic structure, the position of atoms inside the fullerene cage, and the dynamics of the encapsulated atoms. This is followed by a section on endohedral fullerites, with discussions on aggregation and crystal structures. The chemistry of endohedral fullerenes is discussed, followed by a section on filled carbon nanotubes. The conclusions section of the paper includes a good review, as well as a short discussion on direct applications, which at this time are relatively few.

Why, might you ask, is a review of a paper on carbon structures included in a newsletter devoted to rare earths? The reason this article is included here is that many of the sections of the paper deal directly with rare earth elements as the atoms inserted into the fullerenes. The prevalence of the rare earths throughout the paper, as well as the basic discussions on fullerenes presented, make this an interesting and informative review of the subject. ▲

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Mazda, Subaru, Suzuki, Nissan, and Daihatsu. Maximum driving ranges, battery storage energy, and speeds vary between the developed models, with driving range per charge varying from about 55 km to about 240 km. PEV cost more than twice the price of a regular gasoline car.

Another use of Ni-MH batteries is in hybrid electric vehicles (HEV). These vehicles use the battery for starting and low speeds, and a gasoline engine for higher speeds. They are less expensive than PEV, and have significantly lower emissions and higher gas mileage than standard gasoline vehicles. Toyota currently has a version on the market, and other companies have HEV in development.

Fuel cells (FC) operate at efficiency of about 60%, twice that of an internal combustion engine. A FCEV has been developed by Daimler-Benz that operates solely on a FC system, and Toyota has developed a hybrid FCEV with a FC system and a Ni-MH battery, as has Mazda. FC vehicles are expected to be the wave of the future, but are currently not available to the public.

If PEV, HEV, and FCEV become more popular, as a result of environmental concern or the desire for greater fuel efficiency, Ni-MH batteries could be prevalent in cars throughout the world.

Information for this article comes from the *Journal of Alloys and Compounds* **293-295** (1999) 762-769. ▲

Advanced Hard and Soft Magnetic Materials

April 5-9, 1999, was the MRS Spring Meeting in San Francisco, California. The proceedings of Symposia H, I, and some of L are published in volume 577 of the Materials Research Society Symposium Proceedings, entitled *Advanced Hard and Soft Magnetic Materials* (ISBN 1-55899-485-8).

The proceedings illustrate many of the recent advances in magnetic materials, which have been attained through the ability to structure materials on an appropriate magnetic length scale. This length is approximately the exchange length or domain wall width of a hard phase, and is on the scale of a few nanometers. If the grain-size of the materials becomes close to this length, then the properties within the grain vary significantly from the properties of the bulk. Examples include remanence enhancement, exchange spring behavior, vanishing anisotropy, and volume-averaging of magnetostriction. Materials processing issues often center on the need to control nucleation and crystal growth on a very small length scale, and also on grain boundaries and the exchange coupling across them. These problems and advances are addressed in the papers of volume 577.

Some interesting points in the book include an explanation and helpful diagram in an article on exchange springs; some interesting micrographs, crystal structure diagrams, and electron diffraction images on $RE_3(Fe,V)_{29}$ materials; and articles on applications of magnetic materials, especially one on Air Force applications. There is even a little magic, as magic mangles and cylinders are discussed in one of the papers.

Overall, this book contains a large quantity of useful and intriguing information, and shows the current state and diversity of the field of magnetic materials. Of the 72 papers included in this 629-page publication, 40 deal directly with rare earth materials. For more information, contact Materials Research Society, 506 Keystone Drive, Warrendale, PA 15086-7573 USA, Tel: 724 779-3003 Fax: 724 779-8313, e-mail: info@mrs.org, or on the Web at http://www.mrs.org. ▲

Effects Between Adsorbed Molecules and High-temperature Superconductors

Recently, a review by L. L. Makarshin, D. V. Andreev, and V. N. Parmon was published in the *Russian Chemical Review* **69** [4] 279-305 (2000). The review is entitled: "The Chemical and Adsorption Effects of Foreign Molecules on the Properties of High-temperature Superconductors." It appears to be a comprehensive review on the effects between adsorbed substances and the high-temperature superconductors (HTSC) $(La,Sr)_2CuO_4$, $YBa_2Cu_3O_{7-x}$, and $Bi_2(Ca,Sr)_3Cu_2O_z$. Included in the discussion are the effects of simple compounds and organic molecules on the superconductor and effects of the superconductor on adsorbed molecules. Specific features of physicochemical properties of HTSC are included as a prelude to the rest of the paper.

