Elements

The Authoritative Monthly Newsletter on Rare Earths, Specialty Metals and Applied Technology

December 1, 2001
Vol. 2, Issue 12
Published by High Tech Materials

~ TABLE OF CONTENTS ~

The following additional content is available **online only**. To view, please go to http://wwwrareearthsmarketplace.com.

~ INDUSTRY DEVELOPMENTS ~

French chemicals company Rhodia expects improved earnings next year as it speeds up restructuring plans in the face of a downturn in the chemicals industry.

``In 2002, we will benefit more from the technical effects of a lack of provisions whilst our restructuring efforts should start to bear fruit,'' Rhodia Chairman Jean-Pierre Tirouflet.

Rhodia, which is leading rare earths processor and distributor, has issued two profit warnings this year as the European chemicals sector feels the pinch of slumping demand in sectors such as cars and electronics, both highly sensitive to tumbling consumer confidence in the wake of the September 11 attacks in the USA.

The group has already unveiled plans to shut its phosphates site in Whitehaven, Britain, by the end of the year with the loss of 120 jobs, and is closing factories in Morrisville in the United States and at Buckingham, Canada. France's leading maker of chemicals used in detergents and dyes also raised its provision for restructuring for the whole of 2001 to 200 million euros from an initial 150 million.

On January 1, 2001, Rhodia Rare Earths became Rhodia Electronics and Catalysis. The new name emphasizes the mission of the enterprise to be a development partner and a leading supplier of advanced materials to the electronics and catalysis markets, according to the company. It also reflects the company's new responsibility for the development and marketing of all Rhodia Group products used in these markets and thus, the extension of core competencies beyond rare earth technologies. Rhodia Electronics and Catalysis will be structured around three business units: Catalysis, Electronics, and New Markets. (Reuters, November 16, 2001 & High Tech Materials)

=====================

Altec Lansing Technologies, Inc., a leader in the market for personal computer speakers, has introduced two computer speaker systems that use **neodymium** and blend the art of sound with the beauty of design.

The new 4100 and 2100 incorporate advanced micro-driver technology and a sleek, futuristic form to deliver advanced sound. The 4100 delivers 140 watts of total system power to surround listeners in four-channel sound. The system features four compact satellites that use a curved cast-alloy stand and a pair of one-inch, aluminum-coned neodymium micro-drivers to deliver clean, pristine sound. The 4100 features an exclusive dual-mode audio selected to allow the user to customize the listening experience based on the audio source. The 2100 offers 2.1 channel audio for a variety of sound sources including music, video, and games. The 4100 and 2100 have a suggested retail price of US$199 and $129, respectively.
(High Tech Materials, November 2001)

===================

Rare earths are always finding their way into new high-tech devices and Apple Computer's new iPod (MP3 player) is no exception.

The iPod, Apple's "breakthrough digital device," uses neodymium transducer magnets in its ear-bud headphones to provide smooth sound for the listener. The iPod is the first MP3 player to pack 1,000 songs and a 10-hour battery into only a 6.5-ounce package you can literally take everywhere. It works by plugging in to a Macintosh computer, where all of your iTunes songs and playlists are automatically downloaded into iPod.
(High Tech Materials, November 2001)

~ WHAT'S NEW ~

Great Western Gold Corporation in Financing Talks

Neil Yingling, president of Great Western Gold Corporation has announced that the company has entered into serious discussion with both private industrial users of rare earth oxides and private investment and asset management entities in the USA, Canada, and Europe -- each of which has expressed intent to take an equity position in the company.

At this time the company is inviting funding subscriptions to a series of four separate private placements of US$150,000 each, on a scheduled basis, based on progress milestones to cover it's intended $600,000 engineering work programs. GWG is also entertaining negotiations for a flow-through financing for completion prior to the end of 2001. The company has left the door open on all discussions until it determines which avenue, based on funding availability, will enhance shareholder value.

One company has communicated a conditional letter of intent to GWG that could result in funding the first increment of 150,000 by early next year in four trenches of equal amounts placed every 45 days until a total of $600,000 has been invested. That company, however, has asked GWG to accept its request for a pre-emptive right until that time. In that regard, GWG has opted not to award such exclusivity until it is fully assured of a bank guarantee of such funding preceded by a due diligence investigation. A private asset management company in Europe has expressed interest to acquire a large equity position in the GWG for which mutual due diligence is now underway.

All parties have been informed that any funding must coincide with previously announced plans to commence a winter work program at Hoidas Lake after mid-January. The program would include infill drilling of Zone 1 (JAK Zone) to a depth of 300 meters; ground geophysics over all showings along the entire strike area to the south of Zone I; and completion of Phase II metallurgical testing and related engineering. The objective of this work is to establish an ore reserve base suitable for a feasibility study leading to a production decision.

GWG management is very encouraged by the recognition of these parties that the Hoidas Lake rare earth discovery has the potential to become a world-class ore body and recognizing that a secure North American supply of rare earths is of utmost strategic importance in a global context.

As previously announced, GWG's metallurgical testing program has shown that 98.6 percent of the rare earth oxides present in the rock can be recovered using simple cold acid leaching. Additional information will be made available at appropriate intervals as negotiations progress.

Géo-Consilium Property Has Rare Earths Potential

Géo-Consilium has announced the discovery of many economic-grade samples of rare earth elements in the Grevet Twp, Lebel-sur-Quévillon area of northwestern Québec, Canada. This area may become the first rare earths mine in Canada and in eastern North America.

Hydrothermal-type mineralization is related to Grevet Alcaline Complex. To be economic, the ore grade must be higher than 0.20 percent rare earth elements. An amount of 14 economic grab-samples, taken on Grevet Property's outcrops, have returned values between 0.24 and 4.70 percent light rare earth elements (LREE) (lanthanum, cerium, neodymium, and samarium). The other 11 grab-samples have yielded sub-economic grades, ranging between 0.03 and 0.20 percent LREE.

Grevet Property is composed of 19 contiguous claims, covering 328 hectares and is registered to Québec Natural Resources Department. The property is equally owned by Géo-Consilium and Proulx Michel, a geologist and prospector. This property is to be optioned or sold. Géo-Consilium is the matriculated company for geological consulting owned by Proulx Michel. For further information, please contact: Proulx Michel MSc geologist, phone/fax: 819-825-9753 or by e-mail at: proulxmichel0@sympatico.ca.

Novosibirsk to Develop Foreign Trade

Novosibirsk Rare Metal Plant is now searching for partners, contractors, and buyers. The company will consider foreign trade contracts once production is underway. Basic products include:

- Cesium nitrate ($CsNO_3$)
- Cesium chloride (CsCl)
- Cesium iodide (CsI)
- Cesium sulfate ($CsSO_4$)
- Rubidium chloride (RbCl)
- Rubidium nitrate ($RbNO_3$)

The company also offers the following services:

- purification of above materials in accordance with requirements of the buyers;
- customer`s raw material processing on the plant territory with the subsequent back delivery; and
- tolling.

While the company guarantees competitive prices and high quality products, the final price depends on terms and conditions of each contract. For further information, please contact:
Boris Pustovalov,
General Director
Public Corporation "Novosibirsk Rare Metal Plant", Russia 630099
Novosibirsk, Lenin Street 12, Office 703
Phone/Fax: 011-7-3832-22-36-49
Email: alexey@daf-trade.com
Internet: http://www.cesium.daf-trade.com

~ IN FOCUS ~

Etrema Products Inc. Finds Success with TERFENOL-D

By
Myra Pinkham
==========================

TERFENOL-D is a burgeoning market for rare earths, Jonathan D. Snodgrass, vice president and chief scientist for Etrema Products Inc., Ames, Iowa, declared.

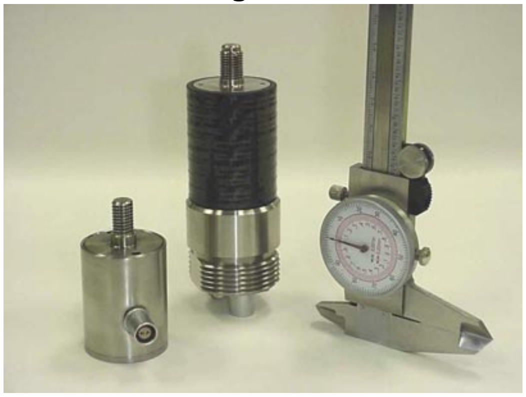
TERFENOL-D, which is an acronym of the metallic elements that it is composed of and its original developer, is a near single-crystal metal alloy that converts electrical power to mechanical power and vice versa. Its name stands for terbium (ter), iron (fe), US Naval Ordinance Labs (nol) and dysprosium (d). The Naval Ordinance Labs (now known as the US Naval Surface Warfare Center) developed the material for the use in higher power sonar because of its greater bandwidth and greater reliability.

While the Navy continues to pursue that use for the material, Etrema was formed in 1987 to develop commercial applications for the material. "Currently we have developed applications in over 16 different industries, including automotive, chemical processing, miscellaneous manufacturing, aerospace, hydrocarbon oil exploration, and electronics.

It is said to be a smart material because of its ability to adapt to outside influences. "It changes shape in response to an applied magnetic field," Snodgrass explained. However, Etrema, reportedly the world's leading producer (and the only US maker) of TERFENOL-D, which holds many licenses and patents for that material, maintains that this smart material is more powerful than others and performs more reliably than any other competing smart material in a smaller package.

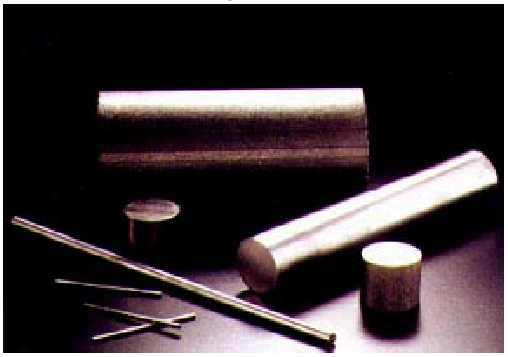
Smart materials, the company says, have significant uses in commercial products as well as military applications. Overall, worldwide sales of smart materials exceed $1 billion annually, with electrostrictive technology accounting for 75 percent of the market; magnetostrictive (like TERFENOL-D) and shape memory metals each have a 10-percent share and rheological fluids have the remaining 5 percent market share. TERFENOL-D's share, however, has been growing steadily, Etrema says.

Figure 1



TERFENOL-D actuators

Figure 2



TERFENOL-D can be produced in specific shapes for a variety of applications.

"Its advantage is its energy density," Snodgrass explained. "The amount of power that it can handle is much higher than other materials currently in use, including piezoceramics." With its higher energy density, long life and electric drive advantages, it is replacing older actuators and transducer materials.

As a result this market, which is still in its infancy and has historically been produced in gram quantities, production is now approaching ton quantities and could explode in the next five to 10 years to a level of hundreds of tons a year, he stated, noting that TERFENOL-D was first available in 1987 in research quantities and has been available in commercial quantities only since 1995.

