Features and Interviews

Niobium. Or Columbium?

Written by Tom Vulcan
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When it comes to a metal, what's in a name?

Some would like niobium to be called "columbium"—and, in fact, still continue to call it that. The U.S. Geological Survey (USGS) still lists its Mineral Commodity Summaries and Minerals Yearbook entries for the metal as "Niobium (Columbium)." And a goodly number of others in the world of metals also prefer the old name, columbium.

It makes sense for Americans, after all, since columbium refers to the provenance of the mineral sample containing the element sent to Charles Hatchett in the U.K. back in the late 18th century. It was that sample from which he discovered the new element in 1801.

For others, however, niobium's name is not as important as its utility; the metal is used in a variety of modern industries—particularly steel making, where it's a crucial ingredient in the construction of automobiles, oil pipelines and even airplanes.

What Is Niobium?

Niobium—named after Niobe, the daughter of Tantalus in Greek mythology—is the 41st element in the periodic table. It nestles between zirconium on its left and molybdenum on its right, and is directly above tantalum. (In the early days after its discovery, niobium was often indistinguishable from tantalum, somewhat like identical twins; hence its name as an offspring of Tantalus.)

As a pure metal, niobium is ductile, white, shiny and soft. It has a number of both interesting and useful qualities.

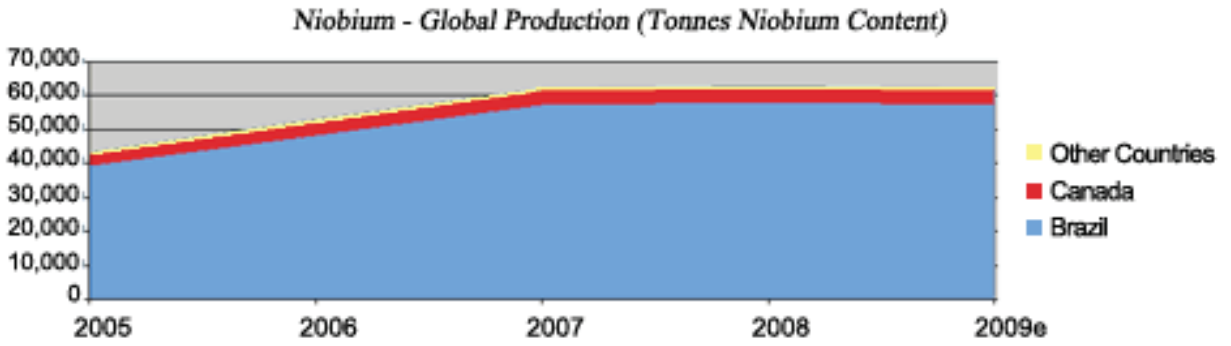
In particular, it is:

- *Superconductive*, when cooled sufficiently
- *Corrosion resistant*, imparting resistance to corrosion when used in alloys
- *A versatile additive*, imparting strength and toughness when used in alloys, as well as high-temperature resistance and great ease of forming and welding

As an oxide, niobium has a high index of refraction and high dielectric constant, and it increases light transmittance.

Whence Niobium?

According to the latest figures (2009) from the USGS, Brazil remains, by far, the world's largest producer of niobium. Canada remains a small but significant producer as well.



Niobium Content - Mass of metal produced: Nb_2O_5 is 69.904 percent niobium

e - Estimated

Source: USGS

Apart from Brazil and Canada, the big producers, the following countries also produce (and report reasonably reliable figures for their production of) niobium:

- Democratic Republic of Congo
- Ethiopia
- Mozambique
- Nigeria
- Rwanda
- Uganda

According to the USGS, the following countries are also believed to produce quantities of niobium, but no reliable figures for their production exist:

- Bolivia
- China
- French Guinea
- Kazakhstan
- Russia

However, there has been no significant niobium production in the U.S. since way back in 1959.

While niobium and tantalum inevitably occur together in nature, according to the Tantalum-Niobium International Study Center (TIC) in Lasne, Belgium, "[a]pproximately 85 to 90% of the niobium

industry obtains its niobium ores from sources other than those associated with the mining of tantalum-containing ores." If nothing else, this means that the niobium industry is not beset by the same issues that the tantalum industry faces with the likes of "coltan" coming out of various regions of Africa.

In contrast with tantalum, however, crystal niobium is 10 times more abundant, with pyrochlore—$(Na,Ca)_2Nb_2O_6(OH,F)$—as it primary mineral source. And, indeed, the world's largest producer of niobium, Companhia Brasileira de Metalurgia e Mineracao (CBMM), owns the world's largest deposit of the mineral in Araxa, Brazil. According to TIC: "The reserves are enough to supply current world demand for about 500 years, about 460 million tons."

