



NEWS

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Double Exchange and Manganites

Yu. A. Izyumov and Yu. N. Skryabin have written a review devoted to the explanation of the physics of colossal magnetoresistance based on the double exchange (DE) model. The review, "Double exchange model and the unique properties of the manganites," was published in *Physics-Uspel* **44** [2] 109 – 134 (2001).

The introduction to the paper provides a short overview of manganites, and focuses on $(La,A)MnO_3$, where A is a bivalent atom in the sequence Ca, Sr, Ba, etc. The crystal structure, dependence of resistivity on temperature and concentration, magnetoresistance, and a typical magnetic phase diagram are presented, along with an introduction to electron models. The electron model employed is the DE model, which uses a two-term Hamiltonian, the first term describing the motion of an electron over lattice sites, and the second term accounting for the Hund exchange coupling. However, to describe real manganites, more terms and considerations are needed to properly interpret the Hamiltonian.

Next the effective Hamiltonian of the DE model is discussed, as well as the idea of quantum spin and its application to the exchange Hamiltonian, the properties of the DE model in the dynamical mean field approximation, especially using the classical spin model, and an analysis of the numerical results obtained using this model. The relationship between the Curie temperature and the kinetic energy, a simplified double exchange model, the coherent potential method, and a variational approach to the mean field approximation and how each specifically affects the DE model being used

are explained.

The article describes how the magnetic phase diagram for manganites can be determined. Detailed information on the steps taken in applying Monte Carlo calculations and the DE model to the phase diagram are presented, along with several figures illustrating the magnetic phase assemblage. Two areas that add to the model to make it fit even better are added as well. The first is on orbital degeneracy, and the second is on the effects of electron-lattice interaction. Both topics show the modifications necessary to the model and then compare the theory to experimental results.

There are problems that remain in the physics of manganites. One is the metal-insulator transition. The problem arises in describing the paramagnetic phase at ferromagnetic compositions. Three possible mechanisms for how this can occur are presented. Another problem is that of charge ordering. The problem here is the formation of stripe domains. These domain structures have been observed experimentally, but not predicted theoretically, and their formation mechanism and impact on physical properties of the material is not yet known.

The entire work is explained carefully and the reasoning behind the theory is clearly presented. The conclusions of the authors are supported by 20 figures, 119 references, and 124 equations. For more information, Yu. A. Izyumov and Yu. N. Skryabin can be reached at the Institute of Physics of Metals, Ural Branch of the Russian Academy of Sciences, ul. S. Kovalevskoi 18, 620219 Ekaterinburg, Russian Federation, Tel: (7-

3432) 74 41 93, Fax: (7-3432) 74 52 44, e-mail: Yuri.Izyumov@imp.uran.ru. Also, another article reviewed in this issue, entitled "Perovskite Oxides," is related to this topic.



ASC 2002

The Applied Superconductivity Conference, ASC 2002, will be held at the George R. Brown Convention Center in Houston, Texas, August 4 – 9, 2002.

The Applied Superconductivity Conference is the premier conference on applied superconductivity held biannually in the United States. The conference will include invited talks, oral and poster presentations, and exhibitions highlighting the latest developments in the field. Workshops and tutorials are being planned for the weekend before the conference. Contributed papers are being solicited in three general areas of applied superconductivity: Large Scale, Electronics, and Materials. Abstracts must be submitted by February 15, 2002.

For more information about the conference, abstract instructions and submissions, registrations, hotel reservations, and other information, please visit www.ascinc.org. The Conference Chair is Paul C. W. Chu, and the Program Chair is Donald Gubser. ▲

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HTM-2001

The Third International Conference "Hydrogen Treatment of Materials" (HTM-2001) was held in Donetsk, Ukraine, May 14-18, 2001. More than 130 scientists, experts, and industrialists took part in the conference.

A book on the same topic, *Progress in Hydrogen Treatment of Materials*, was published this year by Donetsk-Coral Gables: Kassiopeya. The book contains contributions by world-renowned scientists and experts from ten countries, is edited by Professor V. A. Goltsov of Donetsk State Technical University, Ukraine, and is prefaced by Professor T. N. Veziroglu, President of the International Association for Hydrogen Energy, Miami University, USA.

