

Beryllium and Defense call for regulatory coherence

Summary

Beryllium is an element with unique properties, allowing the making of equally unique products. Beryllium is critical to produce numerous defense products. As a result, the European Union has listed Beryllium as a critical raw material.

Beryllium has a hazardous classification as *inter alia* a carcinogen. However, health risks are found exclusively in processing activities by inhalation of fine particles, not with end products. To manage these risks, regulators have decided not to restrict the use of Beryllium, but rather impose measures, notably a binding Occupational Exposure Level, to protect workers and to develop a Product Stewardship Programme.

Although the use of Beryllium is now adequately regulated, the EU continues to review the material and issue rules that undermine its use. We call for a stop on regulatory interference with Beryllium unless new scientific data would call for it.

Introduction

Beryllium is a metal with unique properties, due to which it plays a crucial role in areas of modern technology, such as aerospace, defense, precision instruments, medical equipment, nuclear reactors, and advanced electronics. The significance to the defense industry is one of the reasons why the European Union has identified Beryllium as a critical raw material.



Alongside its numerous beneficial applications, Beryllium has a classification as a hazardous substance, with certain defined health risks. It is classified as a carcinogen under European law, and as a result, Beryllium was thoroughly reviewed under the REACH chemicals legislation.

The review concluded that Beryllium is critical for a variety of applications, including defense. It was also determined that a health risk only occurs in the processing phase and does not occur with the use of products containing the material. A mandatory Occupational Exposure Level (OEL) was therefore introduced with the purpose of mitigating the risk to workers in processing phases. In addition, the Beryllium industry agreed to develop a Product Stewardship Program called "Be Responsible".

In this paper, we intend to demonstrate the relevance of regulatory consistency for the continued use in defense applications as well as research and technological development. We will identify the threat of inconsistencies that undermines the approach taken under REACH and, ultimately, the availability of Beryllium to the defense industry.

Beryllium's Unique Properties

Beryllium constitutes a critical material to defense, due to its unique properties listed below :

1. Lightweight \Rightarrow weight saving ($\frac{2}{3}$ weight of Aluminium)
2. High stiffness \Rightarrow stability and accuracy (6 times stronger than steel)
3. High melting point ($>$ Magnesium & Aluminum) \Rightarrow good performance in high-temperature environments
4. Thermal conductivity ($>$ steel and Copper) \Rightarrow efficient thermal management
5. Corrosion and oxidation resistance \Rightarrow durability and longevity
6. High specific strength
7. Low thermal expansion \Rightarrow stability and adaptability across a range of temperatures
8. Non-magnetic \Rightarrow magnetic interference's minimization
9. Transparency to X-rays
10. Neutron reflection and moderation \Rightarrow control and elasticity

As a result of its unique properties, Beryllium allows the making of products with a performance that could not be achieved with other substances. The European Union has therefore classified Beryllium as one of the few *critical raw materials*. The U.S. Department of Defense (DoD) has identified beryllium as the only substance which is both critical and strategic at the same time , stating that *"Beryllium is essential for important defense systems and unique in the function it performs"* .

Beryllium in Defense Applications

The combination of these unique properties makes Beryllium highly sought after in several strategic applications in the defense sector.

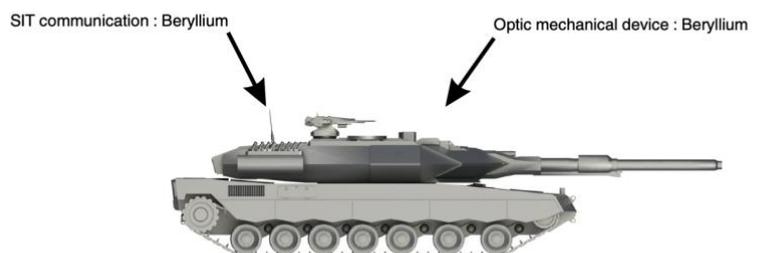
1. Application in Missile Technology

- Used for **missile guidance** because the heat distribution of Beryllium reduces internal stress and enhance overall precision
- Used to answer **environmental challenges** thanks to its resistance to oxidation and corrosion
- Used in **navigation systems** thanks to its seamless integration to missile inertial navigation systems
- Used to **direct, target and destroy** missile threat



2. Applications for Weapons

- Used for **target acquisition** and **target firing**
- Used for **battle tanks** to target and fire controls jitter-free optical path and to dampen vibration
- Used for **airbornes equipment** to detect and destroy improvised explosive devices (EID) and tactical mines.