"With prices of rare earths going down, it has helped to allow for more applications using those materials," Snodgrass observed, explaining, "Because they are found together, when there is a need for the more popular rare earths, such as neodymium, the prices for all of the rare earths go down. That opens up the possibility for applications that people didn't think of before." Because of this, he said, there will be more lower cost rare earth applications in the future, mainly for things like magnets, nickel metal-hydride batteries, and refrigeration. While these applications might not use TERFENOL-D, it creates a need for more rare earth production capacity and a need to do something with the less popular rare earths, including terbium and dysprosium. As a result, these rare earths become more economical to use.

Snodgrass added, "While people are reluctant to be the first to try TERFENOL-D for a new application, once someone does try it, others beat down the door. With each success we tend to have three new inquiries." And as Terfenol-D is produced in larger quantities, its price has also fallen appreciably. "Volumes have gotten to the level that we can take advantage of volume discounts for our raw materials," he noted.

A number of new applications are currently in the works, Snodgrass said. The Navy is currently moving on three separate programs involving the use of TERFENOL-D over the next few years. This, Snodgrass said, includes its use on a destroyer that is expected to undergo sea tests in the 2003-2004 timeframe.

There is also an automotive program in development, he said. Etrema has partnered with Westport Innovations Inc., Vancouver, British Columbia, on the use of TERFENOL-D in the natural gas fuel injectors for the next generation Ford Focus, which is scheduled for production in 2005. Early in November, Westport began road testing the prototype Ford Focus containing this technology. It is expected to save significantly on fuel costs, and more importantly, generate an order of magnitude less pollution than a similar gasoline-powered vehicle.

Also, Snodgrass said, Etrema will be announcing within the next three months the first consumer audio application for TERFENOL-D. While he said he could not disclose the exact nature of the device, Snodgrass did say that it was to be a low-cost, high-volume product, with over 1 million units expected to be produced in the first year and possible growth to 10 million units in a couple of years. "We should see further growth in other consumer products," Snodgrass said, adding that there are several opportunities being worked on in other industries, but he said he could not say what they were because of confidentiality agreements.

TERFENOL-D, Snodgrass admitted, will not totally overtake the piezoceramics market, but it will continue to replace many of the higher-end applications, where piezoceramics cannot meet the power or reliability requirements of the applications.

The material is produced in automated crystal growth machines at Etrema, which holds the exclusive license for processing TERFENOL-D, as well as several patents, including a number of process patents and a composition of matter patent. Etrema has licensed its technology to one other company, Westport, in order to allow that company to ink an agreement with the automaker for the development of the natural gas fuel injectors, but Snodgrass could not say if the company would sell licenses to other companies as well. "We are taking it one day at a time," he said.

For more information contact Jonathan D. Snodgrass at 2500 North Loop Drive, Ames, Iowa 50010, phone: 515-296-8030, fax: 515-296-7168, e-mail: jon.Snodgrass@etrema-usa.com, Internet: http//www.etrema-usa.com.

Jonathan D. Snodgrass is vice president and chief scientist for Etrema Products Inc., Ames, Iowa. He joined the company in 1990 after working at Ames Laboratory as an undergraduate researcher doing non-destructive evaluation. During his time at Etrema, Snodgrass has overseen the development of all the production processes for the manufacture of TERFENOL-D materials and is currently leading the company's research into next generation advances in that area.

~ SPECIAL FEATURE ~

Rare Earths Industry Overview 2001

By
Gail Fox
Myra Pinkham
Louise Rodriguez
Rich Vito

==========================

The rare earth elements have had a unique and important impact on our lives, especially in the industrial age of the twentieth century. This trend is certain to continue in the twenty-first century as research and development efforts uncover new applications for these little known materials in our increasingly high-tech world.

This small industry continues to evolve in an effort to grow with the anticipated new demand from cutting-edge technologies. Some rare earths prices have suffered recent instability in an attempt to find a balance between supply and demand and also because of changing export quotas by China, the world's leading supplier. However, experts are optimistic that demand will remain strong for several years, while achieving a market balance will lead to more stable prices.

Rare Earths Supply

World Mine Production

As one knows, finding data on rare earths mine production is very difficult and this year is not exception. Rare earths resources are found in the following basic forms:

- Bastnaesite
- Monazite
- Xenotime
- Loparite
- Ionic Clays

Current reserves are estimated at 85 mt contained rare earth oxides (REO). China has the largest proportion at approximately 50 percent, followed by the USA (16%), Australia (6%), and India (3%). The majority of these minerals contain light rare earths, which are the least expensive and have the greatest market demand.

Most of the lights come from northern bastnaesite deposits located in Inner Mongolia, at Baotou Iron, Steel and RE Enterprises and Gansu RE Corp., and Baotou Hefa RE Development Group Co. Ltd. In the southern region of China ionic clays are mined. According to *Mining Journal*, total mine production in 2000 was 75,500 tons per annum (tpa) REO, while the US Geological Survey (USGS) has reported production of 81,000 tpa REO in 2000. With the closing of mines and refineries, a depressed rare earths market, and the cut in export quotas, High Tech Materials estimates a total mine production out of China of 70,000-74,000 tpa REO in 2001.

Loparite is mined by Lovozerskaya Mining Co. in Russia's Kola Peninsula. The ore is concentrated there and sold to Solikamsk Magnesium Plant for further processing. Russia exported all of its rare earth oxide production to Silmet in Estonia. According to *Mining Journal*, 2,492 tpa REO were mined in 2000. Typically, it is difficult to attain any production numbers from the Commonwealth of Independent States.

Indian RE Corp. mines monazite from mineral sand deposits. In 2000, exports reached 1,557 tpa REO, with this year's export total approaching 2,700 REO.

In the USA, Molycorp is still in limbo since its operations were suspended in March 1998, by the California Environmental Protection Agency. Presently, it is producing an estimated 5,000 tpa REO in bastnaesite concentrates and is selling rare earth compounds from stocks. There have been plans to solve the wastewater problems and come back on line for mining, concentrating, refining, and marketing at its Mountain Pass, California facility. At full production, Molycorp can mine 20,000 tpa of REO.

Table 1
World Mine Production (metric tons REO per year)

Country	2000	2001	Future	Reserves
USA	5,000	5,000	20,000	13,000,000
Australia	-----	-----	11,000*	5,200,000
Brazil	1,400	1,400	------	280,000
Canada	-----	-----	NA	940,000
China	78,500	72,000*	NA	43,000,000
India	1,557	2,700	NA	1,100,000
Malaysia	350	250	NA	30,000
South Africa	-----	-----	6,000*	390,000
CIS	-----	-----	NA	21,000,000
World Total	**89,299**	**83,650**	**+37,000**	**103,940,000**

*High Tech Materials
Sources: USGS, *Mineral Commodity Summary*, January 2001
Mining Journal Ltd., Mining Annual Review 2001

Potential Production Sources

Canada

Discoveries of rare earth deposits are few and far between; however, Canada has been well-represented this year.

Saskatchewan

There are more than 40 reported rare earth occurrences in northern Saskatchewan, but of these only a handful were actually explored primarily for potential rare earths mining. Many were discovered as a result of uranium exploration, as they are associated with low-level radioactivity. The occurrences are subdivided into five types:

- Pegmatite-granite association
- Metamorphosed detrital occurrences
- Allanite veins
- Detrital, heavy mineral sands in the Athabasca Group
- Diagenetic-hydrothermal associated with unconformity uranium deposits

Although there has been no commercial rare earths production to date, the unconformity-related types show the greatest potential for developing large commercial deposits.

Table 2
Canadian Rare Earths Occurrences

Showing Name	Location
Hoidas Lake North Allanite Showing	Hoidas Lake – north
Nordbye Lake REE Showing	Nordbye Lake - west end
Lacey Lake Allanite Showing	Lacey Lake – southeast
Alces Lake Trenched REE Showing	Alces Lake area
Norwest Allanite Showing	Norwest Lake area
Sunlite Oil Rare Earth Element Showings Nos. 306 and 401	Cup Lake – east
Trans Canada REE-U Zone No. 2 or Archie Lake REE Showing	Archie Lake – northeast
Hoidas Lake Allanite Showing or JAK Zone, Hoidas Lake Auriferous Boulder Train	Hoidas Lake - north tip
Hazleton Lake (southeast shore) REE Occurrence	Hazelton Lake - southeast shore
Iskwatam Lake Allanite Showing	Iskwatam Lake - Romuld Island
Nisikkatch Lake Allanite Occurrence	Nisikkatch Lake - south tip
Hoidas Lake South Allanite Showing	Hoidas Lake - south tip

Source: Saskatchewan Energy and Mines, Saskatchewan Mineral Deposits Index

North America is one step closer to being less reliant on China for its rare earth elements, as Great Western Gold Corp., Vancouver, British Columbia, announced late in October that they have received independent confirmation that not only is there strong mineralization of rare earth elements at their Hoidas Lake property in northern Saskatchewan, but that simple cold acid leaching will achieve a 98.6 percent extraction rate of the rare earth oxides there.

Great Western, according to its Neil P. Yingling, president and chief executive officer, has been eyeing the Hoidas Lake area for about two and one-half years, ever since it acquired the property from Daren Industries Ltd., Vancouver, British Columbia. Daren did early exploration work on property claims in 1996, preceded by Kintla Explorations Ltd. in the 1970s, which explored for thorium and uranium. "Instead metallurgical testing turned up showings of rare earth elements," Yingling noted.

In 1999, Great Western started work on the property, first doing a ground geophysical survey that it followed up with a substantial trenching program. That was followed immediately by independent assay by the Saskatchewan Resource Council, who also published a complete petrographic analysis report of thin slices of samples from the trenching program.

The strike area, Yingling said, is a well defined six-mile in length site covering over 15 zones of rare earth oxide showings. A total of 26 separate rare earth showings have been identified on the property. The rare earths identified include: cerium, dysprosium, erbium, gadolinium, hafnium, holmium, lanthanum, lutetium, neodymium, praseodymium, samarium, scandium, terbium, thorium, thulium, ytterbium, and yttrium (see “In Focus,” *Elements*, November 1, 2001, for further information on Great Western Gold Corporation).

British Columbia

Cross Lake Minerals Ltd., announced that it had acquired the Myoff Creek Property, located 55 km north of Revelstock, British Columbia. The property covers a carbonatite deposit hosting cerium, lanthanum as well as niobium and tantalum. The property covers 37 mineral claims over 12 kilometers of the carbonatite horizon. It is well-connected by logging roads with the Mica Dam power transmission lines crossing the property. Exploration to include mapping, soil and rock sampling, trenching and diamond drilling was to commence late spring and summer of 2001. Geological Survey of Canada has mapped the region with previous exploration work carried out by Duval International Corp. in 1983 and by Teck Corp. in 1988.

Pacific Ridge Exploration has received assays for rare earth oxide (REO) minerals on its Xeno Property, located 30 kilometers east of the Tournigan River road and 40 kilometers east of Dease Lake in northern British Columbia. Pacific Ridge has the right to earn a 100 percent interest in the Xeno Property.

Xeno covers 11 kilometers of the "Gabe Belt" geologic host to REO mineralization and an occurrence of kimberlite. Pacific Ridge's exploration program of systematic mapping and sampling is directed to prioritizing continuity and grade of four mineralized zones discovered to date.

