BERYLLIUM

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Beryllium is both very light and strong, has a high melting point of 1,280oC, is resistant to acids and has a high thermal conductivity. These characteristics make beryllium very useful in a number of applications, either as a metal, as part of an alloy, or as an oxide. High processing costs mean that beryllium is expensive so it tends to be used where there are no practical alternatives or where performance is critical.

The majority of world beryllium ore production, over 89% in 2000, is carried out in the US; most of the remaining material is mined in China, Madagascar and Brazil. Brush Wellman is the sole US beryllium ore producer, mining bertrandite in Utah. In China, Ningxia Non-ferrous Metals Smelter has been reported as mining beryllium ores. Brazilian beryl production virtually stopped following the ending of exports to the US in the early 1990s. The main producer at the time, Esmeralda de Conquista, holds stocks of beryl in case of future demand. Mineracao Coriolano, the sole current producer, mines small amounts of beryl.

Beryllium ores are also produced in small quantities on a regular basis in Portugal and Zambia. Production of beryl is also reported to take place in Bolivia, but no data are available.

Beryllium ore production in Russia and Kazakhstan was discontinued during the 1990s. Other countries where the mining of beryllium ores appeared to stop during the 1990s were Argentina, Namibia and Zimbabwe.

Production

Brush Wellman of the US is the only confirmed fully integrated beryllium company in the world. However, the Chinese beryllium product company Ningxia Non-ferrous Metals Smelter may mine and process beryllium ores.

The quantity of bertrandite ore processed by Brush Wellman fell from 113,000 t in 1998 to only 48,000 t in 2001. The bertrandite is used as feedstock in beryllium hydroxide concentrate production at the company's Delta plant in Utah. The concentrate is then used as feedstock for metal, alloys and ceramic grade powder at Elmore in Ohio, and strip and wire products at Reading in Pennsylvania.

World Production of Beryllium Ores (t gross weight)

	1996	1997	1998	1999	2000
Brazil	6	7	5	11	13
Chinae	500	500	500	500	500
Madagascare	11	28	30	30	30
Portugale	5	5	5	4	4
Russia[e]	70	70	-	-	-
US	5,260	5,770	6,080	5,070	4,510
Zambiae	4	4	4	4	4
World total	**5,856**	**6,384**	**6,624**	**5,619**	**5,061**

[e] *estimated*

In 1999, the hot and cold rolling technology in use at Elmore was upgraded leading to a trebling in beryllium-copper strip production capacity. Ceramic powder from Elmore is also supplied to the company's plants in Tucson in Arizona and Newburyport in Massachusetts. In May 2000, Brush Wellman became a wholly- owned subsidiary of a holding company, Brush Engineered Materials.

In 2001, Brush Wellman reported sales of US$472.6 million compared with the record US$563.7 million of 2000. The reason for the fall in sales was a decline in demand, especially in the telecommunications and computer markets.

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Other important US beryllium product companies are NGK Metals and Starmet who use raw materials supplied by Brush Wellman. Starmet, formerly known as Nuclear Metals Inc., jointly developed beryllium-aluminium alloys with Lockheed. The company has since developed a family of beryllium-aluminium alloys under the trade name Beralcast®.

NGK Metals Corp. is the largest producer of beryllium-copper alloy castings, strip, rod bar and plate products in the world, with plants in France, Japan and the US. The company aimed to be capable of producing 600 t/mth of beryllium copper products in 2000 following a series of investments. In 1998, NGK Metals invested a reported US$12 million in its Sweetwater plant in the US, mainly on the installation of the first beryllium-copper alloy continuous caster in the world. This raised production capacity to around 100 t /mth.

NGK is the sole Japanese producer of beryllium copper master alloys. The company produces BCMA and other beryllium copper alloys at its Chita plant in Handa City, Aichi Prefecture. In October 2000, NGK commissioned a mill-hardening furnace at Chita that increased capacity to 400 t/mth. Japanese demand for beryllium copper alloys rose to around 2,400 t in 2000. This followed an estimated rise of 30% in demand between 1998-1999.

In France, NGK is adding a new pickling line and considering the addition of a new mill-hardening kiln to its Coueron plant. The capacity of the plant will rise to 100 t/mth following the investment.

The Ulba Metallurgical Plant (UMP) in Kazakhstan was the largest beryllium product manufacturer in the former USSR mainly using beryllium concentrate from mines in Russia. UMP stopped importing beryllium concentrate from Russia in the mid-1990s, partly because it had accumulated considerable stocks of material. This eventually led to the end of Russian beryllium concentrate production during 1997, as producers no longer had a market for their concentrates. There has been no reported production of beryllium concentrate from ore in Kazakhstan since 1993. UMP reportedly holds sufficient stocks of beryllium concentrate to support production for decades.

Beryllium product output by UMP rose in the late 1990s as capital to upgrade the plant was obtained from overseas investors. According to the National Statistic Agency of Kazakhstan, UMP produced 737 t of unprocessed beryllium in 2001, an increase of 71% on 2000 output. UMP is currently in the middle of a five-year investment programme, scheduled for completion in 2005. This includes a number of developments that will substantially raise beryllium product capacity including:

- BCMA capacity to be increased by up to 3,000 t/y using carbothermic reaction technology;
- development of digestion and refining production methods for beryllium hydroxide to international standards;

- introduction of new techniques to raise beryllium concentrate capacity by up to 200 t/y;

- and beryllium copper product range to be extended and capacity raised by up to 1,000 t/y.

UMP aims to control 20% of the world beryllium market following the completion of these developments.