There are two additional major pyrochlore deposits: the Boa Vista open pit in Catalao, Brazil, which is owned by Anglo American Brasil Limitada (Catalao), a subsidiary of Anglo American PLC (LON: AAL); and IAMGOLD Corporation's (NYSE: IAG) deposit at the Niobec Mine in Quebec, Canada, the only such pyrochlore source in North America. Together, these three deposits account for some "...85% of the world's demand for niobium products, with most of that output being in the form of ferro-niobium with a nominal 60% niobium oxide content, for making high-strength, low-alloy steel."

In terms of the actual amounts of niobium produced by CBMM, Anglo American and IAMGOLD, CBMM is, by far, the heavyweight. CBMM's actual niobium production in 2009 and 2008 was north of 50,000 tonnes, while Anglo American and IAMGold produced (in the form of ferro-niobium) only 5,100 tonnes and 4,100 tonnes in 2009, respectively, and 4,600 tonnes and 4,396 tonnes in 2008, respectively. These numbers take into account that Paranapanema SA (SAO: PMAM3) produces a small amount of niobium from columbite out of its Pitinga Mine—probably not more than 1,000 tonnes in either 2008 or 2009—and that some niobium also comes out from Companhia Industrial Fluminense's operations.

Indeed, even with its current enormous production capacity, CBMM wants to expand further. Mining Technology reported as recently as this past January that CBMM had announced intentions to increase its ferro-niobium capacity at Araxa, from 85,000 tonnes per year in 2008 to 150,000 tonnes per year by 2013. Based on the niobium content of standard-grade niobium being around 66 percent, "this equates to a niobium capacity upgrade from 56,000 to 99,000 t/y [tonnes per year]." In addition, CBMM sees production levels for the metal returning to precrisis levels by 2011—not an insignificant expectation.

The Importance Of Niobium

Niobium is most important for its use in steels, particularly HSLA (high-strength, low-alloy) steels. (These are also called "micro-alloyed" steels, because of the small amounts of alloying elements they use.)

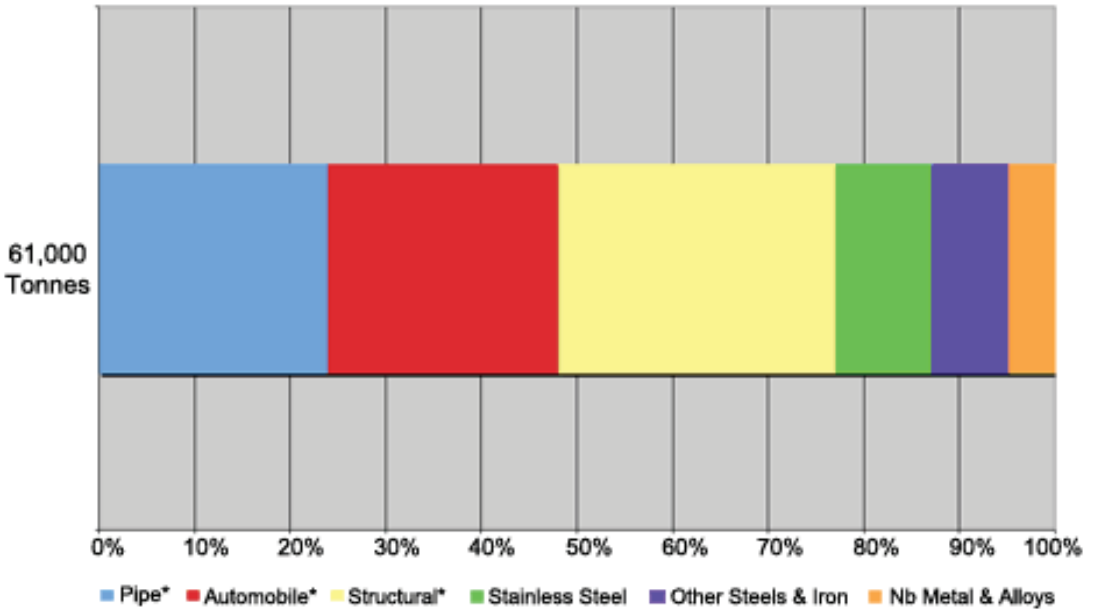
HSLA steels containing niobium are used in automobiles, airplanes, and oil and gas pipelines. In addition, they're useful in structural purposes, including bridges, buildings, nuclear reactors (alloyed with zirconium to make core elements), railroad tracks and in ship building. It has been estimated that, historically, HSLA steels have accounted for some 10-12 percent of total steel production, with the figure for the ferro-niobium used in total steel production now probably standing at around 10 percent.

Other uses for niobium include heat-resistant and stainless steels for the petrochemical industry, together with cutting and machining tools, well casings and drill pipes. In addition, in the form of vacuum-grade ferro-niobium and nickel-niobium, the metal can constitute a super-alloy addition in such applications as rocket subassemblies and turbine blades, in both jet engines and land-based turbines.

