



Beryllium: THE MIRACLE METAL



Introduction



One-third lighter than aluminum and six times stiffer than steel, beryllium has been an essential material in ushering in major advances in technology, ensuring national security and improving the quality of life for literally millions of Americans for more than 50 years.



Often called the “miracle metal” because of its unrivaled combination of physical and mechanical properties, beryllium and beryllium-containing materials such as alloys and ceramics are widely utilized to make increasingly sophisticated products function more effectively. Beryllium materials deliver higher levels of performance and reliability and have enabled major advances in technology in markets as diverse and critical as aerospace, defense, energy, medical, automotive, telecommunications and consumer electronics.



FOR EXAMPLE:

- Beryllium has enabled the development of high resolution x-rays key in the fight against breast cancer. Because it is transparent to x-rays, beryllium is the perfect “window” to focus and control the x-ray beam of energy generated by medical and scientific equipment.
- Beryllium is playing an increasing role in America’s search for energy independence. The ability of beryllium-based ceramics to withstand large temperature swings led to the first automotive electronic ignition system, which resulted in huge reductions in tailpipe emissions and the savings of tens of billions of gallons of gasoline. These unique properties are now being applied to the generation of solar power.



- Its use on fighter jets saves weight and improves guidance system performance while beryllium infrared enemy detectors allow pilots to identify and pinpoint enemy aircraft.
- Beryllium is also toiling in the deepest places on earth, with the goal of keeping us connected and entire populations safer. Copper beryllium housings protect transoceanic cable equipment and undersea earthquake monitoring systems more than six miles below sea level.
- From the beginnings of U.S. spaceflight through today’s advanced orbiting telescopes and satellites, beryllium has been integral to NASA’s greatest discoveries. A beryllium heat shield protected astronaut Alan Shepard, Jr. during the United States’ first manned space journey and more than five decades later, the 18 large beryllium mirrors on the James Webb Space Telescope will give new eyes to NASA in 2014 when it is scheduled to replace the Hubble Space Telescope.

Most users of beryllium, and all consumers, come in contact with the metal in a finished, solid form that presents no health risks. However, like many other vital and versatile elements of nature, beryllium must be handled with care. The risks of beryllium are largely confined to the workplace where workers must follow well-established procedures to protect against the material in a respirable form. Since these risks were first identified in the 1940s, the beryllium industry, along with the medical and scientific community and government regulators, have worked to advance the understanding



of how beryllium in the form of dust, fume or vapors can impact the health of workers, and to build safeguards to minimize or prevent this risk. Major advances in workplace practices, personal protective gear, and equipment and process changes have demonstrated that beryllium can be manufactured and handled safely throughout its lifecycle. By investing in and following the appropriate precautions, the beryllium-using community ensures that this critical material continues to benefit society.

The metal remains irreplaceable in many of its uses, so if beryllium were no longer available domestically, defense and homeland security

contractors would have no choice but to turn to less reliable offshore sources or concede to providing less effective defense and security systems. The U.S. Department of Defense (DoD), in its December 2008 “Analysis of National Security Issues Associated with Specialty Metals” stated that of all the metals used by the DoD, only high purity beryllium was deemed to be critical to national defense. The DoD acknowledged beryllium for being “essential for important defense systems and unique in the function it performs”. The report noted that the Department “should continue to take special actions necessary to maintain a long-term domestic supply of high purity beryllium.”



Background and Properties

A naturally occurring element present in the earth's crust, beryllium can be found in coal, wood, water, many minerals and all soils. In fact, beryllium can be found in many fruits and vegetables that absorb it from the soil. Beryllium-bearing minerals such as beryl, aquamarine and emerald are prized as gemstones.

Beyond its light weight and stiffness, key properties of beryllium include an extremely high melting point, relatively low density and atomic structure that give it remarkable sound and thermal conductivity, and high heat absorbing capacity and dimensional stability over a wide range of temperatures. Its properties make possible

A “YOUNG” METAL

the miniaturization of products and beryllium-containing alloys make it possible to shield electromagnetic radiation in electronic devices, thereby protecting users from the potential effects of electromagnetic energy and the device from possible circuit failure.