3. Application in Aviation

- Used for **military helicopters** through enhanced surveillance and targeting systems to keep crews safe
- Used for **unmanned aerial systems** for real-time imagery and targeting on surveillance and reconnaissance flights
- Used for **aircraft landing gear**
- Used in **connectors** (ca. 40'000 in an aircraft) as alloying element in copper, to obtain the best possible material in terms of conductivity and mechanical resistance.
- Used in **electronics for navigation**, more specifically fixed-wing aircrafts and fighters
 - F-35 Lightning II Joint Strike Fighter
 - F22 Raptor
 - F-18 Super Hornet
 - F-16 Fighting Falcon
 - F-15 Strike Eagle



4. Applications in Surveillance and reconnaissance systems

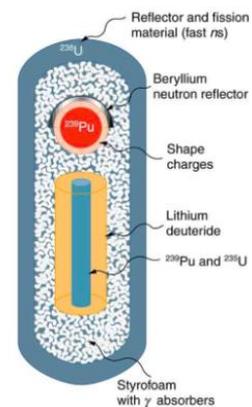
- Used for **command and control communications** in network hubs, switches, routers
- Used for **security devices at airports**, through material support surveillance such as x-ray machines, sorting equipment, scanners
- Used for **metal satellites** for structural and dimensional stability as for reliability + light weight



Use of Beryllium in window frames and door systems of a satellite

5. Application in Nuclear Weapons

- Used in most **contemporary nuclear weapons** because it has a low thermal neutron absorption cross section
- Applied as a neutron reflector and moderator in nuclear reactors and weapons.
- 3 main roles of the Beryllium in nuclear weapons
 - It is a reflector which directs neutrons back into the plutonium pit
 - It is a tamper which initially contains and thereby helps to increase the force of the explosion
 - It is a generator of additional neutrons



Schematic of a fusion bomb (H-bomb)

Beryllium Occupational Exposure Level

Beryllium and its compounds are classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC). Inhaling Beryllium particles, dust or fumes, can also lead to inflammation and scarring of lung tissue, and consequently to chronic respiratory issues, such as Chronic Beryllium Disease (CBD).

The 2009 Classification, Labeling, and Packaging (CLP) Regulation classified Beryllium and its compounds as Carcinogen 1B, harmonizing the EU system with the Globally Harmonized System (GHS). This regulation introduced new classification criteria, European hazard symbols, and Risk and Safety Statements for labeling.

In 2011, the German State Laboratory for Occupational Safety and Health (BAuA) initiated a substance review under REACH, followed by a Risk Management Option Analysis initiated in 2014. In 2016, it concluded that Beryllium metal is critical for several applications, both defense and civilian, and advised against restricting its use. It also concluded that health risks are limited to manufacturing processes, which create fine beryllium particles. The amount of fine particles that could be inhaled by workers would have to be limited to mitigate the risk of adverse health effects. In a following regulatory process, the European Commission, upon advice of European chemicals agency ECHA, issued an EU harmonised binding Occupational Exposure Level for all 27 Member States and requested the Beryllium industry to implement a Product Stewardship Program which is in place since 2017.

Therefore, in 2018, the EU added beryllium in the Carcinogens, Mutagens and Reproductive Directive (CMRD, first adopted in 2004), mandating employers to minimize workplace beryllium exposure and arrange medical surveillance for exposed workers.

Regulatory Coherence

Considering Beryllium's numerous properties and various critical applications, especially in defense, regulatory coherence is crucial for an undisrupted use of Beryllium and will encourage developers to invest in Beryllium based technologies. Product development cycles will often take several years. A developer will not start this cycle with Beryllium if the use of the material may be subject to regulatory restrictions.

BeST believes that Beryllium is adequately regulated under the REACH Regulation and Occupational Safety and Health (OSH) legislations, which sets a binding Occupational Exposure Level. This regulation should not be undermined by various other rules that are not coherent with the REACH regulation on Beryllium.

Below are samples of (proposed) legislation that could negatively affect the use of Beryllium:

- ELV - End of Life Vehicles Directive 2000/53/EC
- Construction Products Regulation
- Ecolabel - Restrictions for Hazardous Substances/Mixtures
- Reviews of Restriction of Hazardous Substances (RoHS) in Electrical and Electronic Equipment (EEE)
- Proposal for a Green Claims Regulation
- General Product Safety Directive - Hazardous Substances
- Medical Devices Regulation
- Pressure Equipment Directive
- WFD - Waste Framework Directive
- REACH review



Beryllium Science & Technology Association

Conclusion

Beryllium is a unique substance used in a variety of applications. In the defense sector it is critical to produce missiles, satellites, aircraft, and nuclear applications.

The health risks posed by exposure to Beryllium are limited to the workplace and have been addressed through implementation of a binding Occupational Exposure Limit and Product Stewardship Program, Be Responsible. This is now done and implemented.

Despite adequate protections having been put into place, the EU continues to evaluate Beryllium and to issue legislation with negative effects on Beryllium. Promoting Beryllium as a CRM and restricting its use in other ways is inconsistent and should be stopped. We call for a moratorium on the regulation of Beryllium until new scientific data would justify a new evaluation.

BeST

The Beryllium Science and Technology Association (BeST) represents the manufacturers, suppliers and users of Beryllium metal, Beryllium containing alloys and Beryllium oxide ceramics in the EU market. BeST has the objective of promoting sound policies, regulations, science and actions related to the safe use of Beryllium and to serve as an expert resource for the international community on the benefits and criticality of Beryllium applications. It is also the objective of BeST to promote good practices in the workplace to protect workers handling Beryllium containing materials.

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