After an introduction by V. A. Goltsov reviewing the status and development of hydrogen treatment of materials over the last 25 years, the book is organized in 4 parts. Part 1 contains 9 review papers, and includes fundamentals of hydrogen treatment of materials, the thermodynamics of hydrogen solution, diffusion and diffusive phenomena, theory of hydrogen elasticity phenomenon, hydrogen in thin films and multilayers, nature and manifestations of uphill hydrogen diffusion effects, hydride shape-memory effects, and the hydrogen phase naklep phenomenon and its use in hydrogen treatment of metallic materials.

Part 2 contains 11 review papers covering some hydrogen effects at the metals surface treatment; hydrogenation behavior, microstructure and hydrogen treatment, hydrogen as a temporary alloying element, and the achievements and prospects of hydrogen technology in production and treatment of titanium alloys; hydrogen in technologies for aluminum alloys casting; systematization and peculiarities of hydride crystal structures forming under the interaction of hydrogen with intermetallics; hydrogen induced amorphization of intermetallics, kinetics and some general features of hydrogen induced diffusive phase transformations in $\text{Nd}_2\text{Fe}_{14}\text{B}$ type alloys; surface modifications of hydrogen storage alloys and their applications in recent hydrogen technology; effects of hydrogen inclusion on electrical properties of metal oxides and nitrides; and hydrogen

Conference Calendar

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

September '01

Rare Earths' - 2001

São Paulo - SP, Brazil

September 22-26, 2001

Website: <http://www.iq.usp.br/geral/congress.html>.

RIC News XXXIII, [4] 3 (1998)

November '01

46th Annual conference on Magnetism and Magnetic Materials

Seattle, Washington, USA

November 12-16, 2001

*This issue

March '02

4th Bi-annual School on the Physics and Chemistry of Actinides

and

32emes Journees des Actinides (32JA)

Ein-Gedi, Israel

March 17-22, 2002

*This issue

June '02

14th International Symposium on Boron, Borides, and Related Compounds (ISBB'02)

St. Petersburg, Russia

June 9-14, 2002

*This issue

July '02

The 23rd Rare Earth Research Conference

Davis, California, USA

July 13-18, 2002

RIC News XXXV, [2] 4 (2000)

August '02

Applied Superconductivity Conference (ASC 2002)

Houston, Texas, USA

August 4-9, 2002

*This issue

17th Int. Workshop on Rare-Earth Magnets and their Applications

Newark, Delaware, USA

August 19-22, 2002

RIC News XXXV, [4] 3 (2000)

July '03

International Conference on Magnetism (ICM'2003)

Rome, Italy

July 27-August 1, 2003

RIC News XXXVI, [1] 4 (2001)

*denotes an article on this conference appears in this issue of the *RIC News*

treatment of non-metallic catalytic materials.

Part 3 includes 2 review papers, covering hydrogen degradation of some hydride-forming metals and their alloys and hydrogen in welding processes. Part 4 is a set of appendices covering historical and scientific features of the generation and development of HTM and how a new paradigm of materials science has been formed, classification of hydrogen treatment of materials, and the status of the world-wide HTM community.

Of interest to the rare earth community is the generalized information on hydrogen

interactions with rare earth intermetallic compounds, oxides, and other rare earth materials. The topics of special interest are crystal structures of hydrides, hydrogen-induced amorphization, hydrogen-induced phase transformations, and improvement of physical and catalytic properties by hydrogen treatment.

For more information, contact Professor V. A. Goltsov, e-mail: Goltsov@physics.dgtu.donetsk.ua or Goltsova@fem.dgtu.donetsk.ua, or on the Web at <http://dgtu.donetsk.ua/hydrogen> or <http://64.177.6.116/hydrogen>. Our thanks to V. A. Goltsov for contributing this story. ▲

32JA

The fourth bi-annual School on the Physics and Chemistry of Actinides and the 32emes Journees des Actinides (32JA) will be held March 17 – 22, 2002. They will be held at the guest house of kibbutz Ein-Gedi, Israel, on the shore of the Dead Sea.

The Journees des Actinides is a series of informal conferences devoted to the physics and chemistry of the actinides. A strong emphasis is given to mixed actinide-lanthanide systems, such as compounds, solid solutions, complexes, etc. The JA series began in 1972 in Grenoble, France, as a semi-annual meeting. It has been an annual meeting since 1975. Participants are primarily from Europe, with some also coming from the USA, Japan, and Israel. The attendance this year is expected to be around 100.