There are three types of commercial forms of beryllium. By far the most common is as an alloying element with copper or nickel, containing 0.3 to 2% beryllium by weight. Beryllium alloys offer high electrical conductivity, long-lasting spring properties (metal memory) and corrosion resistance. Metallic, or pure beryllium is prized for its light weight, stiffness, stability throughout huge swings in temperature, high heat dissipation and nuclear energy management. Beryllium oxide, also known as beryllia ceramics, provides temperature stability, high heat dissipation and high electrical insulator properties.

The extraction of beryllium begins with the raw materials, bertrandite ore and/or beryl ore. The extraction process involves a series of processes including leaching with sulfuric acid to produce water soluble beryllium sulfate, formation of a beryllium concentrate by solvent extraction and hydrolysis to ultimately produce an extremely pure beryllium hydroxide. The hydroxide is the universal input material for beryllium-containing alloys, beryllia ceramics, and pure beryllium metal manufacturing.

While other metals, including gold and copper, have been known to early civilizations, beryllium is a relative newcomer. In 1798, the element beryllium was discovered by the French analytical chemist Louis-Nicholas Vauquelin as the oxide in beryl. He named it glucinum, because of its sweet taste, similar to glucose. In 1828, the chemists Antoine Bussy and Friedrich Wöhler, working independently in France and Germany, respectively, isolated metallic beryllium.

The commercial value of beryllium was first recognized in 1926 when the Siemens Company patented copper beryllium alloys for use in the fast growing telephone relay applications. The use of copper beryllium alloys, beryllia ceramics and metallic beryllium grew at a dramatic rate during World War II. In the economic boom that followed the war, beryllium and beryllium-containing materials began emerging in other civilian markets, such as telecommunications, appliances, automotive, and plastic injection molds and tooling. During the space race, with American pride, scientific endeavor and national security at issue, the demand and uses for beryllium soared.

Beryllium is commercially mined and processed in only three areas of the world—the U.S., China and Kazakhstan. The world's leading producer of beryllium and its alloys is Materion Brush Inc., based in suburban Cleveland, Ohio.

The Many Important Uses of Beryllium

HEALTH CARE

The same technology that makes x-ray screening at airports so effective is saving lives in other ways. In fact, beryllium is an integral material in much of the equipment physicians rely on to accurately diagnose and treat patients. The metal is used in CT (computer tomography) scanners and x-ray machines. Specifically, beryllium is a key component of the next generation x-ray machines created for mammography, enabling lower radiation dose CT scans, with significantly finer tumor resolution, thus making breast cancer easier to detect at its early, most treatable stages.

Medical lasers made with beryllia ceramics are providing the gift of restored or improved sight to millions around the world. Doctors rely on the performance of surgical instruments constructed with copper beryllium connectors to ensure the reliable transmission of electrical and electronic signals. Copper beryllium wire is used for the flexible leads of pacemakers to provide a long, fatigue-resistant life for these devices, and beryllium is used in the analytical equipment used to analyze blood for HIV and other diseases.

ENERGY CONSERVATION AND ALTERNATIVE ENERGY

Beryllium is helping America conserve fuel, which drives down costs and reduces the nation's dependence on foreign energy sources – a cornerstone of economic security in the United States. Beryllium materials also play a role in lowering the cost of directional drilling for oil and gas, as well as making the searches more fruitful through the use of directional tools and x-ray sensors. The more cost effective and successful an exploration, the lower the ultimate cost for consumers.

In a particularly remarkable advance, the use of beryllia ceramic in early electronic ignition systems led to a 20 percent increase in automotive fuel efficiency and reduced pollution. That breakthrough, in other words, amounted to a savings equivalent to taking one of every five cars off the road. More recently, alloys containing beryllium are enabling all-electric and hybrid electric vehicles to operate reliably at high voltages.



