

But even with its very low density (1.85 grams/cubic centimeter), it has a very high melting point: 1,278° C. (Lithium, on the other hand, has a very low melting point: 180.54° C.)

In other words, beryllium is a mighty tough metal. Although only two-thirds the weight of aluminum and a quarter of the weight of steel, on a kilogram-for-kilogram basis, beryllium is actually six times stronger than steel. And, in addition both to being nonmagnetic and having excellent thermal conductivity, it also remains stable over a wide range of temperatures.

Combining all these qualities, as it does, beryllium is ideally suited for a number of specialized applications, whether in the form of an alloy (accounting for around [75%](#) of its consumption in the U.S., according to [Roskill](#)), as a pure metal, or as any one of a number of different chemical compounds, but particularly as an oxide in ceramics.

Electronics and Electrical Components

The greatest use of beryllium in alloys is in beryllium-copper alloys or “beryllium bronze.” For the most part, these are usually either high-strength or high-conductivity alloys for use in circumstances in which either or both characteristics are needed.

Applications in which these alloys are found include:

- Electrical contacts and connectors in cell phones and computers
- Spot-welding electrodes
- Underwater fiber optic cable systems
- Cable and HD TV
- Very hi-fi loudspeakers

Because of its good spring properties at high temperatures, too, beryllium is also used in:

- Thermostats
- Bellows
- Sockets

With both high thermal conductivity and good electrical insulation properties, as well as resistance to chemical corrosion and high melting points, beryllium oxide ceramics are also used extensively in electronics. They are, in particular, to be found in substrates used in the computer and telecom industries and as heat sinks.

In Space

Because of not only its lightness, but also its rigidity and strength at low, as well as high, temperatures, beryllium is ideal for use in the space industry.

Beryllium and beryllium alloys were used in both the Mars Rover and Cassini orbiters. The space shuttle uses beryllium in its window frames and doors. Polished and used as a mirror, the metal is also ideal for use in telescopes in space. To date, its most notable uses have been in the Hubble Space Telescope and Spitzer Space Telescope. If it is still launched, it will also be used in the James Webb Space Telescope,

scheduled to be hoisted into space some time in 2013.

Defense

While beryllium is still used in nuclear warheads, it is also now used in a wide variety of other applications in the defense industry.

As a lightweight metal it is used in the construction of jet fighters (e.g., F16s), helicopters, spacecraft and satellites. According to Metal Bulletin Monthly, the aluminum-beryllium alloy AlBeMet 162 is “[used in over 340 parts on the F-22 fighter.](#)”

In missiles, because of its high modulus of elasticity and, thus, its ability to remain rigid under very high g-forces, it is used for the gimbals in which the navigation gyroscopes are mounted.

Because of its strength at high temperatures, in military (and commercial) aircraft, it is also used extensively in landing gear, particularly the brakes. But whereas brakes in military aircraft will be 100% beryllium, those in commercial (not required to operate under such exacting conditions) will use the metal in an alloy form.

Interestingly, another property of beryllium that makes it ideal not only for use in this context, but also in the oil and gas industry, especially in drill bits, is the fact that the metal is nonsparking. In neither use would showers of sparks be advisable! (Beryllium is also used extensively in the oil and gas industry both for pipe couplings and in pumping stations.)

The metal is also used in military optics, especially in forward-looking infrared systems, surveillance systems and for sensors in, and the actual structure of, military satellites.

Elsewhere

Elsewhere in our lives, beryllium is used in medicine for pacemakers, X-ray machines, CAT scanners, MRI machinery and laser scalpels. It is also used in the ultrahigh-speed optical lasers to be found in, for example, luggage bar code scanners in airports, photo separators and photocopiers.

Finally, in addition to its use both in sprinkler heads and fire extinguishers, in your car, beryllium alloy will most probably have been used in your power steering, ignition switch and air bag sensors.

Whence The Beryllium?

Beryllium is found in around 100 different minerals, the main being beryl ($\text{Al}_2\text{Be}_3\text{Si}_6\text{O}_{18}$) and bertrandite ($\text{Be}_4\text{Si}_2\text{O}_7(\text{OH})_2$). The majority of the world's currently mined beryllium comes from the U.S. (100 tonnes, or [nearly 77%](#) of world mine production in 2007, according to the USGS), in particular from Utah, where it is mined as bertrandite ore. The only other countries in which it is currently mined in any quantity are China (20 tonnes) and Mozambique (6 tonnes).