The bi-annual School on the Physics and Chemistry of Actinides was begun in 1996. Its primary goal is to introduce young scientists into the field of basic properties of the actinides and mixed 4f-5f systems, possible as future support to the nuclear science and industry. The School on Physics and Chemistry of Actinides will be free of charge for lecturers and students presenting their work at the 32JA.

The first announcement for the conference will be mailed in October 2001 to past participants. Anyone else interested in receiving this information should contact Dr. Moshe Kuznietz, Chairman of the Organizing Committee, 32emes Journees des Actinides, P. O. Box 9039, 84190 Beer-Sheva, Israel, by letter or fax to +972-8-6567878, providing full address, telephone, and fax numbers, and e-mail address. ▲

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Magnetism and Magnetic Materials

The 46th Annual Conference on Magnetism and Magnetic Materials will be held in Seattle, Washington, USA, November 12 – 16, 2001.

Members of the international scientific and engineering communities interested in recent developments in magnetism and associated technologies are invited to attend the conference. The conference will cover basic and applied science and technology related to the field of magnetism. The planned symposia are spin transfer torques, novel superconductivity and magnetism, spin polarization in half metals, spin injection in ferromagnetic/semiconductor materials, thermal magnetic stability of nano-sized magnetic devices, perpendicular recording, and MRAM- prototypes and feasibility.

For more information, visit <http://www.magnetism.org>, or contact Diandra Leslie-Pelecky, Secretary, University of Nebraska – Lincoln, Tel: 402-472-9178, Fax: 402-472-2879, e-mail: diandra2@unl.edu.

New Magnetic Powder from Magnequench

Magnequench Inc. now has a new spherical isotropic powder product, MQPTM-S-9-8, available for customer sampling and in commercial quantities.

The new powder is designed for plastic injection molded magnet parts and would also be suitable for calendared or extruded flexible magnets. The powder allows improved flow of polymer bonded compounds and results in an enhanced ability to make fine, sharply defined products. The powder size is approximately 50 micrometers, and helps improve dimensional tolerances, thermal stability, resistance to corrosion, and flux uniformity. It can also be used with other products to be used in hybrid NdFeB, thick film, and thin film applications.

Magnequench Inc. is headquartered in Anderson, Indiana, USA. For answers to questions on products and services, visit www.magnequench.com, e-mail infopowders@mqii.com, or call 765 648-5000. ▲

ISBB'02

The A. F. Ioffe Physical-Technical Institute and the Russian Academy of Sciences is sponsoring the 14th International Symposium on Boron, Borides, and Related Compounds June 9 – 14, 2002, in St. Petersburg, Russia.

The scientific program will integrate both basic and applied interdisciplinary research that is centered on boron, borides, and related compounds. Oral and poster contributions are invited in the areas of preparation of new materials in normal and extreme conditions, crystal structure and chemical bonding, physical and chemical properties in a wide range of temperature and pressure, and applications and prospects. Plenary lectures are planned. The language of the symposium will be English. Registration forms are due October 1, 2001, and abstracts are due December 10, 2001.

For more information, contact Dr. Maria M. Korsukova, Symposium Secretary, Ioffe Physical-Technical Institute, Russian Academy of Sciences, 26 Polytekhnicheskaya street, 194021, St. Petersburg, Russia, Tel: +7(812) 247 99 19, Fax: +7(812) 247 89 24 or +7(812) 247 10 17, e-mail: Maria.Korsukova@pop.ioffe.rssi.ru. ▲

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), e-mail, web address, and areas of expertise.

We would like to update our information as much as possible, so if you have submitted your information in the past but have something that has changed, if you are new to rare-earth consulting, or if it has been a while since you have had any of your information published in the *RIC News*, please resubmit your information: Tel: (515) 294-2272, Fax: (515) 294-3709, e-mail: ric@ameslab.gov. ▲

News from Japan

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

Toyota Motor Corp. press release, June 12, 2001: Toyota has unveiled a new hybrid system that can be applied in many vehicles, and will be used in production later this year. The new system is called Toyota Hybrid System-Mild (THS-M). The system consists of a small motor/generator, a compact 36V battery, and a control unit. This system improves fuel efficiency by 15%. The larger battery allows for thinner wires than in standard 12V systems, resulting in weight reduction and increased fuel economy. The mild hybrid system is less expensive than traditional hybrids systems, and is less dependent on electricity.