Beyond traditional energy sources, copper beryllium alloys and beryllia ceramics are increasingly finding favor throughout the two dominant technologies for solar energy's photovoltaic cells. Alloys with beryllium provide superior thermal management, conductivity and strength in connecting conductive terminals that join solar panels together in the thin film solar arena. In the alternative concentrator photovoltaic (CPV) technology, the superior thermal management properties of beryllia ceramics allow cells to operate at very high solar concentrations, already achieving 1,000 times the intensity of the sun, while still keeping the delicate electronics of the CPV cell cool, a critical factor for adding solar power to the electric grids in areas with abundant sunshine.

Metallic beryllium has a front seat in the race to harness the power of fusion, the same energy source that lights the stars, and generates an unlimited source of clean energy with virtually no green house gas emissions and very little nuclear waste. Beryllium has already been qualified for use in several critical components of the International Thermonuclear Experimental Reactor (ITER) project, a partnership of the European Union, the United States and five other nations to design, construct and operate the world's largest and most complex prototype nuclear fusion reactor. ITER is currently under construction in France. In England, beryllium is already at work in the Joint European Torus experimental reactor (JET).

PUBLIC SAFETY

Beryllium also makes life safer in many everyday ways. It helps save lives in a fraction of a second. Beryllium alloyed with nickel provided the technological breakthrough that allowed air bags to reliably activate on impact, and ultimately to be installed as standard equipment on today's cars and trucks. Anti-lock brakes rely on beryllium alloys to transmit electrical signals. Electrical relays made with beryllium alloys make it possible for automotive directional signals and emergency flashers to operate for years of service.

Fire control equipment and sprinkler systems use nickel beryllium alloys. In hospital operating rooms, chemical plants and other environments where combustible gases may be present, non-sparking tools and equipment depend on copper beryllium alloys. Reliable control of the breathing air equipment for firefighters, too, is enhanced by the use of alloys containing beryllium. Weather forecasting satellites designed with beryllium optical components predict and track weather patterns.

Handheld x-ray systems, made possible through the use of beryllium, check imported clothing and children's toys, as well as consumer electronics, for the presence of lead, mercury, cadmium and other restricted materials.

NATIONAL DEFENSE

Beryllium is found in many major elements of our national defense from aircraft to satellite technology. In aerial combat, America's military jets are known to "own the night," in large part because jets with equipment containing beryllium are lighter and more maneuverable, as well as razor-sharp in targeting, striking and eluding the enemy in nighttime or other limited visibility conditions. The nation's unmanned aerial vehicles (UAV) rely on beryllium for real-time imagery and targeting on surveillance and reconnaissance flights. In military helicopters, beryllium optical systems provide enhanced surveillance by detecting weapons at greater "stand off" range, keeping pilots and crews from harm's way.

Beryllium is also integral to the U.S. military services' latest weaponry, which is used to detect and destroy improvised explosive devices (IED) and tactical minefields. In emerging guided missile defense systems, beryllium is widely used to assure a first line of defense in directing, targeting and ultimately destroying missile threats. For battle tanks on the move across rugged surfaces, extremely stiff beryllium mirrors dampen vibration to provide a jitter-free optical path for sighting and firing controls.



BERYLLIUM PRODUCTION AND CONTRIBUTIONS TO ECONOMIC GROWTH

As a matter of maintaining peace, experts on international relations say, the world is a safer place with the U.S. as the leading processor of beryllium. But economists insist that prosperity is at stake, too.

The processing of beryllium provides many well-paying jobs in the U.S., both directly and indirectly. Materion Brush Inc., the only domestic producer of beryllium, employs approximately 1,000 workers. The company extracts beryllium in Utah, and operates plants in Arizona, California, Ohio and Pennsylvania.

A major exporter of U.S.-produced materials to Europe and Asia, the company has distribution centers globally and serves thousands of customers. These buyers of beryllium and beryllium-containing materials include both commercial businesses and government agencies. They make a wide variety of consumer goods, such as cell phones, and national security equipment, including jets, which, in turn, employ an exponential number of workers. These are jobs that stimulate many industries, including electronics, communication, defense and transportation.

Equipment containing beryllium can be found in a wide range of military equipment, including the F-35 Lightning II Joint Strike Fighter, F-15 Strike Eagle, F-16 Fighting Falcons, F-18 Superhornet and the F-22 Raptor, as well as the AH-74 Apache and OH58D Kiowa Warrior helicopters. It is used in the M60 and M1A2 Abrams main battle tanks.