Metallurgical test work will determine if a premium product can be produced from this REO mineralization enriched in lanthanum, neodymium and cerium. Future markets look positive for Several of the REOs particularly neodymium and lanthanum with growth potential forecasts in related to the development of hybrid batteries, fuel cells, electronics, hybrid cars and super-magnets.

The company is now ready to seek a joint venture partner to initiate drill testing for the delineation of REO resources at the Xeno Property.

Ontario

Greenville Gold Corporation has confirmed the presence of an iron-rich carbonite deposit, enriched with rare earth elements, in its property in Grimsthorpe Township of southeastern Ontario, Canada. There are only approximately 330 known carbonatite deposits worldwide, and rare earth elements are strongly aligned in carbonatite. Samples have been submitted for XRF trace element analysis with results to be announced in 2001.

Québec

Géo-Consilium has announced the discovery of many economic-grade samples of rare earth elements in the Grevet Twp, Lebel-sur-Quévillon area of northwestern Québec, Canada. This area may become the first rare earths mine in Canada and in eastern North America.

USA

The Sur American Gold Corp. has acquired a 100-percent interest in the Texas Creek RE property in Fremont County, Colorado. The property consists of several zones of RE mineralization, which occur over strike length of a minimum of five kilometers. Sur is planning a detailed geological mapping and sampling program, which will commence in late November 2001. At least nine rare earth elements have been found by ICP analysis. The three samples tested contain potential economic concentrations of rare earth metal oxide values of 1.3%, 0.92% and 0.88%, with most of the rare earths being lanthanum, cerium, and neodymium and 0.13% niobium.

South Africa

The Kangankunde Hill carbonatite deposit in Malawi, South Africa, is situated approximately 80 kilometers north of Blantyre, in the Kasupe district of Malawi. The deposit takes the form of a carbonatite hill rising from the valley plain of the western part of the Nyasa Rift, to a height of about 200 meters above the surrounding plain. The identified economic minerals in the carbonatite pipe are mainly strontianite and monazite.

Kangankunde has been investigated extensively, first by the Malawian Geological Survey, thereafter by Lonrho, and more recently by the French Co. BRGM. Rhodia (Rhone Poulenc) was involved with the investigation with BRGM.

The Malawi Ministry of Forestry and Natural Resources has quoted that only one part of the deposit, as containing 11 million tons of ore at an average grade of 8% strontianite and 2% REO. This represents about 500,000 tons of monazite, sufficient to produce 6,000 mt annually of mixed rare earth chloride for a period of 54 years at an overall recovery of 65 percent.

Australia

Kawatetsu mining company and Itochu Corporation are purchasing 40 percent of a zirconia project at Dubbo (NSW) Australia, owned by Alkane Exploration Ltd. Group. Alkane's zirconia project has a large resource of zirconium, hafnium, tantalum, niobium, yttrium, and other rare earth elements.

Alkane has developed a sulphuric leach/solvent extraction process capable of producing a high-purity end product. Proposed throughput is 200,000 mt annually, with annual production of 3,500 mt zirconia; 1,500 mt yttria-rare earth concentrate; and 900 mt niobium-tantalum concentrate. The cost of the project is estimated at A$60 million (US$30.6 million).

Trends Affecting World Mine Production

Future Mine Production

Inner Mongolia is ready to develop its rare earth industry. The government has a five-year plan (2001-2005) that lists the development of high value-added products, environmental, and functional products. This region accounts for 66 percent of the world's proven rare earth reserves, which presently has not been developed outside of Baotou City.

The Department of Foreign Trade and Economic Cooperation of the Inner Mongolia Autonomous Region has officially empowered Rare-Earth High-Tech Zone in approving foreign investment projects. The zone can now allow up to US$30 million per each investment.

On the negative side, Leading RE enterprises in Northern China's Inner Mongolia Autonomous Region, have reported a 51% decrease in industrial output value during the third quarter of 2001.

In the first half of 2001, Baotou RE Hi-New Developing Zone has increased production 30 percent over 2000. A total of 25 investment projects have been initiated in 2001, a few of the examples are:

- RE Ni-H power battery project ($30 million)
- High Performance NdFeB project
- Hydrogen-storage alloy powder project
- CT light Source Instrument
- High Energy Neutron Magnetic Device

The State Economic and Trade Commission (SETC) want to stimulate reforms for its nonferrous industry from 2001-2005. The manager of the SETC's metallurgy and nonferrous divisions, Xu Xuegan indicated that priority would be given to mining, raw material procurement, downstream processing and production of new materials. Mr. Xuegang also stated, "…development plan 2001-2005 is made to adapt to the needs of the domestic and international markets, improve the performance of the domestic industry, increase the competitiveness of products and ensure the sustainable growth of the industry. We will improve cooperation with foreign companies to establish long-term and stable channels for the supply of raw materials."

Lynas Corporation Ltd., sold the rights to its Paraburdoo Gold Project/Mill to concentrate on its strategy to become a major player in the world market for rare earths. Lynas Corp. plans to be profitable in 2004 with production started sometime before that. The Mt. Weld RE deposit, located near Laverton, Western Australia, is a resource of 1.7 million tons at an average grade of 19.6% REO, with a 15-year mine life. This is the World's largest high-grade rare earths deposit.

Baogang cut its rare earths concentrate output from 110,000 to 90,000 mt annually in the second quarter of 2001.

Imports/Exports
Japanese RE imports from China are down 21 percent in second quarter 2001 from its previous quarter. Japan is the primary importer of Chinese rare earth products.

Foreign investors have driven China's economic growth rate of 7 percent for the January-June 2001 period.

Refineries
Yangjiang Rare Earth Company has expansion plans into 2004. Guangzhou Fuda Group acquired 86 percent of Yangjiang with the vision to make it into the largest rare earths processor within China and eventually, the largest in the world. This facility supplies rare earths products to General Motors, General Electric, Phillips, Toshiba, and Samsung.

New Products
Ningbo Yunshenig Group plans to build a high-performance NdFeB magnet production line in the Baotou Hi-Tech Development Zone. The production line will produce 600 tpa of high-performance sintered magnets.

Pure yttrium vanadate crystal production at Beijing Crystal Science & Tech Co., Ltd. is in great demand by the long distance optical fiber communication industry. The Beijing facility consists of 20 high inductive refining furnaces, which produces 200 kilograms of yttrium vanadate crystal.

In April 2002, Japan's Sumitomo Metals Co. is planning to start production in China of miniature high-performance magnets used in cellular phones, audiovisual equipment, and other products. Production at the company's first Chinese plants is aimed at satisfying the rising demand for small magnets from the communications equipment industry and electronic parts makers relocating there.

Construction of the plant in Dongwan, a suburb of Shenzhen, is expected to be completed by the end of December. The plant will be run by a local joint venture between Sumitomo Special Metals and Super Electronic Co., a Taiwanese maker of magnets and electronic parts. The plant will have a workforce of 200. Initially, the plant will produce around 20 million neodymium magnets per month, for use in cell phone micro speakers and CD player pickups.

Rhodia Electronics & Catalysis' Eolys fuel-borne catalyst (cerium-based) received widespread European recognition at the International Auto Show in Frankfurt, Germany, in September for its use in the Diesel Particulate Filter (DPF) technology designed and developed by Peugeot Citroën to provide a means to efficiently control automotive emissions in a diesel powered passenger vehicle.

Shimura Kako of Japan completed a nanocrystal spherical powder plant with a capacity of 45 tons during 2001.

Growth Rates
The world market of nanoparticulate materials in electronic, magnetic, and optoelectronic applications reached $333 million in 2000 and is expected to reach $667 million by 2005.

Piezoelectric ceramics market is expected to reach $340 million by 2005.

Manufacturing
On October 5, 2001, TDK Corporation, Tokyo, Japan, the world's largest manufacturer of magnetic heads for hard-disc drive is cutting its global workforce by 24 percent by 2004. The cuts are the result of declining demand for electronic parts.

Hitachi Metals reported a sales loss for the first time in its history, due to the downturn in the World electronic parts demand.

All types of car sales in Japan were down 4 percent in September of 2001.

Morgan Crucible announced in late October that it may need to downsize more, due to a "substantial" drop in profits.

Rare Earths Demand
Worldwide demand for rare earths is forecast to reach 100,000 mt — at a total value of $1,000-$1,200 million — by 2004, according to *Mining Annual Review 2001*. While rare earths consumption was 70,000 mt two years ago, future demand is expected to grow in pace with newly introduced rare earths applications.

Rare earths processors are expected to meet global demand until 2004. Within this time frame, the trend in demand will be toward the use of individual compounds, metals, and special mixtures in magnets, glass additives, catalysts, batteries, and specialty alloys applications.

Specifically, demand for cerium, which is used in autocatalysts, may increase at rates in excess of the growth in Gross World Product, according to *Mining Annual Review 2001*, as more greenhouse gas-reducing legislation is passed worldwide.

Other cerium-containing applications, such as polishing powders for cathode ray tubes (CRT), lenses, and mirrors, as well as additives for CRT faceplates that enhance picture quality, will drive demand for this rare earth upward, especially as the popularity of larger screen televisions grows among developed countries. The use of cerium polishing powders in the manufacture of computer chips—a new cerium applications sector—is currently a hot market, experiencing a growth rate of over 50 percent annually.

The CRT and trichromatic lamp phosphors markets should maintain steady growth. China is now the leading producer of phosphors, now that Japan has transferred its technology to China in hopes of moving production off shore.

Magnet manufacturing is also expected to relocate from Japan to China, as China is the world's largest source of magnet raw materials and Magnequench, the leading magnet manufacturer, is now owned by a Chinese company. Demand for magnets is expected to wane in response to supply constraints.

Table 3
World Rare Earths Markets 1999 (in metric tons)

Application	N. America	Europe	Asia	China	Others	Total
Catalysts	12,500	5,000	3,000	3,000	500	**24,000**
Glass	4,000	3,500	9,500	2,500	500	**20,000**
Metallurgical	1,500	200	3,300	5,200	300	**10,500**
Magnets	1,500	1,300	4,000	3,000	200	**10,000**
Ceramics	600	300	800	300	---	**2,000**
Phosphors	500	500	2,400	1,000	100	**4,500**
Other	500	200	700	1,500	100	**3,000**
Total	**21,100**	**11,000**	**23,700**	**16,500**	**1,700**	**74,000**

Source: The Mining Journal, *Mining Annual Review 2001*

Table 4
Forecast Growth of World Rare Earths Markets

Application	Rare Earths Demand (in metric tons)		Annual Growth Rate (%)
	1999	2004	
Catalysts	24,000	28,500	3-5
Glass	20,000	24,000	3-5
Metallurgical	10,500	16,000	8-10
Magnets	10,000	18,000	10-15
Ceramics	2,000	3,500	12-15
Phosphors	4,500	6,500	7-8
Other	3,000	3,500	2-4
Total	**74,000**	**100,000**	**4-10**

Source: *The Mining Journal*, *Mining Annual Review 2001*

In the USA, consumption of rare earths was approximately 17,900 mt in 2000, up 6,400 mt from the previous year, according to the US Geological Survey (USGS). The temporary closure of Molycorp's Mountain Pass, California rare earth separation plant continues to result in high levels of rare earth imports to the USA (**Table 5**).