In China, three companies are known to produce beryllium in a variety of forms. These are Ningxia Non-ferrous Metals Smelter, Ningxia Orient Tantalum Industry Co. and Shuikoushan Mining Bureau. The combined capacity of these companies is estimated to be around 500 t/y gross weight of beryl or about 20 t/y of beryllium, mainly in the form of beryllium copper alloys.

Applications

In 1991, the value of Brush Wellman's beryllium business was mainly divided between electronic components (45%), defence and aerospace (29%) and electrical components (20%). By 2001, this pattern had changed with telecommunications and computers accounting for 42% of sales, optical media 15%, automotive electronics 12% and defence/aerospace only 8%.

Alloys are the most common form of beryllium used, accounting for around 75% of US consumption. In the US, ceramics (15%) incorporating beryllium oxide, also known as beryllia, are the next most important form of beryllium followed by metal (10%).

Beryllium-copper is the most commonly used type of beryllium alloy. Beryllium-copper alloys can be divided into high strength types, typically containing between 1.6% and 2% beryllium, and high conductivity types, containing around 0.3% beryllium. High strength alloys are typically used in telecommunications applications and high conductivity alloys in automotive markets. Beryllium copper is also used in drilling equipment, aircraft landing gear and other heavy industrial machinery where its properties outweigh its expense.

Beryllium-aluminium alloys are becoming increasingly important in terms of beryllium consumption as they can contain up to 65% beryllium compared with the 0.3% and 2% typically present in beryllium-copper. Applications for beryllium-aluminium alloys include aerospace, hard disc drives and brakes.

Beryllium oxide ceramics have excellent electrical insulation properties and a thermal conductivity close to that of pure aluminium and double that of copper. These characteristics, together with the high melting point of 2,570oC and resistance to chemical attack, mean that beryllium oxide ceramics have a wide variety of applications in the electronics sector. These include heat sinks for electronic and microelectronic applications where a high rate of thermal dissipation is required. The telecommunication and computer industries use beryllium oxide ceramics in substrates, where performance and the need for high levels of reliability and heat dissipation outweigh the cost.

Beryllium metal is used in spacecraft, inertial guidance systems, high performance brakes and space optical systems because of its strength, low weight and stability over a wide range of temperatures. Beryllium metal is also used in research reactors as a reflector. Beryllium is also transparent to X-rays so is also used in applications where this is desirable.

Trade

US companies play a pivotal role in world trade in beryllium; either exporting beryllium products or importing raw or scrap materials for processing. The US Government imposes import tariffs of 3.7% on beryllium oxide or hydroxide, 5.5% on wrought beryllium and 8.5% on beryllium waste and scrap on imports from countries with normal trade relations. All other forms of beryllium are allowed to be imported free of tariff.

The majority of reported world beryllium trade is in the form of waste, scrap, powder, wrought and unwrought material. The most commonly traded type of beryllium material is almost certainly beryllium-copper alloy but data for this commodity are not generally available, with the exception of some information for the US. UMP supplies 4% BCMA and other beryllium products to Brush Wellman under a long-term supply contract signed in 2000.

The only known significant reported trade in beryllium oxide is between US and Chinese companies and consumers in Japan. Outside the US, Japanese companies are one of the main consumers of beryllium along with those in France, Germany and the UK.

Stocks

The US Government has long held quantities of beryllium in the National Defense Stockpile (NDS) in order to guarantee supplies to the defence industry in times of conflict. In Fiscal Year 2001, significant quantities of beryllium materials held in the NDS were sold. These included around 1,260 t of beryllium-copper master alloy (BCMA), containing around 51 t of beryllium, and about 23 t of beryllium metal. No beryl ore was sold during this period. For fiscal 2002, proposed maximum sales from the NDS are 3,630 t of beryl ore, about 2,000 t of beryllium-copper master alloy and around 36t of beryllium metal.

Prices

Prices for beryllium products are inevitably determined by the Brush Wellman published producer price. Prices change very infrequently and are, at best, a very general indicator of price movements. The last reported increase in beryllium prices by Brush Wellman took place in March 2001. The price of the majority of beryllium copper bulk products was increased by between 5% and 10%. The rise was to absorb increases in the cost of energy and materials.

The previous increase was in July 2000 when the price of all wrought and cast beryllium containing bulk products, except for Protherm(r) bar and plate, was raised by an average of 5%. Minimum order requirements for all products were also raised from US$100 to US$300 for the first item and US$100 for each additional item. The previous reported increase in beryllium prices by Brush Wellman took place in 1998 when they were raised by an average of 4%.

Market Trends

Following the end of the Cold War in 1992 with the break-up of the former USSR, world demand for beryllium declined as defence expenditure was reduced. Rising demand for electronic products, partially the result of growing internet capacity, revived demand for beryllium towards the end of the decade.

Demand for beryllium, especially in the form of alloys, fell in 2001 following a fall in consumption by the telecommunications and computer industries. This fall is likely to be temporary but beryllium producers became increasingly reliant on these markets in the late 1990s. The current reduction in demand by the telecommunication and computer industries may encourage beryllium product companies to diversify into new markets.

Consumption of beryllium is forecast to rise over the long-term but rising demand is unlikely to encourage the development of new sources of beryllium raw materials as current beryllium producers have access to sufficient resources.

The miniaturisation of electronic products requires the use of strong materials, such as beryllium-copper alloys, able to cope with higher operating temperatures. The electronic content of automobiles is steadily rising, leading to higher demand for beryllium-copper alloys. The use of beryllium-aluminium alloys in aerospace applications is growing, especially in defence projects, but from a low base. Demand for beryllium oxide ceramics for use as substrates is also increasing as ever more powerful computer chips generate larger amounts of heat that must be rapidly dissipated. Beryllium metal consumption is unlikely to increase significantly in the immediate future.