Beryllium has no replacement in America's nuclear defense arsenal and the nation's overall strategic deterrent capabilities. In its pure metallic form, beryllium is integral as a moderator of neutrons required for a controlled nuclear fission reaction.

Because no other ingredient can substitute for beryllium, the use of the metal in war can determine whether battles are won or lost and lives are saved. Any disruption in the availability of beryllium would risk compromising the effectiveness of the nation's defense forces.

HOMELAND SECURITY

Beryllium plays an important part in defending the nation at home as well, where the threat of terrorism challenges our military and law enforcement authorities to devise new means and methods to protect against cyber warfare, or chemical, biological or nuclear attack. The material serves a vital role in behind-the-scene technology and countermeasures at airports and borders along with other high value targets, such as bridges, power systems, dams and other public facilities.

Beryllium is a crucial component of the technology responsible for making air travel safe. This includes Global Positioning System (GPS) technology used for air-traffic control and air route surveillance. Beryllium is a component in the x-ray machines used to inspect baggage and in the high speed lasers used for luggage bar code scanners.

At our nation's ports, beryllium is at work in analytical devices that inspectors use to inspect cargo for harmful or banned materials.

The material is also key to our ability to prepare for natural disaster. Subsea seismic monitoring systems utilize sensitive electronic equipment, protected by copper beryllium housings, to warn coastal communities and entire nations of an approaching undersea earthquake or tsunami.

Further, homeland security and military personnel monitor and evaluate various threats to citizens with advanced communications, including satellites, wireless and microwave technologies, and computers and routers, that all function with the use of beryllium.

COMMUNICATIONS

Beryllium materials help keep people and populations connected all over the planet. The metal, especially in its alloy and ceramic forms, is at work every day throughout a vast range of communications infrastructure and consumer end-use applications that bring people and data together faster, more reliably and more affordably than ever before.

Strong and highly conductive, copper beryllium alloys allow for the electrical/mechanical contacts that enable the reliable transfer of power and signals within and between computers and computer peripherals.

High strength, corrosion-resistant copper beryllium materials house and protect delicate signal amplification equipment installed in 60-kilometer intervals along undersea fiber optic lines that connect the world's continents.

Owing also to its superior strength, formability, electrical conductivity and spring "memory," designers turn to copper beryllium alloys for the electrical terminal contacts in connectors critical to the functioning of today's cell phones and other mobile devices. These same alloys enable consumer electronics products to further miniaturize and converge multiple functions - phone, camera, MP3 player - into a single more reliable device with a longer working life, which also reduces the volume of electronic waste.

Beryllia ceramics' properties of high thermal conductivity, excellent electrical insulation, resistance to chemical corrosion and a high melting point provide an ideal materials solution for various applications in the telecommunications sector. In electronic semiconductor chip packaging for wireless and Internet infrastructures, for example, ceramic materials protect the components and entire systems from the crippling effects of the intense levels of heat generated.

Beryllium-containing alloys in GPS equipment free individuals and businesses to function and move about effectively and safely. Mobile and compact GPS devices allow owners to monitor the location of all vehicles in a fleet of trucks, ships or railroad cars. Farmers can effectively manage fertilizer and pesticide application for crops, and closely control large irrigation systems by real-time temperature and water pressure monitoring. In addition to the impact on the workplace, GPS systems utilizing beryllium materials are regularly used to guide people to their travel destinations, find lost children and assist law enforcement in tracking down criminals.

TRANSPORTATION

Beryllium has important applications for commercial transportation, as well. Here, copper beryllium is helping airplanes travel farther, faster, and more fuel efficiently while producing reduced levels of green house gases. Copper beryllium alloys, used in the bearings and bushings of aircraft landing gear, wing flaps and emergency exit doors, ensure long life and reliability. Aviation engineers rely on these alloyed materials because of their very low coefficient of friction and ability to withstand enormous compression and the forces of wear, regardless of temperature extremes. Virtually all aircraft electrical and electronic connections are made using copper beryllium alloy terminals in the connectors to provide vibration-resistant contact. Diaphragms made of copper beryllium alloys are essential to aircraft instruments such as altimeters

that rely on the measurement of changes in atmospheric and barometric pressure.