Table 5
US Rare Earths Imports - 2000

Monazite	**Percentage of Imports**
Australia	67
France	33
Rare Earth metals, compounds	
China	71
France	23
Japan	3
United Kingdom	1
Other	2

Source: USGS, *Mineral Commodity Summaries*, 2001

Automotive catalytic converters, permanent magnets, and rechargeable batteries are the leading applications setting the trend for increased use of rare earths in the USA (**Table 6**).

Table 6
US Distribution of Rare Earths by End Use - 1999

End Use	Percentage
Automotive catalytic converters	60
Glass polishing and ceramics	11
Permanent magnets	8
Petroleum refining catalysts	7
Metallurgical additives and alloys	6
Phosphors	2
Other	6

Source: USGS, *Mineral Commodity Summaries*, 2001

Applications

US consumption of rare earths in 2000 reached 17,900 mt REO, a significant increase from the 1999 total of 11,500 mt REO. Consumption of rare earths is dominated by six main applications:

- catalysts,
- phosphors
- magnets
- glass
- ceramics
- metallurgy

In addition, rare earths are used in several other industries including electronic data storage, fertilizers, jewelry, lasers, superconductors, as well as in the fields of medicine and nuclear engineering (**Figure 7**). By far, the leading rare earth in commercial use, by volume, is cerium, used in all major applications.

Table 7
Rare Earths Applications

Cathode ray tube (CRT) phosphors	Semiconductors	Fiber optics
Trichromatic lamp phosphors	Low-temperature superconducters	Optical glasses
Intensifying screen phosphors		Garnets-for computer memory
Incandescent lamps		Magnetostrictive alloys
Laser crystals		Magnetostrictive transducers
X-ray sources		
Oxygen sensor ceramics	Soaps & lubricating greases	Chemical catalysis
Ceramic capacitors	Cosmetics	Automotive catalytic converters
Stabilized zirconia		Petroleum fluid cracking catalysts
Refractory crucibles		
Glass polishing		
Lighter flints & pyrophoric alloys	Nickel metal hydride alloy	Nuclear reactor neutron absorbers
Cast iron alloys	Rechargeable batteries	Oxidizers in self-cleaning ovens
Aluminum alloys	Hydrogen storage alloys	
Superalloys	Permanent magnets	
Magnesium castings		
Corrosion inhibitors	Pharmaceutical isotopes	Glass colorization
Waterproofing	Pharmaceuticals for sea & pregnancy sickness	Dying and printing textiles
Cryogenic refrigeration	Agriculture	

Catalysts

The largest market for rare earths in the USA is autocatalysts and demand has grown significantly since the 1980s. Autocatalysts, which contain small amounts of cerium and lanthanum, are becoming more popular worldwide as well, as exhaust emissions legislation becomes more widespread.

Lanthanum-rich rare earth chloride is used in the making of catalyst material for petroleum cracking. Scandium oxide is used as a catalyst in making crucibles and other ceramic parts. Other catalyst materials include rare earth metal exchanged Y type (REY) zeolite and nickel supported REY zeolite, which is used in catalytic cracking in a steam atmosphere.

A new catalyst material — Mitsui Chemicals' post-metallocene catalyst (FI Catalyst) –exhibits 10 times the ethylene polymerization activity of metallocene catalysts. The FI Catalyst is a complex catalyst that combines salicyladimine and group IV metals, including zirconium, titanium, and hafnium. According to Mitsui, the FI Catalyst is economic as well, employing inexpensive rare earth metals and providing long-lived catalytic activity at one-tenth the cost of a metallocene catalyst.

Autocatalysts account for more than 40 percent of total platinum demand. Palladium, cerium, and rhodium are also used in autocatalysts, with 79 percent of the total demand for rhodium, alone, attributed to autocatalyst manufacturing. An autocatalyst is composed of a three-way converter, a "catalytic converter." Engine exhausts, which contain nitrogen oxide, unburnt hydrocarbons, and carbon monoxide, pass through the catalytic converter at around 300 degrees Celsius and are converted by the metals (platinum, rhodium, cerium, and palladium) that coat the ceramic honeycomb surface of the converter into harmless nitrogen, water, and carbon dioxide.

Through an exclusive agreement with Clean Diesel Technologies, Inc. (CDTI), The Lubrizol Corporation will be a licensed distributor and blender of CDTI's patented Platinum Plus® fuel additive technology, which helps stop clogging of particulate filters used to trap soot emitted from diesel engines. The seven-year contract covers diesel original equipment manufacturers, original vehicle manufacturers, and the retrofit market in Europe.

Platinum Plus is a platinum and cerium catalyst that, when mixed with diesel fuel, facilitates the combustion of carbon-rich particulate (soot) into carbon dioxide, removing the particulate from the filter. The combustion of particulate, also known as "regeneration," prevents particulate filters from plugging with soot. The use of diesel particulate filters is becoming mandatory for diesel equipment used in mining, tunneling, and construction throughout Switzerland, Germany, and Austria. Other countries in Europe, as well as the USA, Japan, Hong Kong, and Taiwan, have announced programs calling for the retrofit of filters in both on-road and off-road engines

Ceramics

A wide range of specialty ceramics is emerging, based on rare earth oxides. Yttria ($Y2O3$) has long been used to stabilize zirconia ($ZrO2$) ceramics at high temperature, but recent research has uncovered numerous additional applications for ceramics containing rare earth oxides.

T/J Technologies is developing transition metal-based ceramics for use in rechargeable lithium batteries. Lithium nitrides are used as the basis for the ceramics, which can be doped using transition metals such as yttrium, lanthanum, zirconium, and titanium. Scientists have noted that even adding a small amount of dopant can greatly increase the performance of the ceramic material.

Coatings

PPG Industries is now supplying a yttrium coating to several leading auto manufacturers, according to Metal-Pages. The new coating will replace a traditional use for lead ions, which are used to provide an adherent, corrosion-resistant interface between the metal of the car body and the polymeric binder of the paint.

Despite the fact that lead ions have been banned for many years in most applications, exemption exists for soluble lead pigments up to 1,000 ppm in electrodeposition coatings as no satisfactory substitute had been found. The new water-based yttrium coating provides corrosion resistance that is equal to or better than that of lead, and maintains surface quality. In operation YOH is deposited from an yttrium salt during electrocoating and converted to Y2O3 during heat curing. PPG intends to introduce yttrium in all of its electrocoat products over the next decade.

Fuel Cells

Fuel cells are used in many settings, such as homes, hospitals, schools, utility power plants, and airports, in portable devices including wireless telephones and laptop computers, as well as to power automobiles, trains, buses, and space vehicles. Fuel cells are available in many varieties—phosphoric acid, proton exchange membrane, molten carbonate, solid oxide, alkaline, direct methanol, and regenerative—and run on many types of fuels, including hydrogen, methanol, natural gas, gasoline, renewable fuels, ethanol, propane, and hydrogen peroxide.

The most expensive component of the fuel cell is the catalyst material, which is most often made with platinum. Specifically, it is a platinum, carbon powder, and proton exchange membrane powder mix, bonded to a conductive carbon fiber cloth.

Many commercial vehicles that use fuel cells have been developed, including Mercedes-Benz's NECAR II van, Daimler-Benz's NEBUS and NECAR 3, Daimler-Chrysler's NECAR 4 car, Jeep's Commander SUV, Mazda's Demio, Ford's Prodigy, and Opel's Zafira and Sintra. Other fuel cell-powered vehicles include taxicabs, utility vehicles, and golf carts.

Stationary fuel cells provide backup power to institutions, smaller buildings, homes, and power plants. Some companies claim that the use of residential fuel cells could save consumers about 15 percent on their current electricity and natural gas energy bills.

Portable fuel cells are currently on the drawing board. Laptop computers, video cameras, traffic signs, and even modern soldiers' basic equipment may some day be powered by miniature fuel cells.

Glass

General Electric (GE) has introduced a new light bulb that it claims produces a higher quality of light. The crisper quality of light is achieved by adding **neodymium** to the glass. This gives the new bulbs, called Reveal, a distinctive powder blue color when not lit. When lit, the neodymium produces a pure, true light by filtering out much of the dulling yellow emitted from ordinary light bulbs. According to consumer tests, the new bulbs make colors and home environments richer and more textured, and also make task-related details appear crisper, or more highly defined.

More than six years of research and consumer testing went into developing the neodymium bulbs for the consumer market. The Reveal light bulbs is the largest product launch in GE Lighting's history. This introduction began this fall and is expected to surpass that of the industry-standard Soft White bulbs introduced nearly two decades ago.

Lasers

Semiconductor lasers, defined as light amplified by stimulated emission of radiation, are typically made of gallium compounds, such as GaAs, aluminum-gallium arsenide (AlGaAs), or aluminum-gallium-indium phosphide (AlGaInP). Lasers emit light with a wavelength of about 820 nanometers (nm), which can read grooves on compact optical disks (CDs) no smaller than a micron in size (approximately equivalent to one fiftieth of a human hair).

Blue diode lasers, which emit light at a wavelength of 460 nm, are now being developed to be able to read much smaller pits. This breakthrough would make it possible for considerably more data to be stored on CDs. Wide band gap material, zinc selenide (ZnSe) and gallium nitride (GaN), are used to create blue wavelength light. GaN laser diodes have potential markets in laser printers, medical equipment, and DVDs.

In 1998, Nichia Chemical Industrial Co. Ltd. of Japan developed high-power GaN laser diodes that are capable of emitting violet light, which is of a shorter wavelength than blue light. This breakthrough allowed CDs to store even greater amounts of data, giving rise to the GaN laser diode's potential use in flat panel displays. At the time, Nichia was eyeing the DVD market.

A new erbium YAG (yttrium-aluminum-garnet) laser for use in cavity preparations and other dental procedures is currently in development at American Dental Technologies in Texas, USA. The laser, called Cavi-Lase 250, will provide "painless and patient-friendly dentistry," according to the company. Shipments of the Cavi-Lase 250 will begin in the first quarter of 2001.

Light-Emitting Diodes (LEDs)

LEDs reside in our stereos, alarm clocks, microwave ovens, computers, car dashboards, and televisions — as well as our remotes. Two forms of gallium have traditionally been used in LED technologies: AlInGaP (aluminum indium gallium phosphide) and InGaN (indium gallium nitride). AlInGaP is used to create red, orange, and amber light; while InGaN is used for green, blue-green, blue, white, and ultraviolet (UV) light.

The latest LED to hit the market is the UV LED. When used with a phosphor, the UV LED creates unbelievably efficient white lighting, brighter and more efficient than any lighting used today. Currently, the UV LED is used in validating currency and event tickets — an application once relegated to fluorescent "blacklight" fixtures. A major manufacturer of UV LEDs is LumiLEDs.

Medical Applications

Gallium nitrate is useful in treating a variety of human diseases that are characterized by bone loss, such as cancer, bone metastases, Paget's disease, and post-menopausal osteoporosis. According to medical researchers, gallium and its compounds are potent inhibitors of bone resorption and act to maintain and restore bone mass. Gallium is also thought to cure navicular disease in horses, if given during the early stages of the affliction.