The Japan Times, June 13, 2001: Mazda Motor Corp. is working on a fuel cell electric vehicle (FC-EV) in cooperation with the Ford Motor Co. group. The fuel cell for the vehicle is supplied by an alliance of Ford, DaimlerChrysler, and Ballard Power Systems. Mazda is using methanol to make hydrogen to power the fuel cells of the vehicles, and hopes to have them in practical use by 2004.

The Asahi Shimbun, June 16, 2001: Toyota Motor Corp. has a new hybrid vehicle, the Estima, which is a minivan that is claimed to use half the fuel of comparable gas-only vehicles. The Estima is a four-wheel-drive vehicle, has a 2.4 liter gasoline engine and two electric motors, and gets about 42 mi/gal (18 km/l) of gasoline. Toyota expects to sell 1000 Estima Hybrids a month in Japan. Hopes are that the Estima will be exported someday, but no plans are made at present.

The International Herald Tribune, June 16, 2001: LM Ericsson AB has signed an \$850 million agreement to supply equipment and services to Chinese telecommunications operators. Ericsson will provide network equipment and services for GSM, CDMA, and multi-service networks for three Chinese companies: Jiangsu Mobile Communications Co., China Unicom Jiangsu Branch, and China Telecom Group, Jiangsu Corp. The number of mobile phone users is expected to triple to 300 million by 2005.

The Japan Times, June 19, 2001: Toyota is developing a 63-passenger bus with Hino Motors. The bus, FCHV-BUS1, is powered by a high-pressure hydrogen fuel cell and Ni-MH batteries. It can travel about 185 miles and reach speeds of 50 miles per hour. Toyota is also road testing its FCHV-4, a fuel cell hybrid sports utility vehicle, with direct storage of hydrogen in high-pressure tanks. These vehicles are expected to be the basis of new vehicles to be launched in 2003.

The Nikkei Weekly, July 1, 2001: Dell computer Corp. is beginning to make PCs in China for delivery to Japan. Dell is using its own original supply chain management model to produce low-cost, high-quality products in China. They maintain control over supply of parts by requiring local suppliers to have their factories within 15 minutes of Dell's factory. The management system allows customers in Japan to receive their orders within 5 days, faster even than computers made in Japan can get to them. Dell hopes these cost-saving measures will help to quadruple their world market share.

The Nikkan Kogyo Shimbun, July 25, 2001: Matsushita Electric Industrial Co. and Matsushita Battery Industrial Co. have formed a subsidiary in China to produce NiCd and NiMH rechargeable batteries. The Wuxi Matsushita Battery Industrial Co. is Matsushita's first production base for rechargeable batteries in China. NiCd batteries will be produced for use in electric tools, and NiMH batteries will be produced for use in personal computers and mobile phones.

Japanese reports on U.S. activities include the increasing popularity of hybrid vehicles in the United States (*The Nihon Keizai Shimbun* June 4, 2001), General Motors Corp.'s purchase of a 20% interest in Quantum Technologies Inc., a company that manufactures hydrogen storage tanks (*The Japan Times*, June 14, 2001), and an alliance formed between FuelCell Energy Inc. and Marubeni Corp. to generate more power through Direct Fuel Cell power plants with the eventual goal of introducing FuelCell to Japan and Asia, with long term plans for power plant to be built in Asia (*The Japan Times*, June 20, 2001). ▲

Fuel Cell Funding

The U.S. Department of Energy (DOE) has selected four industrial teams to participate in a 10-year, \$500 million program to develop better ways to manufacture less expensive and commercially acceptable solid oxide fuel cells (SOFC). The four industrial teams are Honeywell, Siemens Westinghouse Power Corp., Delphi Automotive Systems and Battelle, and Cummins Power Generation and McDermott Technology, Inc.

An article by Jeff Johnson in *C & EN* 79 [34] 13 (2001) gives some details of the program.

SOFC are just one of several fuel-cell technologies that the DOE is supporting because of their commercial potential. The particular application of SOFC has been to higher power operations, like industrial or large-scale electricity generating stations. SOFC can use fossil fuels as a source of hydrogen, and they can run at high temperatures (1500°F) that can be used as a heat source for industrial applications.

