***Beryllium*** **maintains a legendary role in constant pursuit of knowledge.**

From NASA's earliest days, when **beryllium heat shields** protected Mercury spacecraft **during re-entry,** scientists, designers, and engineers continue to depend on this stiff, lightweight and versatile material to meet their most demanding challenges. Beryllium is almost transparent to x-rays, and beryllium foil is used as window material in x-ray and other radiation machines. In nuclear reactors, beryllium metal and beryllium oxide are used to **control fission reaction**. https://geology.com/usgs/beryllium/ Beryllium is now classified by the U.S. Department of Defense as a strategic and critical material because it is used in products that are vital to national security

**Beryllium has also been used in the trigger mechanisms for nuclear weapons,** Orbiting the earth. Beryllium **serves on current NASA vehicles including the Space Shuttle, where it adds strength, dissipates heat and lightens weight in window frames and door systems.** Beryllium components also fly in the Spitzer Space Telescope. Beryllium occurs naturally in the earth's crust and in the air, soil and water. Every day, people are exposed naturally to extremely small amounts of beryllium by breathing the air, drinking water and eating food grown in soil. Beryllium metal is used in the aerospace and defense industries to make lightweight precision instruments. With a specific gravity of 1.85 g/cm$^3$, beryllium is the lightest metal that is workable. It is 45 percent lighter than aluminum and approximately five times as stiff. Its stiffness to weight ratio (164) makes it a natural for low inertia, fast scanning applications.

https://beryllium.com/about-beryllium/sources-of-beryllium

Beryllium is also introduced into our lives through human activities. Here, the material typically ends up in a solid form that is designed into and contained within consumer or industrial products -- everything from portable **electronics** and X-ray equipment to cell phones to industrial machinery to medical devices. In virtually all human-generated end-use applications, beryllium is enclosed within products and is not readily exposed to, or accessible to, people. In these enclosed forms, beryllium provides no special health risks. Beryllium's low x-ray absorption cross section and **high neutron scattering** cross section make it ideal for x-ray windows and as a neutron reflector and neutron moderator in nuclear applications. Most pure beryllium blanks are machined using conventional CNC fabricating equipment. https://www.thebalance.com/metal-profile-beryllium-2340127,

Many applications benefit from beryllium's natural heat sink and radiator qualities. Its excellent thermal conductivity (216 W/mK), thermal capacity (specific heat 1925 J/kg K), and emissivity of 0.61 at 650 nm as well as its natural 98+ percent reflectivity in the IR at 10.6 µm and above Beryllium compounds were used in fluorescent lighting tubes, but this use was discontinued because of the disease berylliosis which developed in the workers who were making the tubes. Healthcare. Beryllium is a component of several dental alloys. Occupational safety and health. Beryllium is a health and safety issue for workers.

Beryllium Extraction

Only three countries, the United States, China and Kazakhstan, currently process commercially viable quantities of beryllium ores and concentrates into beryllium products. Today, the extraction of beryllium begins with the mining of raw materials (bertrandite ore and/or beryl ore). Beryl ore is melted in industrial furnaces, solidified and crushed, then treated with sulfuric acid to produce a water-soluble sulfate. Bertrandite ore is crushed, made into slurry and treated with sulfuric acid to form a sulfate. The sulfate solutions undergo a series of chemical extraction steps to ultimately produce extremely pure beryllium hydroxide, from which virtually all contaminants have been removed. Beryllium hydroxide is the common input material for copper beryllium alloys, beryllia ceramics and pure beryllium metal manufacturing.

Roving the Red Planet. Two Mars Rover vehicles, Spirit and Opportunity, have far exceeded original expectations. Aluminum beryllium components helped protect the rovers on their landings, and then served again to unfold their drive-off ramps. Aluminum beryllium parts used in the Rovers' rock exploration tools have helped our understanding of the planet. Fixing Hubble. When the Hubble space telescope could not see clearly, its new "corrective lenses" were mounted in beryllium fixtures that met the requirements for **lower weight, high stiffness and resistance to dimensional distortions brought on by extreme temperatures**.

The United States is the world's leading source of beryllium. A single mine at Spor Mountain, Utah, produced more than 85 percent of the beryllium mined worldwide in 2010. China produced most of the remainder, and less than 2 percent came from Mozambique and other countries. National stockpiles also provide significant amounts of beryllium for processing.

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Looking ahead. The next-generation James Webb Space Telescope, scheduled to deploy in 2014, will depend on a 6.5 meter **beryllium mirror** to see objects 200 times fainter than visible before. Such mirrors must combine high stiffness and lightweight with an extraordinarily smooth, precise and defect-free surface. And, they must retain their visual quality for decades in deep space, where temperatures never exceed minus 253 degrees Centigrade.

Recreating the conditions after the "Big Bang." Scientist are utilizing beryllium components in earth-based particle accelerators to ensure **high-energy collisions of subatomic particles**, recreating the conditions that could provide clues as to how the universe was formed. In the European Organization for Nuclear Research's (CERN) $10 billion Large Hadron Collider underground near Geneva, Switzerland, **beryllium beam pipes surround the collision regions** where experiments will be conducted.

Beryllia (beryllium oxide) ceramics are often used to contain and control lasers used in surgery. The U.S. Department of Defense aims to hold approximately 45 metric tons of hot-pressed beryllium metal powder in the National Defense Stockpile.

https://www.photonics.com/a25113/Beryllium_Mirrors_Refinements_Enable_New