Simple compounds treated include oxygen, hydrogen, halogens, CO_2, water, argon, helium, and nitrogen. Discussion includes transitions between different crystal structures, effects of adsorbed molecules on superconductivity, effects of the molecules on stability and decomposition of the HTSC, and effect of non-oxygen molecules on oxygen content of the HTSC. Several organic molecules are mentioned in that portion of the paper, and the discussion is divided into adsorption of the molecules and intercalation of the molecules into the crystal structure of the HTSC. Primarily, the effect of different adsorbed molecules on T_c is discussed, with some mention of their effect on critical currents and on the character of the susceptibility curves of the HTSC. The intercalation discussion is more on the physical and magnetization effects, but superconductivity effects are also mentioned. The effects of the superconductor on the adsorbed molecule focus on the electrical state of the molecule and such properties as specific surface, heat transfer, fluorescence lifetime, among others.

Several figures, 5 numbered and several other equations, and 280 references support the discussion and conclusions of this work. The paper is a good overview, and is an interesting read. ▲

Finite-temperature Properties of Doped Antiferromagnets

J. Jaklič and P. Prelovšek have presented a review of doped cuprate antiferromagnets in their article, "Finite-temperature properties of doped antiferromagnets," as published in *Advances in Physics* **49** [1] 1-92 (2000). Their article includes an overview of the current understanding of anomalous normal-state cuprate properties, an extensive discussion of a model to help describe and predict cuprate properties, the presentation of the properties predicted by the model, and areas where questions are left open.

The reference materials for this study were La_2CuO_4 and $YBa_2Cu_3O_6$, whose properties are relatively well understood. The behavior of other cuprates can be understood when taken in the context of doped reference materials. The understanding and description of these materials is a theoretical challenge. Most methods use calculations for the ground state, T=0. The method presented in this paper addresses systems at T>0 by using Lanczos techniques and random sampling. The finite-temperature Lanczos method (FTLM) and the *t-J* model obtained using this method are presented and discussed extensively in this article.

Following the discussion of the FTLM, predictions for thermodynamic properties, electronic properties, magnetic properties, spectral properties, and a few other properties are presented. Whenever possible, comparisons are made to experimental data. The authors show the validity of their work through the correlation between the model and experimental data, even on a quantitative level for some properties.

Open questions include theoretical explanation of the marginal Fermi liquid dynamics in the intermediate doping regime, the explanation of the development of a Fermi surface in the underdoped region as the hole concentration approaches 0, and the description and verification of thermodynamic properties at very low doping. Not covered in this review is the Hall effect, as its inclusion would make calculations much more difficult.

The results and discussion are extensive throughout this 92-page article. To support the authors' arguments, 119 equations and 48 figures are used, and 187 references are cited. ▲

Magnetism Beyond 2000

The 200th volume of the *Journal of Magnetism and Magnetic Materials* is a collection of 46 invited review articles, edited by Arthur J. Freeman and Samuel D. Bader. The articles, while not intended to be all-inclusive, cover many of the most important topics in magnetism science and technology today. The publication of Vol. 200 is just 8 years after Vol. 100 was published, which shows the tremendous growth of research in the field of magnetism and magnetic materials.

Many topics are covered in this volume, ranging from colossal magnetoresistive materials to giant magnetostriction, from quantum tunneling to quantum phase transitions, from magnetic refrigeration to perpendicular magnetic recording, from multilayers to bulk materials and their surfaces and interfaces, and from polarized-neutron reflectometry to x-ray magnetic scattering.

The book is beautifully produced, with a blue cover featuring a color image of the molecular structure of Fe18 antiferromagnetic iron(III) ring, and several color images and graphs, as well as many black and white figures, help add to the visual appeal of the book. Overall, this volume can serve as an important tool to provide insight into the current state of magnetic research and applications, and would provide a strong basis in magnetics to any scientist with even a casual interest in magnetism and magnetic materials.

This 820-page book, ISBN 0444503374, is available for US$213 from Elsevier Science, P. O. Box 211, 1000 A E Amsterdam, The Netherlands, Tel: (+31) 20 485 2603, Fax: (+31) 20 485 2425. In the U. S. A. or Canada it is available from Elsevier Science Inc., P. O. Box 945, Madison Square Station, New York, NY 10160-0757, U. S. A. ▲

Charles James, Revisited

In the June 2000 issue of the *RIC News*, there was an article devoted to Charles James and his work on separation of rare earth elements. We received a nice response to this article from Dr. Per O. Enghag, at MATERIALTEKNIK HB, in Örebro, Sweden. He wrote to inform us that he has written a trilogy, with support of the Swedish National Committee for Chemistry, on the discovery of elements on earth. Volume II of this set is dedicated to rare earth metals, noble metals, noble gases, and naturally occurring radioactive elements.

Dr. Enghag states that Charles James' contributions are addressed in volume II, and also that the simultaneous discovery of element 71 (lutetium) was made by Auer von Welsbach in Austria and Georges Urbain in France. James' work was the most important, as he was able to obtain larger quantities than his European counterparts. Dr. Enghag's books are now available in schools across Sweden, and he states "…Charles James will not be forgotten here."

At this time, the books are only available in Swedish, although Dr. Enghag says an English translation is planned. ▲

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Since the June issue of the *RIC News*, we have received support from one new family member and renewed support from 16 other organizations and individuals.

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