The goal of the DOE program over the next 10 years is to cut capital costs to \$400 per kW through manufacturing improvements while raising efficiencies to 60-70%.

The DOE will provide approximately \$270 million over the next 10 years, and the balance of funding will come from the industrial teams. A related R&D program to support the industrial manufacturing projects with about half the funding is expected to be announced this fall.

Specific projects included in the program include making modular 3- to 10-kW SOFC systems, 7- to 10-kW combined heat and power residential systems, and small units for vehicle applications. ▲

Newsletter on the Web

A paperless alternative to receiving an electronic form of the *RIC News* via e-mail is to access our website: <http://www.ameslab.gov/ric>, where current and previous issues of the *RIC News* are available, along with general information about the Rare-earth Information Center and a list of our sponsors. ▲

Low-dimensional Cuprates

In high temperature superconducting cuprates one of the central issues is whether the two-dimensional (2-D) CuO_2 planes with strong electron correlation behave as a Fermi liquid or as a non-Fermi-liquid one-dimensional (1-D) system with electron correlation. This issue is addressed in a review article by Sadamichi Maekawa and Takami Tohyama entitled "Charge and spin in low-dimensional cuprates," *Rep. Prog. Phys.* **64** 383 – 428 (2001).

The theoretical study of spin-charge separation goes back to 1950. The charge and spin in 1-D systems do not have the same values (e and $1/2$) as they do in regular Fermi liquids, but instead are like spin and charge degrees of freedom that result from the decay of a hole or electron introduced into a 1-D system. Spin-charge separation studies have been extended to the 2-D cuprates, and advances in both 1-D and 2-D systems have helped provide clues to high- T_c superconductivity.

The body of the review is organized into three parts. The first is an introduction to the underlying electronic structure of cuprates. A discussion of the electronic structure includes basic crystallographic structure, density of states, optical conductivity, and the Hubbard model and associated Hamiltonians. This is followed by a discussion of exchange interactions, including magnetic susceptibility and the importance of bond angles.

The second section covers 1-D cuprates. The primary topics of discussion include spin-charge separation, the realization of spin-charge separation in 1-D cuprates through angle-resolved photoemission spectroscopy, charge dynamics in insulating cuprates, and spin dynamics in insulating cuprates.

The third section covers 2-D cuprates. After an introduction, phase separation versus d -wave superconductivity, electronic excitation near the Mott insulator, electronic excitation in the Mott insulator, and stripe phases are all presented.

The conclusions to be drawn from the

Gate Dielectrics

"High- κ gate dielectrics: Current status and materials properties considerations," is the title of a recent review by G. D. Wilk, R. M. Wallace, and J. M. Anthony that appeared in the *J. of Appl. Phys.* **89** [10] 5243 – 5275 (2001). The review addresses the problem of finding suitable materials for replacing SiO_2 as the gate dielectric material for sub-0.1 μm complementary metal-oxide-semiconductor (CMOS) technology.

The article gives an excellent overview of the subject. It begins by introducing metal-oxide-semiconductor field effect transistors (MOSFET) and the scaling of these based on CMOS properties. There is a short discussion on scaling and improved performance and another on the metal-insulator-semiconductor (MIS) gate stack structure that make up the MOSFET.

The scaling limits for current SiO_2 gate dielectrics are presented. The discussion is broken down into six separate areas: ultrathin SiO_2 properties, ultrathin SiO_2 reliability, boron penetration and surface preparation, SiO_xN_y and Si-N/ SiO_2 dielectrics, fundamental limitations, and device structures.

Alternative (non- SiO_2) high- κ gate dielectrics that have been studied so far make up a major portion of the article. This section includes high- κ candidates from memory applications, issues for interface engineering, and recent high- κ results. This last segment contains discussions on Group IIIA and IIIB metal oxides, Group IVB metal oxides, pseudobinary alloys, and high- κ device modeling and transport. The sections on Group IIIA and IIIB metal oxides, which include Y_2O_3 , La_2O_3 , Pr_2O_3 , and Gd_2O_3 , and pseudobinary alloys, which include La-Si-O, Gd-Si-O, Y-Si-O, Sc-Si-O, and Ce-Si-O, make the most mention of rare-earth materials. If these materials proved to be particularly useful as high- κ gate dielectrics, there could be increased demand for rare earths for use in the semiconductor industry.

