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International Beryllium funds nuclear fuel research

JUNIOR HOPES TO BOOST DEMAND FOR METAL

BY RON MANDEL

International Beryllium (IB-V, IBRYF-O) has agreed to fund a two-year, US$500,000 research project by Purdue University in West Lafayette, Ind., to investigate the possibility of producing a better nuclear fuel pellet by adding beryllium oxide. By funding the project, the company hopes to increase beryllium demand in the "nuclear renaissance."

Conventional nuclear fuel pellets are made of uranium oxide on which uranium metal is deposited, and the radioactive metal produces heat from nuclear reaction. Although this pellet technology is well established and has been used for decades, it is far from perfect because uranium oxide is a poor heat conductor. Another problem is that the poor heat conductivity leads to large temperature differences between the outside surface of the pellet and its core, causing thermal stress and gradual pellet degradation and cracking. Once the pellets degrade too much, it is necessary to recharge the reactor with new fuel.

In an effort to improve pellet performance, a team of Purdue University researchers, including professor Shripad Revankar and professor emeritus Alvin Solomon, has investigated an experimental pellet where beryllium oxide was added to the uranium oxide to enhance heat conductivity (*T.N.M.* April 28-May 4/08). Because of its superior heat transfer properties, the resulting pellet produces more heat and offers a longer service life. The new pellet is also safer, because the superior heat transfer allows the pellet to quickly dissipate any heat build-up, making a nuclear meltdown less likely. Another benefit is a lower reactor temperature. To achieve these improvements, the pellet must contain 3-7% beryllium oxide.

The current project seeks to advance Purdue University's research findings toward commercialization. Over the next two years, the experimental pellets will be produced and tested in a laboratory. The project will be led by Revankar, while Solomon will serve as a consultant. The laboratory work will be carried out by professor Sean McDeavitt at Texas A&M University and if successful, the next step toward commercialization will be to test the new pellets in the advanced test reactor at the Idaho National Laboratory, in Idaho.

In return for the funding, International Beryllium will have the option to receive either an exclusive or non-exclusive licence for the new pellet technology. A non-exclusive licence would be royalty-free, while an exclusive licence would include royalties. Besides gaining access to the new technology, International Beryllium hopes that if the research project is successful, it will increase beryllium demand.

In an interview, Revankar said that the project's objective is to create a standardized, repeatable fabrication process to manufacture a stable, robust multi-oxide pellet. Researchers will try various beryllium oxide levels to find the one that is most stable and conducts heat the best. In addition to being thermally optimized, Revankar says that the pellet must also be optimized with regards to neutrons, to ensure that it works well in a radiation environment. Beryllium acts as a moderator in a reactor, slowing down the reaction.

International Beryllium CEO Anthony Dutton says the project is not basic research but an applied development project seeking to commercialize a practical multi-oxide pellet. The first phase has already been completed successfully at Purdue University.

"If this technology bears fruit, the demand for beryllium and beryllium oxide will skyrocket," Dutton says. "I would think that the demand curve would go vertical."

Dutton believes that multi-oxide nuclear fuels will be used in future.

"We are not sure yet that it will be uranium beryllium oxide, but of all the multi-oxide fuels that are currently being contemplated, uranium beryllium oxide is the furthest ahead in research and acceptance, and also has the inherent fundamental characteristics to make it the most suitable multi-oxide fuel."

Dutton's goal to use the Purdue project to increase beryllium demand ties in with his strategy of building a vertically integrated beryllium company, handling the metal from the mine mouth to the alloy, and even further downstream to semi-finished products. This is a somewhat unusual strategy compared to the *modus operandi* of most mining companies, which produce concentrate or metal ingots, and prefer to leave processing, alloying and downstream applications to specialist companies close to the end user.

Dutton's strategy is dictated by the highly specialized nature of beryllium applications and products. Because end uses for this metal are unique niche applications, processing and production know-how is both crucial and rare, and often requires detailed knowledge of the end use.

The largest company in the beryllium

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industry is Brush-Wellman, a subsidiary of Cleveland-based **Brush Engineered Materials** (BW-N) — a vertically integrated company that owns mines as well as metal processing and fabrication facilities. Last year, Brush Engineered Materials reported net income of about US$53 million on revenues of about US$950 million. Because it has other operating subsidiaries besides Brush-Wellman, not all of these revenues come from beryllium-related products.