A radioactive form of gallium (^{67}Ga) is used to detect tumor cells and white blood cells in patients with Hodgkin's disease and non-Hodgkin's lymphoma. Specifically, the gallium scan detects inflammation, which usually indicates tumors or infections.

Doctors are turning more often to **gadolinium** in the battle against tumors and other unwanted medical conditions, according to experts. Often referred to as "gad" by surgeons and radiologists, gadolinium is a rare earth element with unusual magnetic properties that make it ideal for use in magnetic resonance imaging (MRI) to help surgeons pinpoint tumors in the breast, brain, and heart, among many other areas. Scientists say gadolinium's use in MRI has vastly improved diagnostic techniques as doctors can now see inside the body as never before – prompting a closer look at the lesser-known elements to find even more uses for metals in medicine.

Magnet therapy has gained in popularity over the last few years to typically aid those suffering from muscle pain. Relievepain.com offers a lightweight neodymium magnet that provides deep magnetic field penetration.

Some rare earths are used in dietary supplements, such as chromium, selenium, and vanadium. Chromium and vanadium are thought to help in normalizing blood sugar levels. Selenium is one of the country's top 10 most used nutritional supplements used in the USA, according to *Doctor-walllach.com*.

Metallurgical Uses

Mischmetal (generally referred to as Mm) is an alloy of cerium and lanthanum with other rare earth elements that is the direct result of refining rare earth mineral concentrates without separation of the individual elements. It has been used as a flint material in lighters and firearms for many years. Both cerium and lanthanum are pyrophoric and, as a result, small particles of the alloy ignite in air when struck off the flint. Fortunately, the mischmetal usually contains a high level of both iron and interstitial elements, which make it brittle and easily able to form sparks.

Mischmetal has other uses, too. Interstitial and iron-free Mm is being evaluated by a number of researchers as a substitute for pure rare earth metals in applications where the presence of other rare earths is non-critical. The problems in applying mischmetal, however, derive from the characteristics that make it effective in flints—the material is typically embrittled by a high interstitial content and by about 5-10 wt % iron. In addition, Mm varies widely in composition according to source; it may be cerium-rich, lanthanum-rich and may contain more or less of neodymium, praseodymium, samarium and several other rare earths. Historically, no attempt has been made to remove the interstitials from Mm, which may contain several wt % of these impurities.

Rare earth elements, most notably cerium and mischmetal, have also been used as minor alloying additives for controlling inclusions in cast irons and steels. The cerium appears to combine with the sulfide inclusions that are invariably present in these materials to form particles with a more rounded morphology that is less likely to promote cracking. The morphology of graphite particles in nodular irons may also be modified to promote greater ductility. Both results may be due partly to the effect of cerium in modifying the surface properties of the metal or sulfide. The extreme chemical affinity of the rare earth elements for almost anything that they may contact suggests that they will also interact strongly with inclusions in most metals. However, little is known about the mechanism by which this occurs.

A more recent discovery suggests that small additions of the lanthanides may confer even greater protection on those metals and alloys that are already well protected from corrosion by oxide films. These include the iron-chromium and iron-chromium-nickel stainless steels (i.e., both the ferritic and austenitic alloys), and most other alloys that are dependent on chromium for corrosion/oxidation resistance. Further study may suggest that the effect is even broader; for example, that the protection provided by all spinel-forming oxides such as aluminum oxide (Al2O3) or chromium oxide (Cr2O3) is enhanced in this way. Use of rare earths as alloying additions for corrosion control shows promise of becoming a major growth market. There is also strong evidence that at least cerium acts as a grain-refining agent in some steel compositions, just as it apparently does for aluminum and magnesium alloys, with corresponding improvements in mechanical properties and fatigue resistance.

Galfan®

Mischmetal is also used very effectively in an improved zinc-galvanizing product called Galfan® (developed by ILZRO/Weirton Steel). This is a zinc-5 wt.% aluminum alloy with small Mm additions that is used as a substitute for 'straight' zinc. It has been shown to be very effective in most galvanize applications with the possible exception of heavily contaminated industrial environments. It is in extensive use in Europe as a galvanizing treatment for sheet steel.

Mischmetal or pure rare earth additions are also surprisingly beneficial in magnesium and aluminum-magnesium cast alloys. Once again, the grain structure is refined, the negative impact of intermetallics on notch sensitivity, toughness, and strength is offset and corrosion resistance greatly improved. In some cases (e.g., Al8Mg5), formation of the intermetallic may be suppressed.

The beneficial effects of lanthanides on non-ferrous metals extends, not surprisingly, to their metal-matrix composites. Once again, the presence of the rare earths results in grain refinement, improved mechanical properties and, apparently, improved intermetallic morphology in addition to enhanced corrosion resistance.

Nanomaterials
Altair Technologies has produced lithium titanate spinel and yttria-stabilized zirconia (YSZ) on the nano-size stage. A great deal of interest is centered on lithium titanate spinel in advanced energy storage devices. Nano-size YSZ is used to improve thermal spray products for corrosion protection, thermal barriers, and micro-formed products. Altair is now producing evaluation samples at their Reno, Nevada facility and submitting patent applications.

NdFeB Magnets
Increasingly, China is becoming a major producer of neodymium-iron-boron (NdFeB) magnets. NdFeB magnets power small applications, such as

- automobile mechanisms (windshield wiper motors and anti-lock brakes),
- computer hard disk drives,
- video players,
- CD-ROMS,
- digital cameras,
- other small electronic products.

There is currently a trend for Chinese magnet producers to be floated on the stock exchange, which has resulted in investment in magnet production from sources that have no previous interest in the industry. The influx of investment is being used to develop raw magnets and raise production levels. This year, major producers of ferrite magnets and NdFeB magnets are expected to float on the stock market.

In addition, Chinese production capacity for NdFeB magnets is expected to match world demand in the near future, which is causing concern for Japanese producers. Output is estimated at 6,400 mt in 2000.

Today, NdFeB success has been achieved in nanomaterials. Powdermet Inc., Sun Valley, California, has developed nanostructured powdered magnetic materials based on NdFeB particles that can be consolidated into improved energy product permanent magnets. The company has received a $98,000 SBIR award from the US Department of Energy to further develop and characterize the magnets. The magnets are made by organometallic chemical vapor deposition.

Nickel Metal-Hydride Batteries
Commonly used in portable electronic equipment, such as laptop computers, camcorders, and mobile phones, mischmetal-containing-nickel hydride batteries currently face competition from lithium-ion batteries. However, with demand for nickel hydride batteries forecast to grow by an average 10 percent annually to 2005, the demand for nickel-cadmium batteries may be diminished.

In addition, as lanthanum-nickel-hydride batteries continue to become the environmentally preferred choice for use in gasoline-electric hybrid vehicles, over traditional nickel-cadmium batteries, demand for lanthanum could be on the rise.

Nuclear Applications
Europium, gadolinium, and dysprosium have large capture cross-sections for thermal neutrons, and thus, are often incorporated into control rods to regulate reactor operation. Rare earth elements can also be used as burnable neutron absorbers to maintain the reactor flux at a more constant level. Obviously, with little growth anticipated in the nuclear power industry, this is a small and non-growing market for the rare earth metals.

Phosphors
Organolanthanide phosphors (OLPs) offer the normal lanthanide advantage, as the color and efficiency of emission are properties of the lanthanide and can be changed without changing the chemical properties of the polymer. *Advanced Materials* recently reported the fabrication of a high-efficiency organic electroluminescent device using an organoterbium emitter. The device produces green light with peak luminance of more than 2000cd/m2. In order to obtain this efficiency, a multiplayer structure was used.

Semiconductors
The advantages of gallium arsenide (GaAs) semiconductors over silicon semiconductors include the ability to emit light and high absorptivity, which is useful in high-speed computers, cellular telephones, fiber optic telecommunications, communication satellites, and solar cells. Other desirable characteristics of GaAs semiconductors include their relative insensitivity to high temperatures, resistance to radiation damage, and design flexibility.

Triquint Semiconductor, Inc. introduced a newly developed tri-mode, dual-band transmitter for CDMA/PCS/AMPS cellular telephones in October 2001. The transmitter, made with silicon-germanium (SiGe) semiconductor material, maximizes talk time by offering low overall current consumption and the capability to selectively power up individual circuit blocks.

Superconductors
A new powerful rare earth magnet called The Levitator, made from neodymium, iron, and boron, is able to lift several kilos. Makers of the Levitator superconductor expect mechanical devices such as motors, generators, and energy storage devices that use frictionless bearings based on Levitator technology available to be available within a few years.
==

Rare Earths Industry Perspectives
By Myra Pinkham
==========================

Stanley R. Trout
Spontaneous Materials
Stanley R. Trout, backed by 25 years of experience in the permanent magnet and rare earth industries, said that he sees himself as a rare earths evangelist, helping people interested in rare earths to connect the dots and get over the fear of the veil of mystery surrounding these elements, as well as helping them to sift through the lack of rare earths information and the misinformation.

Trout, who currently heads a Fishers, Indiana-based consulting firm—Spontaneous Materials—that focuses on rare earths and magnetic materials, was first introduced to rare earths in the late 1970s as an undergraduate student at the University of Pennsylvania in Philadelphia, where he did research with someone from Latham, New York-based Intermagnetics General Corp. "That corrupted me," he said.

"I was a physics major as an undergraduate student at Lafayette College in Easton, Pennsylvania, but I was worried that I would be unemployable if I stayed with that and eventually decided on metallurgy as a career. It was not that different from physics, but more practical," Trout explained. "And the more I got into it, the more that I realized that I liked magnetic materials."

After graduate school Trout took a series of jobs in the magnetics field, first working with samarium cobalt magnets at Recoma Inc., Fairfield, New Jersey, and Crucible Magnetics, Elizabethtown, Kentucky, and developing neodymium-iron-boron (NdFeB) magnet alloys at Hitachi Magnetics Corp. in Edmore, Michigan.

"But it wasn't until I worked at Molycorp Inc. that I got into the business of selling rare earth materials and, therefore, became more of a rare earther," Trout said. There he was responsible for sales and promoting new applications for rare earths, and sold various materials aimed at a variety of applications including permanent magnets, glass polishing compounds, petroleum and environmental catalysts, thermal barrier coatings, nickel metal-hydride batteries, advanced ceramics, and ferroalloys.

From Molycorp, in 1997, he once again focused on magnetics, working as an applications engineer for Magnequench International Inc., Anderson, Indiana, where he remained until earlier this year.

"One thing that I find interesting about rare earths is the breadth of applications," Trout said. Rare earths go into so many things, but it is only obvious to an insider that they are there. They make a lot of things possible, but very often they don't get credit for it."

Trout noted that while he has a soft spot for anything to do with magnets, including both neodymium- and samarium-based magnets, "I am also gaining respect for yttrium, which is used in a lot of applications, including phosphors, ceramics, and most stable oxides. While it can also be used as a magnetic material, it has not done so thus far because of its cost."