Finally, the review covers materials properties and considerations. The required properties for suitable dielectric replacements are presented here. They include permittivity, band gap, and band alignment to silicon, thermodynamic stability, film morphology, interface quality, compatibility with current or future materials used in processing CMOS devices, process compatibility, and reliability. While many materials meet several of these requirements, it is difficult to find one that meets all requirements. So far, the pseudobinary materials show the most promise.

The review is supported by 3 tables, 14 equations, 27 figures, and 167 references, and should prove to be an interesting starting point for anyone interested in this field.

For more information, G. D. Wilk can be reached by e-mail at gwillk@agere.com, and R. M. Wallace can be reached by e-mail at rwallace@unt.edu. ▲

article are that spin-charge separation has been shown to be real for 1-D cuprates, but the results are somewhat inconclusive and warrant more study in 2-D cuprates. The charge separation that seems to be seen in 2-D cuprates is dependent on momentum and connected to d -wave superconductivity. It is also concluded that stripe domains are the realization of physical spin-charge separation.

The review article has 33 insightful figures accompanying the text, along with 19 equations and 241 references. For more information, Sadamichi Maekawa can be reached by e-mail at maekawa@imr.tohoku.ac.jp, and Takami Tohyama can be reached by e-mail at tohyama@imr.tohoku.ac.jp. ▲

Perovskite Oxides

The structure and chemistry of perovskite materials is the focus of a recent review article “Chemical Structure and Performance of Perovskite Oxides,” by M. A. Peña and J. L. G. Fierro, *Chem. Rev.* **101** 1981 – 2017 (2001).

Around 90% of the naturally occurring metallic elements form stable perovskite oxides (ABO_3), thus the compounds have a wide range of properties. Since the authors have addressed physical properties in a previous review, they are not presented in this paper. The focus of this paper is instead on structures and chemical interactions of the materials, especially as catalysts. The majority of catalysts used in the chemical industry today are mixed metal oxides, and the variety available in perovskites makes them adaptable to multiple purposes. The adaptations are helped by substituting for both the A and B elements in the formula. Perovskite oxides also provide excellent models for catalytic reactions and for establishing correlations between reactivity and surface or bulk properties due to their isomorphous nature.

The review has three major sections, Structure of Perovskites, Acid-Base and Redox Properties, and Heterogeneous Catalysis, followed by a concluding section entitled Future Perspectives. Structure of Perovskites begins by covering the crystal structure, including a diagram of the ideal structure, and some deviations from the ideal structure that can occur. Non-stoichiometry, which includes oxygen non-stoichiometry and cation stoichiometry, and reasons that non-stoichiometry can occur, are discussed. Physical properties are presented, and cover magnetic properties, electrical properties, and optical properties briefly. Adsorption properties, especially for CO, NO, and O, specific surface and porosity, and thermal stability in a reducing atmosphere are also included.

Acid-Base and Redox Properties is a brief treatment of these properties, which are directly related to catalytic performance of perovskites. The surfaces of the materials are most important in producing catalytic properties, so surface sites are the main focus of this section. Acidity and basicity, redox processes, which includes discussions on kinetics and mechanisms and reduction-oxidation cycles, and ion mobility, which discusses both oxygen transport and cation transport, are all encompassed in the discussion.

The focus of the paper treats several different kinds of heterogeneous catalysis. The catalysis reactions cover a wide range of potential applications for perovskite oxides. They include oxidation reactions (like CO oxidation and oxidation of hydrocarbons), pollution abatement (such as NO_x decomposition), exhaust treatment, and a section on stability, hydrogenation and hydrogenolysis reactions (including hydrogenation of carbon oxides), photocatalysis (especially photodecomposition of water and other photocatalytic reactions), chemical sensors, electrocatalysis (specifically oxygen reduction and solid oxide fuel cells), and a section on structure-activity relationships.

Future Perspectives aims to show some possible areas for future development of perovskite oxide applications. It points out the flexibility that can be gained in using perovskites because of their isostructural nature and the degree of substitution that can be achieved. Important applications include cathode materials for solid oxide fuel cells, and the accommodating nature of the structure of perovskites should lend themselves to processes yet to be invented.