Other countries (with known resources) that either have mined beryllium ore minerals, or could so do in future, include Brazil, Kazakhstan, Madagascar, Portugal, Russia, Uganda and Zambia. Finding the ores in sufficient concentration to make them economically viable to mine and process is the difficulty.

In addition to supply provided to the market from continuing mining activities, it has also been provided through sales from certain stockpiles, in particular that of the U.S. government, the National Defense Stockpile and that controlled by [Ulba Metallurgical Plant](#) (UMP) in Kazakhstan. UMP, according to a report on beryllium by Roskill in 2005, “[reportedly holds sufficient stocks of beryllium concentrate to allow decades of production](#),” with the USGS reporting a figure of some [30 years](#).

Whither The Beryllium?

In addition to being the world’s largest beryllium miner, the U.S. is also the world’s largest producer of beryllium products. To be so, it uses not only its own mined ores, but also imports concentrates, compounds, master alloys, ores, pure metal and scrap. The country is also one of the world’s largest beryllium consumers.

Prospects For Beryllium

Even in the current economic circumstances, the prospects for beryllium appear to remain encouraging.

On October 30 this year, the independent market research publishers [Global Industry Analysts](#), Inc. released their latest research on the global beryllium market. In this they project the global market to reach some 423 tonnes by 2012, with the U.S. market alone reaching 98.9 tonnes by the same year. They project that Asia-Pacific will be the fastest-growing market.

One current market participant is even more bullish, projecting in November that while Asia-Pacific’s demand would rise from some 45 tonnes in 2005 to an estimated 65 tonnes in 2010, demand in North America and Europe would rise from 86 and 95 tonnes, respectively, in 2005 to an estimated 319 and 145 tonnes in 2010.

The Marketplace

The beryllium market (both domestically in the U.S. and internationally), from mine (or stockpile) through to end product, is defined by a very small number of key players.

In the U.S. and, indeed, the world, the largest beryllium producer (and, currently, unique in being fully integrated) is [Brush Wellman](#), based in Cleveland, Ohio, a subsidiary of [Brush Engineered Materials Inc.](#) (BEM) (**Bloomberg Ticker - BW:US**). Beryllium is, though, just one of its business activities, albeit an important one.

In addition to mining its own ores in Utah, BEM imports beryllium in various forms from UMP in Kazakhstan and has been a purchaser of beryllium and beryllium compounds released for sale from the U.S. National Defense Stockpile. The company manufactures a wide range of beryllium-based alloys and composites, as well as the pure metal itself, with its largest market, accounting for some 53% of total revenues in 2008, being defense/aerospace. Other markets, by revenue, are medical (16%), industrial components (10%), nuclear reactor (6%), telecom/computer (6%) and other (9%).

Because it was obsolete, BEM closed its primary beryllium production facility in Elmore, Ohio in 2000. However, since then, because of both the limitations imposed upon its processing and the strength of demand for the metal, the company is now building a new facility for Elmore.

In line with the current U.S. government policy of trying to secure supplies of strategic materials (beryllium being one of them) rather than being at the mercy of the market, the U.S. Department of Defense is majorityfunding the facility's construction. Start-up is expected in 2010.

Another key player in beryllium is Japan's [NGK Insulators, Ltd.](#) (NGK) (**Bloomberg Ticker - NGKIF:US**), through its subsidiary [NGK Metals Corporation](#). However, for NGK, its business activities (in electronics) that involve beryllium are in just one of three business segments, the others being ceramics and power.

Then there is UMP, owned by Kazakhstan's nuclear agency [Kazatomprom](#), a major processor and producer of beryllium products, from the pure metal, through aluminum and copper-beryllium alloys, to beryllium oxide base ceramics. While for UMP, beryllium is just one of the metals it processes, and out of which it makes products, in the global beryllium market, the company is a very important supplier of the metal in all its forms: vide the fact that for BEM, UMP is an extremely important supplier and one with whom the company is, reportedly, still in somewhat difficult negotiations over the terms of its purchase commitments.