He added that even people who should know more about rare earths, tend to only know about one area of the market since, "even though all the rare earths come from one type of ore, they tend to be a little quirky…Because the rare earths are found together in nature, the industry can seem very convoluted to those unfamiliar with it, but understanding the chemical and physical nature of the rare earths, as well as the unusually complex commercial interplay between supply and demand, can be critical.

Trout said that his aim as a rare earths and magnetic materials consultant, an endeavor he took up at the beginning of this year after he was downsized out of Magnequench, is to help people to understand what the real issues are. "There is a lot of information out there. We all tend to ignore things that are not as important to us, but with rare earths we need to look at it from a broader view," he said.

Currently, Trout said, his major customer is Polaris Rare Earth Materials, the exclusive North American representative for XiJun Rare Earth in Xi'an, China. "They are trying to add stability to the market and what I am doing is helping them to find customers in the United States."

While there have not been many real big developments recently in rare earths, the market has been going through certain evolutionary changes, Trout said. "Commercially the big thing is the Chinese invasion. Years ago people wanted prices to go lower, and now that they are lower, people are complaining about stability. One thing that many people liked about Molycorp was that they sat on a very large deposit. They also ran their business like a bank, so everything was very transparent."

Everyone thought, Trout noted, that there would always be supply from Molycorp, "but now that has gone away. People are now seeing that there was value to the way that they ran there business, although they didn't enjoy it at the time."

Trout declared, "I find it very interesting that the commercialization of rare earths didn't start until the end of World War II, and I don't know if we have discovered even half of the possible applications. A lot of people tend to ignore that part of the chemical table. It will take time to undo that damage. We need to let people know that rare earths are not really rare. That is why Molycorp does not use that word relating to these elements but call them lanthanides instead."

For more information, please contact:
Stanley Trout
12348 Melrose Circle
Fishers, Indiana 46038, USA
phone: 317-596-0858
fax: 317-577-4106
E-mail: strout@ieee.org
Internet: http://www.spontaneousmaterials.com
==

Les Heymann
Les Heymann Consulting

While anything could happen in the very dynamic minerals business, it is very unlikely that China will lose its controlling grasp upon rare earths any time soon, especially for light rare earths, Les Heymann, head of Les Heymann Consulting, Penetanguishene, Ontario stated.

Heymann has been involved in the mining industry since 1969, working for such companies as Barlow Rand, Kerr Addison Mines, and the Indusmin division of Falconbridge. He first became interested rare earths in 1994, when AMR Technologies Inc. of Toronto, Ontario, then known as Advanced Material Resources, purchased its first Chinese facility—the Zibo Rare Earth factory in Shandong, China.

"I had some background in uranium and therefore knew something about solvent extraction technologies so they asked me to run that factory," Heymann explained. He later became vice president of production for AMR, in charge of both of its Chinese rare earths factories, as well as being instrumental in the launching of a rare earth magnet factory in Thailand.

After serving in that capacity for about four years, Heymann returned to private consulting and in 2000 started up a rare earth separation plant in Yang Zhong, China, for Inter-Citic Mineral Technologies Inc., Toronto, Canada.

Heymann said that he has seen many changes in the rare earths industry in the past eight years or so, including considerable prices drop largely due to increased Chinese production, as well as witnessing Chinese capabilities for rare earths production improve quite a bit. "When they started, their product was pretty rudimentary," Heymann observed, "but now they can compete with anyone in the world."

These two factors when put together have resulted in problems for rare earth producers outside of China, Heymann admitted. "Rare earth separation capacity in Japan has been almost totally annihilated because of the price and environmental issues. US production capacity has also been decimated. Molycorp said it closed the Mountain Pass [California] facility for environmental reasons, but I suspect that price also played a part. Also Rhodia's plants in the USA have cut back considerably with most of the work being done in China and Rhodia just doing the finishing work in North America," he said.

Chinese rare earths, he noted, have not always been of good quality, but that has all changed, largely because of the Chinese work ethic. "The quality is now quite superb. AMR and Inter-Citic have introduced Western quality standards, as well as contributing access to outside markets and introducing better accounting systems to the Chinese," Heymann said, adding, "One thing that communists are good at is capitalism. The Chinese are good businessmen. They've made a tremendous amount of improvement. The first time that I went into China it was like going to St. Petersburg, but now it is booming."

Heymann observed that more and more companies are becoming involved in China – rare earth companies as well as others. "Some come to China for the market, because of the large population. They usually don't do so well because they don't consider what is good for China. Others come to China for what it has, such as rare earth resources. Those companies generally do well. And then there are strategic players, who understand that they need to be in China because it is a growth market," he explained. But the Western company has to be aware that business conditions are different than what they are used to, that there is less of a need to service debts, and that there is much more involvement of the Chinese government in business.

Heymann said that at least for the time being the rare earth industry will continue to be centered in China, especially for light rare earths, which are a by-product of iron ore mining in the country. "They have a great advantage with more neodymium than any other ore in the world," he declared.

As far as heavy rare earths, which the Chinese extract from iron-absorbed clays, there are some people who think that these rare earths are in limited supply, Heymann said, "but light rare earths are likely to be supplied by China for a long time, probably 200 years," he added.

"The minerals business is funny," Heymann admitted. "Tomorrow someone could make a discovery, but that is not likely to happen. The Chinese also have the advantage of having the most rare earth processing knowledge in the world and cheap labor costs."

Rare earth prices, also, might not remain as low as they are now, Heymann said. "The downturn of prices came when there was a buildup of inventories and a collapse of demand for end product. But now with inventories trimmed, especially in South Korea, Japan, and the USA, people will be starting to buy again and prices will again increase," he said, adding that the Chinese are also making moves to firm up prices. "Because of the oversupply of light rare earths, a lot of factories in China have been closed," he noted.

For more information, please contact:

Les Heymann
47 Payette Drive
Penetanguishene, Ontario L9M 1H5, Canada
phone: 705-549-2274
fax: 705-549-3003
E-mail: lheymann@mail.transdata.ca

==

Inter-Citic Mineral Technologies Inc. – A Western Link to China's Rare Earths

Inter-Citic Mineral Technologies Inc., Toronto, Canada, sees rare earths as key to achieving its goal to become a North American gateway to China. It has been making great headway through its 18-month old Yangzhong Zonghai Techmat Co. Ltd. (Techmat) joint venture, in which it has an 80-percent interest.

"We are confident in our business strategy to establish Techmat as a reliable supplier of high-quality rare earth products catering to export markets," James J. Moore, president and chief executive officer of Inter-Citic, declared, adding that the rare earth separation facility located just outside of Shanghai concentrates on cerium and neodymium, both of which are likely to see growing demand.

Cerium, he noted, is used in a number of high technology applications, including the automobile industry. In particular, the market for automobile catalytic converters is considered to have a very promising future. Meanwhile, neodymium is used in the manufacture of magnets used in small and microelectric motors, which is also seen as a growing market.

"There is no question that in the last year or so we have seen a total collapse in the neodymium market," Moore admitted, but he said this is a part of a natural economic cycle and that long-term he is optimistic about its future. "Largely due to an oversupply situation, prices of neodymium have fallen over 50 percent," he said, "But I don't see this as a story itself, but as a chapter within a story. There will be a contraction of the market—a healthy, appropriate contraction—and that will bring with it renewed stability to the market."

Meanwhile, Moore said, cerium demand has been holding its own. "But we are watching that very closely as well, obviously," he stated.

"I am very optimistic about the longer term," Moore said. "For a small industry, the rare earth industry has gone through some radical changes in the last few years and it will go through some more changes. But once it stabilizes, there is good reason to be optimistic."

The industry, he noted, went through a first stage of consolidation when a number of dominant Western producers, including Molycorp, closed down their rare earth facilities, which resulted in the Chinese dominance of the marketplace. Since then, however, a number of new rare earth facilities have been built in China, resulting in overcapacity at the processing level. "The next level of consolidation," he said, "will occur within China."

Once that occurs, Moore said, "there will be a new level of stabilization as far as supply and demand with fewer producers and processors. It is a situation where more research and development will be required for companies to be more competitive."

He said Inter-Citic is likely to have an edge in this new marketplace because the company is not concentrating so much on commodity products, but on those with certain additional enhancements. Also, he noted that the company has targeted export sales, which, in fact, make up approximately 65 percent of total sales and tend to yield the highest profit margins.

Moore maintained that China will likely continue to dominate the rare earth industry. "The economics outside of China just don't make sense," he said, stating that China has several advantages, including its mineral deposits, the level of know-how to produce and process rare earths and its proximity to market in the Southeast Asian community.

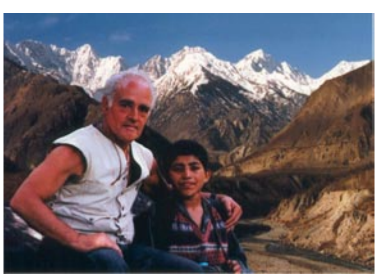
And China's economy itself is an extremely dynamic one, he noted, with its gross domestic product quadrupling in less than 25 years. Also, by 2004 China is expected to have the largest market in the world for mobile phones and digital cameras, and is rapidly installing the latest broadband telecommunications technology throughout the country. It is also notable that more than 25 percent of China's economic industrial output is attributable to the processing of mineral products and the output generated by the mining industry.

And while in the early days some customers had some problems with Chinese rare earths that, Moore said, has been rectified.

"I have heard of some other rare earth opportunities elsewhere," Moore said, "But I don't believe that any truly rival the Chinese resources. I know I wouldn't want to compete with the Chinese."

Moore joined Inter-Citic as executive vice president in 1996. He has been its president and chief executive officer since December 1997. Prior to joining Inter-Citic he worked for Klon Inc., one of Canada's first private Russia-Canada oil joint ventures, after holding various management positions with the National Trust.

For more information contact:
James J. Moore
Inter-Citic Mineral Technologies Inc.
372 Bay Street, Suite 901
Toronto, Ontario, Canada
Phone: 416-363-5055
Fax: 416-363-9688
E-mail: invest@inter-citic.com



A Conversation with Anthony N. Mariano, Minerals Exploration Consultant

While China is currently the most cost-effective way to get the rare earths that people need, there is no reason to believe that there are not other "magnificent" deposits to be found, Anthony N. Mariano, a consulting minerals exploration geologist specializing in specialty rare metals, maintains. The key, he said, is to have such potential resources identified by people with strong rare earth backgrounds and to develop new technologies that allow for the production of rich concentrates of elements at lower prices in an environmentally safe manner.

Mariano, based in Carlisle, Massachusetts, started his career in 1963, working at Kennecott Copper's Ledgemont basic research laboratory, where he first became interested in alkaline rocks and carbonatites, which are strongly enriched with rare earths. There his work was not restricted to the laboratory, but also included fieldwork, including visits to Molycorp's Mountain Pass, California mine, which is a carbonatite deposit.

So it just made sense that once Mariano went out on his own as a consultant/exploration geologist in 1972 that one of his major clients was Molycorp. "They sent me wherever they heard that there was an unusual rare earth deposit that they wanted to investigate," Mariano said, adding that he also got work from various governmental organizations, including the governments of Venezuela and Tanzania, as well as doing work for the United Nations, which sent him to such areas as the Amazon, Mali, Angola, and various locations in Africa, Pakistan, Kashmir, Afghanistan, and Burundi. Also, work for AMR Technologies Inc., Toronto, Canada, took him first to China and then to Thailand and Namibia. All told, Mariano notes, he has worked in 43 countries, mainly exploring rare earths and other rare elements.