On the highway, beryllium materials make driving more comfortable, convenient and reliable. Beryllium-containing alloy connectors are essential to the electronics of today's cars and trucks. Copper beryllium is used in traction control systems and transmissions, in electric motors and for the connections in steering columns, anti-lock brake systems and fuel injection systems. The alloy has made it possible for engineering advances to replace hydraulic and mechanical components, which are bulky and less versatile, with lighter weight electro-mechanical devices.

SCIENCE AND EXPLORATION

Beryllium is crucial to the country's scientific prowess, and the realization of science's future promise. With its stiffness, strength and light weight, together with its powers of thermal management and reflectivity, beryllium has played a significant role in space exploration since the early days of NASA. As the quest for exploration continues, beryllium remains imperative.

Pure beryllium mirrors are a vital element in the renowned Hubble telescope, for example, as well as the next generation of space age marvels, NASA's James Webb Space Telescope which will reveal even greater astronomical discoveries. The Webb telescope features a 6.5-meter (20 feet) aperture primary mirror comprised of 18 beryllium

BERYLLIUM PROCESSING DOES NOT HARM THE ENVIRONMENT

segments and will be the largest deployable telescope ever launched. Beryllium was selected as the mirror technology for its demonstrated track record of operating at cryogenic temperatures (around minus 370 degrees Fahrenheit or minus 223 Celsius) on space-based telescopes, where weight savings and stiffness are obviously primary concerns.

NASA's Spitzer Space Telescope, the largest infrared telescope ever launched into space, relies on beryllium's lightness, its ability to endure the bitterest cold and its optical properties to penetrate vast dense clouds of gas and dust in space, allowing us to peer into regions of star formation, the centers of galaxies, and into newly forming planetary systems.

Beryllium can also be found at the center of a host of other scientific breakthroughs: the Mars Rover, the Gravity Probe B Satellite and the Cassini Orbiter. It is beryllium that is used in the space shuttle window frames, door and guidance systems. Metal matrix composites of aluminum and beryllium have been used in the primary structure of Orbital Sciences Corporation's communication satellites (ORBCOMM).

Back on earth, beryllium is widely used in particle accelerators, including the European Organization for Nuclear Research's CERN LHC laboratory in Switzerland and Brookhaven National Laboratory in New York, where it is helping to advance high energy physics research.

The processing of beryllium is subject to policies, programs, regulations and laws adopted by international, national and state bodies devoted to ensuring environmental health and safety. These include Federal rules requiring clean air and water governed by the U.S. Environmental Protection Agency (EPA). The EPA restricts the amount of beryllium that industries may release into the air, water and wastes.

In terms of sustainability, these metals have the advantage of being infinitely recyclable. Clean scrap can be sold back to the industry for direct recycling into new products that contain beryllium. Moreover, products containing beryllium simply last longer. This longevity forestalls the need for new replacement products that require additional inputs of energy and raw materials to produce them.

In keeping with the way people live – especially young people – beryllium is adept at multi-tasking. The cell phone, perhaps the best example, now serves as a timepiece, computer, alarm, video screen, navigation device, and, of course, a telephone. In devices containing beryllium, this convergence of functions means the need for fewer products to do many more functions – and less raw material needed for manufacture, as well as less disposal at the end of the product life. All of that, naturally, means the use of less energy.

Beryllium Can Be Safely Handled and Processed with Proper Precautions

As a naturally occurring element, everyone encounters beryllium – it's in rocks and soil and as a result, it commonly occurs in air, water and foods. Human activities such as the burning of coal and home heating oil or the processing of earth-based materials into products such as fertilizers can also release beryllium into the air and water. Exposures to beryllium in its natural state are not known to cause adverse health effects.

Using products containing beryllium does not pose a health risk to consumers in the form they encounter it. In almost all end-use applications, beryllium materials are enclosed within products and are not readily apparent or accessible during normal product use.