The paper is supported by 14 figures that help to illustrate the concepts presented, 27 equations, most of which illustrate chemical reactions, and 373 references. For more information, J. L. G. Fierro can be contacted by fax at +34 91 585 4760, or by e-mail at jlgfierro@icp.csic.es. Also, elsewhere in this issue of the *RIC News* is the article “Double Exchange and Manganites,” which is related to this topic. ▲

Batteries and Clean Energy Sources

An excellent review, entitled “Materials for rechargeable batteries and clean hydrogen energy sources,” *Int. Mater. Rev.* **46** [1] 1 – 49 (2001), written by Z. S. Wronski, covers a wide range of materials used in energy applications.

Rechargeable batteries and fuel cells are energy sources that require functional materials. Development of these materials can be challenging because multiple functions required of the material mean multiple requirements must be met. A combination of properties is possible if complex structures are used, involving materials such as functional composites, multi-element and multiphase intermetallics, cermets, layered insertion compounds, and nanostructured and disordered phases. The review presents a variety of these materials used for clean energy storage, which most often means hydrogen energy storage.

The introduction begins with a brief history starting with the invention of the first battery in 1799. The history outlines the development of automobiles and electric power sources for them, as well as the development of metal-hydride storage alloys and fuel cells, and is a nice prelude to the rest of the review. The author states that the review is far from comprehensive, but attempts to show how similar materials are used in more than one kind of energy storage and/or conversion.

The review is organized into three parts. The first introduces battery and fuel cell systems. The second discusses selected materials, with particular attention to intermetallics used in gas hydrogen or electrochemical hydrogen storage. The third part discusses special topics, including nanophase materials and processing. Some materials fit in more than one segment, and are discussed in each segment where relevance occurs.

The battery systems presented include lead-acid systems, nickel-cadmium systems, nickel metal hydride systems, lithium systems, “other” systems, and fuel cells. The selected materials discussed include lead alloys, nickel materials for composite Ni electrodes in alkaline batteries, cadmium and zinc materials

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for rechargeable alkaline cells, H insertion intermetallic alloys for gas hydrogen storage (which include rare earth-nickel alloys of the AB₅ type), H insertion intermetallics for electrochemical hydrogen storage, materials for lithium batteries, and materials for fuel cells (including ceramics and cermets that contain rare earths). Special topics include nanostructured materials, materials requirements for batteries and fuel cells to be used in portable communication and electric vehicle applications, and recyclability and life cycle analysis. There is also an appendix that defines terms from battery and fuel cell technology.

Overall this is a very informative article. To help support the information presented, 13 tables, 15 equations, 29 figures, and 457 references are employed. For more information, Z. S. Wronski can be reached at the Materials Technology Laboratory, Canada Centre for Mineral and Energy Technology, 568 Booth Street, Ottawa, ON, K1B 3B1 Canada, Tel: (613) 992-0160, e-mail: zwronski@nrcan.gc.ca. ▲

Did you know?

Promethium, element 61, was first predicted in 1903, and evidence was collected of its existence in 1926, but it was not "discovered" until 1945, when Jacob A. Marinsky, Lawrence E. Glendenin, and Charles DuBois Coryell found it in the fission products of uranium while doing nuclear research at Oak Ridge, Tennessee.

The name "promethium" comes from Greek mythology, where Prometheus stole fire from heaven and gave it to mankind. In the story, his actions brought him severe punishment from Zeus. Grace M. Coryell has been quoted as saying "This name not only symbolizes the dramatic way in which the element may be produced in quantity as a result of man's harnessing of the energy of nuclear fission, but also warns man of the impending danger of punishment by the culture of war!"

Promethium has several isotopes with mass numbers from 134 to 155. Promethium melts at about 1042°C, boils at about 3000°C, and has a specific gravity of 7.26. It has been used in atomic batteries and as a beta-particle source in thickness gauges. ▲

Search of the Month

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Article

Epitaxial strain induced metal insulator transition in La_{0.9}Sr_{0.1}MnO₃ and La_{0.88}Sr_{0.12}MnO₃ thin films

(La,Sr)MnO₃ 2000 Debye-temp epitaxy Jahn-Teller-ef magnetization met-insulat-tr pulsed-laser-deposition resistivity SrTiO₃ strain TEM temp-dependenc thin-film transition-tem