Mariano said that it was the exotic mineralogy of carbonatites and rare earths that interested him. "At the time rare earths were an area that was not that well studied. They come from the igneous rocks originating in the upper mantle, well below the crust of the earth," he noted, adding that carbonatites, which are associated with alkaline and igneous rocks, bring up many exotic elements, including rare earths, niobium (columbium), uranium, thorium, tantalum, and phosphates.

Over the years there have been significant changes involving rare earths, Mariano observed, noting that demand for these elements have been very dynamic. "In the early days there was great demand for europium, which is used for the red color phosphor in television screens, as well as for yttrium, which is used for a host of phosphors. But with the advent of high field strength magnets, neodymium (for neodymium iron boron magnets) and samarium (for samarium cobalt magnets) have become more in demand." These magnets, he explained, are used in many common applications, including in every Walkman and personal computer. "That has changed the demand for rare earths."

Another change, he said, involves where rare earths are coming from. He noted that previously Molycorp's Mountain Pass operation was able to pretty much take care of all of the world's demand for rare earths, except for yttrium (which accompanies heavy rare earths while Mountain Pass was largely a light lanthanide-enriched deposit), which it purchased from Australia. But now the lion's share of rare earths is coming from China.

This changeover began, Mariano noted, when the Chinese discovered an abundant amount of bastnaesite in a very large open-pit iron mine in Inner Mongolia—the Bayan Obo deposit. "This was largely the same kind of ore mineral as in Mountain Pass, but since it was a by-product of iron mining, it was essentially free. Plus, it had orders of magnitude more tonnage than Mountain Pass," he explained.

The second step, Mariano said, came when the Chinese made "a magnificent chemical innovation" and discovered a way to use inexpensive and weak salts and acids to remove rare earth elements from a weathered granite deposit in southern China, which was formed when feldspars were decomposed into clays in the weathering process enabling the clays to accept ion-absorbed rare earth elements.

While this deposit had very low rare earth concentrations—about 0.2 percent total rare earth elements on average and at times as low as 0.03 percent—the distribution of rare earths was very favorable with high levels of europium, yttrium, and neodymium.

Likewise, Mariano said he also evaluated another deposit in the Szechwan region of China, which he said has fabulous grades and tonnages of bastnasite. "The rock is of a simple mineralogy, which allows it to be concentrated with high rare earth oxide content," he stated. "One problem is that the concentration of neodymium is a little lower and that the bastnasite is more tightly bonded and less amenable to chemical cracking. But it is a magnificent resource, a resource that I never imagined would exist," he noted.

While it is always possible that the rare earths market could change again, today because of its resources and low labor costs, the Chinese totally control the market price and the supply of rare earths, Mariano said. "There has to be other areas in the world where there are similar deposits. If we find some carbonatites that are heavily lanthanide-enriched it could change the picture and there are good possibilities that we could find these types of deposits elsewhere in the world," he stated.

Currently, he noted that you could get rare earths from the USA and Canada, but at a much higher cost. Also, you have to careful of certain factors, including logistics costs. "While there are good rare earth deposits in the mid-Amazon region, logistics costs are high. The same is true in the central Sahara," he explained, adding that the political stability of the area is also a factor.

Likewise, it is important to mine the rare earths *for* rare earths and not as a by-product of another metal, such as titanium or tin. "It could be a bad situation if the market changes for the other metal, much as what happened in Thailand, Malaysia, and Indonesia with tin," Mariano noted.

Therefore, while looking for viable new rare earth resources could be a worthwhile pursuit, he cautioned that these new finds need to be properly evaluated by people who are familiar with rare earths.

He added that the chances of new finds being cost effective would be increased should new technologies be developed to produce rare earths from those deposits that are also nondestructive from an environmental point of view. "No one is working on anything yet. There is not enough funding for those kinds of projects, but it is something that is needed," Mariano said.

For more information contact:
Anthony N. Mariano
48 Page Brook Road
Carlisle, Massachusetts 01741, USA
Phone: 978-369-9242
Fax: 978-287-0441
E-mail: reomariano@aol.com

Historical Rare Earths Prices

The rare earths industry is entering its two hundred fifteenth year of existence. It has traveled from obscurity to high- tech usage, but is still a little known group. Higher prices have accompanied this growth, which is typical of a niche market like that of rare earths. Rare earths, which are the lanthanides plus yttrium and scandium, are critical minor constituents of many advanced materials. Although some of the rare earth elements have relatively high unit cost, they are only a small part of the finished product. It is these rare earths that add the special aspect to a finished product such as color, machineability, strength, conductivity, emissivity, and other unique properties.

Rare earths pricing over the last 215 years have risen drastically since the 1980s as new applications broadened the spectrum of uses. To receive a clear historical view of rare earths pricing, please refer to the feature article published in the November 1, 2001 issue of *Elements* and the historical pricing section of the *Elements* Subscriber page as this includes rare earths prices for 1997-2001.

Rare Earths Prices in Review – 2001

In late 2000 and early 2001, Japan went on a buying spree and overstocked rare earths, which essentially took them out of the market this year. The early part of this year saw the Chinese government intervene in its rare earths sector, in an attempt to stabilize the industry. As a result, prices climbed as the government closed small- to medium-size mines that were either unprofitable or were mining illegally, and also tightened export controls on rare earth products. In particular, prices for mischmetal, neodymium, lanthanum, and cerium products rose slightly.

This increase, however, did not transfer to other end products. During the mid-summer, producers lowered pricing floor levels and the Chinese government again intervened by drastically lowering export quotas for rare earths goods for the fourth quarter of this year. In early November, Metal-Pages reported that up to 75 percent of rare earths smelters are closed and the remaining have reduced production levels. To add fuel to the fire, it was also reported that "rare earth smelters have stockpiled $10 million of unsold products." In addition, some US customers are asking that Chinese producers delay contracted shipments until early next year.

Metal-Pages also reported that Baotou Rare Earth High-Tech cut pricing again on rare earth concentrates by about $20 per metric ton. In fact, concentrate prices have been reduced by 50 percent over the last six months.

Although this year's rare earths prices appear depressed, the Japanese have entered the market due to the low price neodymium metal (US$7-8 per kg) and thus, have signed new contracts.

Editor's Note: Prices will pick up in 2002, as the world gets back on the production trail and the market returns to a more normal state. Look for year-end average prices for rare earths and specialty metals in the Subscribers Only section of our Web site (http://www.rareearthsmarketplace.com).
-- Rich Vito, Managing Editor

Outlook for the Rare Earths Market

The beginning of the twenty-first century has seen the emergence of new technologies and promising new applications. Nanotechnology is impacting every industry that desires miniaturization, including the electronics, computer, and telecommunications sectors. In addition, fuel cell and/or battery-powered automobiles in the next one to five years will put a huge demand on some rare earth elements. In fact, the first hybrid battery-powered car was put on the road this year. Fuel cells are also powering electrical generators of various sizes. In addition, fiber optics applications and the production of PET bottles are demanding more germanium.

In 2001, the down side has been that rare earths and specialty metals prices have "bottomed out" due to an impending recession, consolidations within the industry, large firms such as Bethlehem Steel filing for Chapter 11 Bankruptcy protection, and the September 11 terrorism attacks against the USA. Metals such as tantalum, gallium, germanium, and platinum group metals all peaked during this year and have returned to a comfortable base price area. Presently, the only element on a constant upswing is uranium, where slow upward price movement began in January 2001 and just recently leveled off.

Rare earths prices have been on the decline during 2001, with Chinese government taking steps to stem the tide. They have instituted restricted rare earths export quotas that, as of yet, have not reflected any changes in rare earths prices.

The demand of rare earths will continue through 2004. According to Dudley J. Kingsnorth of Industrial Minerals Corporation of Australia Pty. Ltd., he estimates a 35-percent total increase in rare earths demand from 1999 (74,000 t REO) to 2004 (100,000 t REO). If supply and refining capacity remains adequate, pricing should be fairly stable, even though the trend in the rare earths industry is toward value-added rare earths.

~ University Lab Focus ~

REO Nanotubes Research at Japanese University

Metal-Pages has reported that a way to synthesize rare earth metal oxides into the shape of nanotubes has been developed by a research tem from Saga University and Miyazaki University in Japan.

Erbium oxide, ytterbium oxide, and lutetium oxide have all been incorporated into the nanotube form. The structures grow in a cylindrical shape in lengths up to 200 nanometers. The internal diameter is 6 nanometers.

Rare earth metals have unique properties including the ability to act as magnets and fluorescent materials. They are currently used in a wide range of high-tech industries, from rewritable optical discs to superconductors. These new nanotubes are expected to perform a variety of functions not possible with carbon nanotubes because of the special properties of rare earths.

Now that researchers have proved it is possible to produce nanotubes from rare earth metal oxides, they are now planning to fill the tubes with a variety of other elements in an attempt to increase the potential applications of nanotube technology.

~ University Lab Focus ~

R&D Expands Market for Rare Earths in Medicine —
An Interview with Lidia Smentek

By
Myra Pinkham
==========================

Rare earths are being used in clinical medicine, medical technology, and in molecular biology in an ever-increasing rate, Lidia Smentek, professor of chemistry at the Institute of Physics of N. Copernicus University, Torun, Poland, and an adjoint professor at the Department of Chemistry at Vanderbuilt University, Nashville, Tenn., declared.

Smentek said it has been very interesting to see the development of medical application for rare earths over the years and to see that materials doped by rare earth ions, which were considered to potentially attractive in the early 1970s at the beginning of her career, are now leading systems of modern technology that define several aspects of life.

Her first exposure to rare earth element research came in 1971, just after she received her Master's degree in theoretical physics from N. Copernicus University and when she was appointed as an assistant in the University's Institute of Physics. She has since worked on theoretical description of spectroscopic properties of rare earth-doped materials. "My main aim is to develop an adequate model that reproduces observations of one-photon electric dipole transitions, two-photon absorption, electronic Raman scattering and sensitized luminescence in these materials."

Obviously one thing that drew her to rare earth research was the potential applications, but she said that the unusual electronic structure of rare earth ions and their rather complicated crystalline structures also made them attractive to her. "These ions behave as free ionic systems," she declared. "This feature is demonstrated by very sharp atomic-like lines instead of broad bands expected in the spectra of solid state materials," she noted.

Her current research involving gadolinium also has personal relevance to Smentek. This research is based on recent discoveries that the injection of a new generation contrast agent that contains the gadolinium ion to map the vessels of the brain is painless when introduced into the blood stream. "I remember very well the procedure using the standard contrast in 1989 when I suffered a cerebral hemorrhage," Smentek said, "So the possibility of a new diagnostic procedure created by this particular material makes me obligated to work even harder, having hope that my research will be useful for the further development of modern tools of clinical medicine."