Finally, as both a metal and an oxide, niobium is used in devices such as camera lenses, ceramic capacitors, high-energy particle accelerators and MRI solenoid magnets.

In the U.S., in 2009, the USGS described "[m]ajor end-use distribution of reported niobium consumption" as being "steels, 76%; and superalloys, 24%." In 2008, it was 78 percent and 22 percent, respectively.

Global Niobium End Use - 2008



* Ferro-niobium

Source: IAMGOLD Corporation

The Future For Niobium

If CBMM's confidence in increasing its production capacity is anything to go by, the future for niobium looks secure.

Indeed, in its latest report on the metal, published in December 2009, Roskill Information Services of London concluded that after the first half of 2009 " ... demand for niobium will return to a healthy long-term growth trend. Market segments where niobium is well-established, and often has no substitutes, will continue to expand and new niches for niobium will continue to be developed."

In places like China, this twofold expansion will come in the production and use of higher-value-added steels. (Roskill believes that "[t]here is good potential for that figure [the 10 percent used in HSLAs mentioned above] to grow, perhaps to as much as 20%, as higher-quality steels continue to replace mild steel in a number of applications.") And in other developing countries, expansion will come from increasing growth in the use of steels in general.

The longevity of each one of the leading producers' mines seems assured, given the extent of its reserves: CBMM: 400+ years; Catalao: 20+ years; and Niobec: 18+ years. So it can be tricky to find exposure to niobium (from pyrochlore resources without a major exposure to tantalum) through any companies other than a large diversified mining concern or a predominantly gold mining company.

Among those companies with a particular interest in niobium, Niocan inc (TSX: NIO) has its Oka niobium project about 31 miles northwest of Montreal, although it has been awaiting environmental permits since at least 2001. Elsewhere, Eramet's (FP: ERA) Mabounie project (admittedly also holding "interesting resources of ... tantalum, rare earth and uranium") in Gabon has yet to get going. And Eramet has significant interests other than niobium. The Crevier Niobium project (a joint venture between MDN Inc. (67.5 percent) and IAMGOLD (32.5 percent)) is at the feasibility stage.

However, there is one Australian company that appears to have an interesting niobium project in Malawi, Africa. Although still at an early stage in its development, Globe Metals & Mining Limited (ASX: GBE) expects production at its Kanyika Niobium project in central Malawi to commence "in 2013 at a rate of 3,000tpa niobium metal, principally in the form of ferro-niobium." It is a project probably worth keeping an eye on, along with Avalon Rare Metals' (TSX: AVL) Thor Lake project and Commerce Resources' (TSX: CCE) Blue River niobium and tantalum resources.

So, if companies focusing on the production of niobium are hard to find, what about those "new niches" mentioned by Roskill? Several spring to mind. One is the development by CBMM of niobium catalysts (mentioned in the Mining Technology article) to help convert palm oil to biodiesel. Another is the use of niobium in superconducting magnets, whether it be in simple industrial cyclotrons and synchrotrons, or massive contraptions like the Large Hadron Collider and the International Thermonuclear (Fusion) Experimental Reactor—which, according to Avalon Rare Metals, "is estimated to use 600 metric tonnes of Nb3Sn strands and 250 metric tonnes of NbTi strands."

While it is probably unlikely that many people will order colliders, if fusion research is successful, niobium demand is likely to pick up. Similarly, if cyclotrons (and other particle accelerators) are found to constitute a viable alternative to reactors for producing radioisotopes, then demand for the element could increase in this industry, too.

Finally, despite niobium having played second fiddle to tantalum in capacitors for quite some time now, the day could come when the metal pulls up its seat alongside that of the rarer metal. Research certainly continues to improve the performance of niobium capacitors.

Opportunities here include the specialist companies, such as those making the superconducting wires, those developing the next-generation niobium capacitors or those that discover further uses for niobium in the field of clean fuel technology.

I have a sneaking feeling that niobium could be just one of those strategic metals that has yet to reach its full potential in terms of application. Whether these uses are ones whose importance we don't yet know, or simply don't yet recognize, I am not sure. Perhaps we'll just have to wait.

Afterword

Afghanistan could become a vital new resource for niobium. A June 13, 2010 article in The New York Times reported that "a small team of Pentagon officials and American geologists" had discovered "[t]he vast scale of Afghanistan's mineral wealth." Of niobium, the "[p]otential value of known and estimated

resources in current prices" was some $81.2 billion, third only to iron at $420.9 billion and copper at $274.0 billion.

Resources

Roskill Information Services

Tantalum-Niobium International Study Center (TIC)

U.S. Geological Survey (USGS)

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