Brush Engineered reports that 63% of its revenues across all business lines (Brush-Wellman as well as other subsidiaries) come from the telecommunications, computer and data storage markets, and the balance, from six other sectors. Broken down by segment, Brush reports that 54% of its revenues come from advanced material technologies and services, another 30% from specialty engineered alloys, and the balance, 16%, from three other segments. Although these figures do not reflect the exact breakdown of Brush-Wellman's beryllium business, they do show that this industry is built around specialty products and applications, where processing and fabrication know-how is key.

While Brush Engineered dominates the beryllium industry, there are a few small independent companies making specialty alloys and semi-finished products such as plates, rods and tubes. In keeping with its strategy of creating a vertically integrated supplier, International Beryllium bought one of these companies, **Freedom Alloys**, in May. And in June it signed a letter of intent to buy a second beryllium fabricator. Although the name of the second acquisition target has not been disclosed, what is known is that some of the company's products are finished components for the oil and gas industry.

One benefit that the company derives from buying operating businesses is revenues and profits. After buying Freedom Alloys, International Beryllium has turned profitable, and Dutton expects that once the second acquisition closes, profits will increase further.

While growing its profile in downstream markets through acquisitions, International Beryllium continues to lock up projects that are prospective for beryllium minerals. In January, it has acquired mineral claims near Brush-Wellman's Spor Mountain beryllium mine, in Utah. In June it acquired the past-producing Boomer mine in Colorado, and has staked more claims around the mine. It also owns five projects in Uganda and two in Brazil, and in May, acquired a small consulting business in Denver, Rare Earths Ltd. The consultancy owns a comprehensive database of beryllium occurences around the world.

According to Rare Earths, there are four types of beryllium deposits. The first type is pegmatite, which includes minerals such as beryl, bertrandite, and phenacite (sometimes spelled phenakite.) These are often small-tonnage but high-grade deposits, grading 0.1-0.5% beryl, of which about 5% is beryllium. The second type is bertrandite developed in ash or sedimentary rock. Fluorite or fluorspar are typically present with the bertrandite, imparting certain positive metallurgical attributes. These deposits are usually large, but they are also low-grade because of the substantial overburden usually present. Once the overburden is removed, they typically grade 0.5% bertrandite, of which about 6.5% is beryllium. An example of this type of deposit is the Spor Mountain mine.

The other two types of beryllium occurrences have not been mined so far: One is rhyolitic intrusions into surrounding limestone country rock, with the mineral behoite. The other has the mineral genthelvite, and the deposits are usually large.

None of International Beryllium's mining projects are in production.

Dutton acknowledges there is no real shortage of beryllium because there are a number of projects that could be put into production to meet any increase in demand. However, something else had been missing in the beryllium industry: fresh thinking and the initiative to invest in research and innovation, find new applications, and create new markets for the metal. The Purdue project is an example of this.

"One of the things that we bring to the table is a fresh and new outlook on the whole of the beryllium business and beryllium opportunities," Dutton says.

According to Brush Engineered Materials' website, beryllium is light, strong, stiff, has a high specific heat, and is a good heat conductor. It retains good physical properties at both elevated and cryogenic temperatures, and when combined with aluminum, forms a unique metal matrix composite. Applications include nuclear, aerospace, X-ray, acoustics, vacuum, automotive, bearings, electronics, computers, connectors, oil, gas, mining, plastics tooling, telecommunications equipment, marine and medical specialties. Beryllium oxide is a ceramic material that also has specialty applications due to its good heat conductivity, ability to withstand high temperatures, and rigidity.

With these unique physical properties, beryllium does not come cheap. The market for the metal is opaque, because it is not traded on an exchange, and price estimates range between US$250 and US$500 per kg. However, most applications use beryllium alloys typically costing less than US$10 per kg. Dutton estimates that current demand is 400 tonnes beryllium per year, and it will grow to more than 500 tonnes per year in 2010.

Beryllium processing carries a health risk: fine airborne beryllium particles, fumes or mist can cause a lung disease known as chronic beryllium disease. Skin contact does not trigger the disease, but contact with beryllium salts, solutions or particles may cause beryllium sensitization. Beryllium is also listed as a carcinogen with a number of health agencies.

The company has 120 million shares fully diluted and $6.5 million in cash. Institutional investors hold about 75% of the shares.