The potential for exposure exists in workplaces where the material is being processed in a manner that creates airborne particulate. Like many industrial materials, beryllium may present a health risk if handled improperly. A small number of workers who are physiologically susceptible and are exposed to airborne particles containing beryllium (generally in the form of a dust, fume or mist) may develop a serious and sometimes fatal

lung condition known as chronic beryllium disease, or CBD.

CBD is a condition in which the immune system in the lungs of susceptible individuals reacts to the presence of beryllium-containing particles and the lung tissue becomes inflamed. CBD is not cancer. CBD can be treated, but is not curable. Its symptoms can include cough, shortness of breath and general fatigue.

CBD can develop only when the three following factors are present: 1) a person must be sensitive to beryllium; 2) a person must be exposed to airborne beryllium; and, 3) the beryllium particles must be small enough to reach deep into the lungs. Sensitivity to beryllium is believed to require a genetic predisposition, and therefore, not everyone who is exposed to small airborne dusts, fumes or mists will develop CBD.

With proper precautions, CBD can largely be avoided, which means education plays an important role in the safety of those working with beryllium. Materion Brush has won praise for the safety practices and procedures it has adopted

and the training that it provides customers and others on the subject, including the development and use of an award-winning interactive guide that educates workers and employers about ways to work safely with beryllium and beryllium-containing materials.

There is no test that can determine in advance which workers will develop CBD. The Beryllium Blood Lymphocyte Proliferation Test, or BeBLPT for short, is often used to try to determine if a person has a “sensitization to beryllium” and therefore may be at risk for contracting CBD. However, scientific experts warn that the BeBLPT is prone to error, creating the potential for false positives and false negatives, as well as a low rate of agreement between laboratories. Such errors can create unwarranted anxieties and fears among those tested and their families. Moreover, the use of such a test has the potential for discrimination against employees who may be classified as sensitized, but who may never actually have the disease.

Another concern about use of the BeBLPT is that it has resulted in unnecessary medical treatment. People in good health who have tested positive on the BeBLPT have been provided medication by some treating physicians. Such medication, which would commonly only be used for treating symptoms of clinical CBD, has very serious side effects.

Sub-clinical CBD is diagnosed when lung tissue, examined during surgery, shows evidence of microscopic biological formulations called granulomas. These are not cancers. People with sub-clinical CBD might never go on to develop the symptoms associated with clinical CBD. People with sub-clinical CBD do not require medical treatment.

Because of the risk of CBD, manufacturing operations that generate airborne beryllium dust, fume or mist require special controls to minimize worker exposures. Such safeguards, according to research by the National Institute for Occupational Safety and Health (NIOSH), can dramatically reduce the risk of CBD.

Governments around the world have set mandatory limits on worker exposure to airborne beryllium. In the U.S., these standards are currently under review by the federal government’s Occupational Safety and Health Administration (OSHA). As a matter of safe practice, the industry-recommended beryllium exposure guideline during processing is set at a level 10 times lower than OSHA’s regulations governing occupational exposure to airborne beryllium particles.

While some regulatory agencies around the world have classified beryllium as a carcinogen, there is considerable scientific disagreement over whether beryllium poses a cancer risk.

Recent scientific studies provide new evidence that exposure to beryllium does not represent a significant risk of cancer to humans. The studies, conducted on large worker populations, found no excess cancer risk in modern day beryllium facilities operated after the 1950s. Even those organizations

which consider beryllium a carcinogen state that any association which may exist between beryllium and cancer is only at the higher levels of airborne beryllium particulate exposure that existed at facilities operating before the 1950s.

MATERION BRUSH: THE WORLD LEADER IN BERYLLIUM PROCESSING

Materion Brush Inc. is the world's leading producer of beryllium, beryllium alloys and beryllia ceramics. It is a wholly owned subsidiary of Materion Corporation, which is traded on the New York Stock Exchange under the symbol MTRN.

Founded in 1931 as the Brush Beryllium Company, its original mission was to develop commercial forms and applications for beryllium materials. The venture built on the technical pioneering work which had begun in the 1920s at the Brush Laboratories under Charles F. Brush Jr., son of the famed Cleveland inventor who greatly advanced the practical use of electricity. After his death, his business partner, Dr. Charles Baldwin Sawyer, a Yale graduate, went on to incorporate the company.