Magnetic structure evolution of Pr(1-x)MnO₃ perovskite from neutron powder diffraction data

2000 crystal-struct crystallograph exchange Jahn-Teller-ef mag-moment mag-ordering mag-structure Neel-temp neutr-diffract neutr-scatter perovskite PrMnO₃ spin-glass spin-ordering superexchange symmetry x-ray-diffract

Comparative study of photo-induced effect on the charge-ordered state of Pr_{0.65}Ca_{0.35}MnO₃ in powder and thin films

(Pr,Ca)MnO₃ 2000 charge-order colossal DC electrotranspo EPR Jahn-Teller-ef magnetoresist met-insulat-tr oxide paramag-reson photo-induced photon-injection powder resistance thin-film x-ray-diffract

Electronic structure of LaMnO₃ in the ab initio crystal Hartree-Fock approximation

2000 crystal-struct density-states electron-struct Hamiltonian Hartree-Fock Jahn-Teller-ef LaMnO₃ mag-ordering mag-prop model orbital-order spin-density spin-wave

Influence of the cooperative Jahn-Teller effect on the transport and magnetic properties of La_{7/8}Sr_{1/8}MnO₃ single crystals

(La,Sr)MnO₃ 2000 bibliography conductivity distortion double-exchange field-depend Jahn-Teller-ef lattice-param mag-moment mag-prop mag-suscept magnetization magnetoresist manganese orbital-order ordering oscillation perovskite phase-transiti polaron resistivity Shklovskii-Efros-hopping single-crystal spin-alignment spin-cluster SQUID structure superparamag temp-dependenc transport-prop Wigner-lattice

Wednesday, August 22, 2001

Page 1 of 1

The search above satisfies a search for information on the Jahn-Teller effect contained in papers published in 2000 (Jahn-Teller-ef AND 2000). Many more citations would have been referenced if other years had been included in the search.

The preliminary search report, as shown above, which is provided when the search is requested as an evaluative tool, includes the keywords used for the search, the title of the article, and the other keywords associated with the reference, for each of the references found. A database report, which is sent when the search results are purchased, includes full reference information: our document number, title, authors, bibliographic reference, and keyword list.

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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; e-mail: ric@ameslab.gov. If you would like to become a supporter of the RIC, send your name, address, telephone, fax, e-mail addresses, and your desired level of support to the above address or to LaVonne Treadway, RIC, 116 Wilhelm Hall, Ames Laboratory, Iowa State University, Ames, IA 50011-3020 USA, Tel: 515-294-2272; Fax: 515-294-3709; e-mail: crem_ric@ameslab.gov. ▲

Stable Binary Quasicrystal

Five Japanese researchers have found a stable binary quasicrystal. Their findings are summarized in a brief communication in *Nature* **408** [6812] 537 – 538 (2000). The article is called "A stable binary quasicrystal," and is authored by A. P. Tsai, J. Q. Guo, E. Abe, H. Takakura, and T. J. Sato.

Quasicrystals were first discovered in 1984, and since then the only stable quasicrystals contained at least three metallic elements. Thus, the discovery of a binary quasicrystal is quite a find. The Cd-Yb material represents a new class of packing of a 66-atom icosahedral cluster. The internal structure of the cluster breaks the symmetry.

The stable composition is Cd_{5.7}Yb, and was discovered through systematic investigation of the Cd-Yb system. The x-ray diffraction pattern of the material showed that it is a quasicrystal, and selected-area electron diffraction verified a primitive icosahedral lattice. Laue diffraction patterns clearly show 5-fold, 3-fold, and 2-fold symmetry axes, and the many sharp reflections with these symmetries are indicative of highly ordered quasiperiodicity with long range icosahedral symmetry. Another unique characteristic of this compound is its congruent melting. All other quasicrystals up to this discovery are incongruent melting compounds.

This stable binary quasicrystal is expected to be valuable for studying stability and ther-

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modynamics in binary phase diagrams. The binary compound will simplify the analysis of experimental results by reducing the parameters for theoretical calculation. How this cluster forms remains an open question.

For more information, contact A. P. Tsai at Nationals Research Institute for Metals, and CREST, Japan Science and Technology Corporation, Tsukuba 305-0047, Japan, e-mail: aptsai@tamamori.nrim.go.jp. ▲

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