Finally, in addition to a handful of smaller Chinese players, there is the relative newcomer to the field, the Canadian company, [International Beryllium Corporation](#) (IBC) (**Bloomberg Ticker - IB:CN**), based in Vancouver.

Although still in the early stages, IBC has aspirations to become a global, vertically integrated beryllium company "...[focused on every element of the mine to market value chain](#)." It believes, in its words, that "...[its consolidation strategy will allow it to form the next global beryllium giant](#)." However, although it doesn't have, at present, the processing piece, it does have very good relations with UMP, which helps fill that gap.

In addition to the two businesses it has recently acquired, Freedom Alloys and Nonferrous Products, the company also has some interesting mineral holdings not only in the U.S. (Colorado and Utah), but also in both Brazil and Uganda.

However, perhaps two of the most interesting aspects of IBC are the following.

First, being new in beryllium, the company has none of the legacy health issues with which other operators have to deal. (While the metal and its alloys are not toxic in solid form, if beryllium enters the body by way of fumes, dust or soluble compounds, it can be extremely toxic, causing, for instance, chronic beryllium disease [CBD]). IBC is, as it were, clean in this area.

Second, the company is engaged in an interesting initiative in the field of uranium/beryllium-based nuclear fuels that it is working on together with Purdue University's Department of Nuclear Engineering. In a recent conversation with him, Anthony Dutton, IBC's CEO, was particularly sanguine about the company's progress, saying: "We are more excited than we originally were, as Purdue's research is more advanced than we had originally appreciated."

Vis-à-vis its competition, not only is this a market in which BEM does not have very significant involvement, but also, as a market, nuclear power generation as a whole is increasingly becoming a focus of attention.

Conclusion

Essentially only four key players dominate the market: Brush Engineered Materials (through subsidiaries),

NGK Insulators (through NGK Metals Corporation), International Beryllium Corporation and Ulba Metallurgical Plant. While the first three companies are all quoted, beryllium is a pure-play only for IBC; both the first two companies having significant interests in other markets. And UMP, of course, is practically wholly owned by Kazatomprom.

While, in general, the overall prospects for beryllium appear encouraging, in the current financial circumstances, with the automobile industry (particularly in the U.S.) and the electronics industries (e.g., cell phone, personal computer and handheld electronic devices) both facing uncertain times, growth, if any, in these sectors of the market may be difficult.

On the other hand, if the nuclear power generation industry continues to garner interest, then any improvement in fuel efficiency through the use of beryllium will only be good news for those involved in the metal - both for those with significant beryllium mineral holdings and, of course, to whomever owns the IP to that fuel technology.

Afterwords

Make no mistake, there is enough beryllium about; the problem is both finding it in concentrations that are economically viable to exploit, and the cost and difficulty of processing the stuff.

In addition to beryllium in the stockpiles of both the U.S. and UMP, China is understood to have been, and be, a significant producer of beryl. How much of the stuff it has stockpiled is anybody's guess.

Reverting to a subject I have touched upon in previous pieces on the strategic metals, in its continuing review of the country's strategic defense stockpile (including a case study dealing specifically with beryllium), the current U.S. administration is focusing not only on its levels of sales from the stockpile (beryllium copper master alloy has, currently, been "sold out"), but on the whole issue of securing supplies of strategic materials, of which beryllium is one. Indeed, in the case of beryllium, one of the studies prepared for the government states "[...foreign suppliers are not considered reliable.](#)"

Insofar as sales from the stockpile have been integral to meeting continuing demand for the metal, any change in government policy will certainly have an effect on the industry.

Substitutes: It is currently unclear (publicly, anyway) whether any of the research undertaken into substitutability by the U.S. Army, Navy and Missile Defense Agency has borne fruit. In some nondefense applications, there is a degree of substitutability, but in many instances this leads only to drastically reduced performance. In general, because of its cost, beryllium is already only really employed when its properties are deemed crucial.

Resources

[Minor Metals Trade Association](#) (MMTA)

[Roskill Information Services](#)

[U.S. Geological Survey](#) (USGS)

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