Sawyer, with fellow scientist Bengt Kjellgren, developed a practice of extracting beryllium from beryl ore by thermal shock techniques. Through times of war and peace the company's sales grew steadily and climbed following the prosperous

post World War II years and the second half of the last century as both government and commercial markets expanded. Beryllium became regarded as the perfect Space Age metal for its remarkable strength and light weight. Beryllium contributed to the development of atomic energy and the computer age, and, in fact, was used to form the space capsule heat shield which protected astronauts during re-entry in the Mercury Mission space flights.

Today, beryllium processed by Materion Brush plays a vital role in virtually every important sphere, in economic development and national security. It is used to diagnose and treat disease, protect the nation's defense, explore ways to find affordable energy sources, connect the world through cell phones, and even keep people entertained through products such as MP3 players. The company has been accorded honors for its job creation, investment, technical advances and safety communications.

Materion Brush Sets the Standard for Worker Safety

For more than 50 years, Materion Brush has implemented special handling procedures in the processing of beryllium and instituted a number of protective measures for its workers, based on the best information available at the time.

In every step of the processing of beryllium, the safeguarding of workers and communities stands as a central and overriding mission. Workers are extensively educated and trained in safety practices and procedures to be followed. State-of-the-art equipment and controls are used to ensure the prevention of particles being released during the processing of beryllium.

These practices adhere to recognized industrial hygiene practices, including an extensive recordkeeping system to monitor the exposure of its employees to beryllium.

In 2003, the company completed work on an innovative new beryllium Worker Protection Model (WPM) premised on addressing all potential occupational exposure routes and pathways. The company's program is considered a best practice throughout the beryllium-using industry. The new WPM succeeds because it integrates up to eight levels of containment/protection measures, including:

1 Keeping beryllium out of the lungs

2 Keeping beryllium work areas clean

3 Keeping beryllium off of the skin

4 Keeping beryllium off of clothing

5 Keeping beryllium at the source

6 Keeping beryllium in the work area

7 Keeping beryllium on the plant site

8 Keeping beryllium workers prepared to work safely

INTERACTIVE GUIDE TO
WORKING SAFELY WITH **BERYLLIUM** AND
BERYLLIUM-CONTAINING MATERIALS



CD-ROM

- Why this interactive guide
- How to use the interactive guide
 - Worker Protection Model
- Worker Protection Model and You
- About beryllium-containing materials
 - Glossary

Materion Brush provides safety and hazard communication tools for training to its workers, as well as for downstream users of the material. The company has been lauded by NIOSH for its 10-year partnership to research, develop and test its WPM, as well as communicate its progress about the model's efforts to minimize the risks to those handling beryllium. Materion Brush has acted as a partner with NIOSH on the collaboration of medical and scientific research to better understand the causes and prevention of health effects associated with exposure to beryllium.

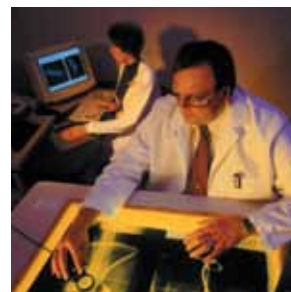
Most recently, Materion Brush has advanced the safe use of beryllium in the workplace with the development and wide-scale distribution of an innovative new training and educational tool,

“The Interactive Guide to Working Safely with Beryllium and Beryllium-containing Materials.” The Guide, accessible on line at www.berylliumssafety.com incorporates high definition digital video, navigation tools, text references, hyperlinks, and printable information to present the latest information on safe handling of beryllium in a brief, easy-to-understand and customized manner, giving the user control over timing, pace and content selection.

Materion Brush's commitment to worker safety has significantly reduced the possibility that its workers will contract CBD. It is a profound commitment, and one without option, because our world needs beryllium, while beryllium workers must be protected.

Beryllium and the Future

To keep the nation safe, connected and prosperous, there is no substitute for the metal that really matters, beryllium. As innovations progress, engineers and scientists know that new developments, from national defense systems to health care, will require harnessing the phenomenal powers of this miraculous metal.





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