She said she is currently planning to perform some advanced calculations on the luminescence of materials that are doped with the gadolinium ion, since it is also very interesting from a theoretical point of view as a half-filled shell system.

But there are many other applications of rare earths in crystals for the medical field in light of their unusual spectroscopic properties.

One obvious application, Smentek said, is lasers, which impacted medicine and surgery almost since the first laser beam was generated in 1960, especially the neodymium YAG laser (which has a garnet crystal build of aluminum and yttrium oxides). This laser, she noted, has been used as a tool in all kinds of surgery, including neurosurgery, to stop arterial bleeding and to stop bleeding from the cut-surface of tumors, dental and oral surgery, and plastic and reconstruction surgery, as well as stopping hemorrhages without surgical intervention, and destroying benign and malignant tumors. These attributes are possible because of the material's favorable properties, including its laser efficiency, optical quality, and mechanical and thermal stability. But rare earth ions are also useful laboratory tools for modern molecular biology, biotechnology and therapy, Smentek maintained, explaining that luminescence techniques can be used to determine inorganic materials and for the analysis metals, alloys, semiconductors, minerals, soil, water, air, biological, and clinical samples, as well as in the analysis of pharmaceutical drugs and in the detection of drugs and metabolites in biological fluids.

However, one of the most impressive applications of rare earth-doped materials, Smentek said, is in bioinorganic chemistry. "The most attractive role of lanthanides is connected with the work on calcium binding in proteins. Calcium, as an inert system, is very difficult to be examined directly, and at the same time it is a very important element in biochemistry. The chemical similarity of rare earth ions to calcium and their ability to be luminescent at room temperature are the main properties why the lanthanides are so commonly used as probes," she explained.

The luminescence of rare-earth sensitized materials has also been used to investigate the binding sites in prothrombin, one of the clotting factors in the blood. It is a protein that is changed by the body in the presence of the calcium ion to thrombin and causes the coagulation, or clotting, of blood, Smentek stated.

Also, the use of lanthanide-based phosphors has had a direct impact upon humans through the construction of radiography screens that reduce doses of x-rays, Smentek said, which has contributed to new technologies that are alternatives to light-emitting diodes.

"The importance of the basic research in the field of spectroscopy of rare earth ions becomes evident when realizing how crucial the precision and accuracy of calculations is in the analysis of these experiments," Smentek declared.

For more information, please contact:
Lidia Smentek
Vanderbilt University
Phone: 615-322-2406
E-mail: smentek1@aol.com

~ Company Profile ~

Stanford Materials Company

Stanford Materials Corporation is a worldwide supplier of oxides, metals, alloys, advanced ceramic materials, and minerals. Established in 1994 to supply high-quality rare earth products to the research and development fields, today the company also provides a wide range of rare earths products for high-tech industrial uses.

==========================

The Company

Stanford Materials was established with the initial focus on supplying high-quality rare earth products to research and development fields. To meet increasing demands for rare earth products and other materials, Stanford Materials now carries a variety of materials to serve not only customers in research and development fields, but also manufacturers in the ceramics, metallurgy, and electronics industries. Stanford Materials supplies both technical-grade materials for industrial applications, as well as high-purity chemicals (up to 99.99999% purity) for research institutes. The company’s annual revenue has exponentially increased since its establishment and reached US$5 million last year.

Because the company understands the importance of reliable and consistent materials for research and development and production needs, solid relationships have been established with its manufacturers. Stanford Materials has created successful working partnerships by frequently visiting manufacturers and talking with their management, production and quality control engineers, and workers in production lines about the quality sought. It is these valued friendships, built over many years, which allows the company to supply consistent and high-quality products to worldwide customers. Stanford Materials’ motto is "We not only provide products, we also provide satisfaction." Stanford Materials Corporation offers professional customer service. Stanford Sales Manager, Dr. James Chen, holds a Ph.D degree in Materials Science and Engineering, a MS degree in Nuclear Engineering, and a BS in Chemical Engineering.

The Products

Stanford Materials Corporation supplies a wide array of rare earths products, and also, advanced ceramic materials, high performance metals, and rare earth permanent magnets.

High-purity Rare Earth Products

Stanford Materials Corporation carries various high-purity rare earth oxides and metals. The high-purity rare earth oxides (with a purity up to 99.9999% REO) supplied by Stanford Materials Corporation are widely used in laser crystal and optical fiber industries. The high-purity rare earth metals supplied by the company, such as terbium, dysprosium, scandium, lutetium, and erbium made by distillation, are also in strong demand in computer, electronic, high-performance alloy, and other industries. Stanford Materials Corporation also supplies rare earth chemicals, such as cerium carbonates and lanthanum chlorides for catalytic, chemical and automobile industries.

Advanced ceramic materials

Stanford Materials Corporation also supplies advanced ceramic materials, such as yttria-stabilized zirconia, YSZ grinding media, boron nitride, and silicon carbide. The company also makes every effort to develop new products to meet the demands from new markets. Stanford has brought many advanced new products, such as nano-materials, Ce-Zr and La-Ce-Zr, and new generation of superconductive materials. The company has been willing to cooperate with customers to develop new products based on customers' requirements.

Rare earth permanent magnets

Stanford Magnets Company is a subsidiary of Stanford Materials Corporation. Several engineers at Stanford Magnets Company have been involved in research, development, and manufacturing of rare earth permanent magnets since mid-1980. Today, Stanford Magnets Company supplies high-performance rare earth permanent magnets, both Nd-Fe-B and Sm-Co, for many applications, including nuclear magnetic resonance, loud speakers, and mechanical devices. The company specializes in manufacturing permanent magnets according to customer requirements in terms of composition, magnetic characteristics, shape, and size.

Other High-Purity Metals

Stanford Materials supplies many other high- to ultra-high purity metals (99.999-99.99999%) for use in the semiconductor and electronics industries, as well as manufacturers needing special alloys, such as:

- Silicon single crystals
- Arsenic
- Antimony
- Bismuth
- Cadmium
- Indium
- Selenium,
- Tellurium
- Zinc

Web Site Reference Library

The Stanford Materials Corporation Web site now includes a "Reference Library" page, which provides visitors with the facts necessary to make doing business on the Internet accountable more reliable. The Reference Library lists links to Web sites that provide helpful information such as Material Safety Data Sheets (MSDS). It also provides links to competitors' Web sites to help customers shop around for materials and to make certain they will get the best quality products at the best prices. Also included in the area is information on materials properties, specifications, and prices.

Corporate Headquarters
4 Meadowpoint
Aliso Viejo, California 92656, USA
Phone: 949-362-1746
Fax: 949-362-1810
E-Mail: info@stanfordmaterials.com
Internet: http://www.stanfordmaterials.com

~ UPCOMING CONFERENCE FOCUS ~

Rare Earth Research Conference

Davis, California, USA

July 13-18, 2002

Contact: Conference and Event Services
University of California, Davis
423 First Street
Davis, California 95616, USA
Phone: 530-757-3331
Fax: 530-757-7943
E-mail: confandeventsvcs@ucdavis.edu
Internet: www.cevs.ucdavis.edu

This international conference on f-element science and technology will be held at the University of California at Davis. The conference will integrate basic and applied multidisciplinary research that is centered on the f-elements. The conference will include oral and poster presentations on topics such as chemistry, physics, as well as materials, earth, environmental, and biological sciences.

An award lecture will be given to present an award for excellence in rare earth research. There will be two concurrent sessions presented each day of the conference and the poster presentations will be divided into three poster sessions. There are no evening sessions; however, there will be a banquet one evening. So, don't miss out on this rare earths extravaganza.

~ LITERATURE REVIEW ~

The "Literature Review" section is an overview of technical papers, articles, and books related to rare earths, specialty metals, and the applied technologies. Please contact the Rare-earth Information Center for further information on obtaining articles and publications listed in this section, at phone: 515-294-2272; fax: 515-294-3709; or e-mail: ric@ameslab.gov.

Ballato, J., Lewis, J.S, III, Holloway, P. "**Display applications of rare-earth-doped materials**." *MRS Bull*. September (1999): 51-6.

====================

Chestnut, G. N., Vohra, Y. K. "**Structural and electronic transitions in ytterbium metal to 202 Gpa**." *Phys. Rev. Lett*. 82, no. 8 (1999): 1712-7.

====================

Henry, D. M., Herringer, J. H., Djeu, N. "**Response of 1.6 mum Er:Y3Al5O12 fiber-optic temperature sensor up to 1520 K.**" *Appl. Phys. Lett*. 74, no. 23 (1999): 3447-9.

====================

Iijima, T. "**Current technology and trend of new battery systems**." *Rare Earths* 34, no. 5 (1999): 68-9 (in Japanese).

====================

Kuz'Menko, V. M., Vladychkin, A. N. "**Hydrogen in amorphous and crystalline ytterbium films**." *Fiz. Tverd. Tela*. 41 (1999): 177-82; English Translation in *Phys. Solid State* 41, no. 2 (1999): 155-9.

====================

Lai, W. H. Yu, Z., Yan, G. J., Wu, Y. J. "**Research & development of hydrogen-storage alloy and MH-Ni batteries in China**." *Forum on Rare Earth Technology and Trade*, Z. Yu, (ed.), The Chinese Society of Rare Earths (1998): 78-83.

====================

Li, C., Wang, X. "**Manufacturing process, electrochemical properties and structure of Ml (NiMnTiCo)5 hydrogen storage alloys**." *J. Rare Earths* 17, no. 1 (1999): 29-33.

====================

McCoy, M. "**When the chips are down**." *C&EN* 77, no. 47 (1999): 21-33.

====================

Shevchenko, N. B., Christodoulides, J. A., Hadjipanayis, G. D. "**Preparation and characterization of Dy nanoparticles**." *Appl. Phys. Lett*. 74, no. 10 (1999): 1478-80.

====================

Stankus, S. V., Khairulin, R. A. "**Holmium volume change on crystallization in the bcc and hcp phases**."*J. Alloys Compds*. 297 (2000): 30-2.

====================

Terukov, E. I., Kudoyarova, V. K. H., Kon'Kov, O.I., Konstantinova, E. A., Kamenev, B. V., Timoshenko, V. Y. U. "**The influence of local surroundings of Er atoms on the kinetics of decay of Er photoluminescence in amorphous hydrogenated silicon**." *Fiz. Tekh. Poluprovodn*. 34 no. 1 (2000): 90-2; English Translation in *Semiconductors* 34, no. 1 (2000): 92-4.

====================

Xiong, B., Zheng, W. "**Application of rare earth in agriculture--the main pillar of development of rare earth industry in**." *Forum on Rare Earth Technology and Trade*, Z. Yu, (ed.), The Chinese Society of Rare Earths (1998): 68-70.

~ About the Publisher ~

Main Office

High Tech Materials
1049 Ponderosa Circle
Longmont, Colorado 80501-3931 USA
e-mail: richvito@RareEarthsMarketplace.com
Internet: http://www.RareEarthsMarketplace.com

Staff

Managing Editor — Rich Vito
Editor — Gail Fox
Assistant Editor — Monica Hulm
Feature Writer — Louise Rodriguez
Feature Writer — Myra Pinkham
Subscriptions — Gayle Vito
Webmaster — France Addington-Lee
