1st Stakeholder Consultation – Compilation of initial substance information for beryllium and its compounds

Abbreviations

BeST	Beryllium Science & Technology Association
BAUA	German Federal Institute for Occupational Safety and Health
BeO	Beryllium oxide
CLP	Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging
CoRAP	Community Action Plan
EEE	Electrical and Electronic Equipment
EU	European Commission
ECHA	European Chemical Agency
ESIA	European Semiconductor Industry Association
GADSL	Global Automotive Declarable Substance List
JBCE	Japan Business Council in Europe
REACH	Regulation (EU) No 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemical substances
SIN	Substitute it Now! List
SVHC	Substances of Very High Concern

1. Legal status

In past processes for identifying substances of relevance for possible restriction under RoHS, only beryllium metal and beryllium oxide were considered. The current assessment looks at a broader scope in this respect, namely beryllium and its compounds. In the following table beryllium and its compounds are presented.

Table 1: Overview on beryllium compounds

Chemical name	CAS	Formula	REACH Registered
Beryllium metal	7440-41-7	Be	Yes
Beryllium oxide	1304-56-9	BeO	Yes
Beryllium copper alloy	11133-98-5	BeCu	No
Beryl (Beryllium aluminosilicate)	1302-52-9	Al_2Be_3 $(SiO_3)^6$	No
Beryllium chloride	7787-47-5	$BeCl_2$	No
Beryllium fluoride	7787-49-7	BeF_2	No

Chemical name	CAS	Formula	REACH Registered
Beryllium sulfate	13510-49-1	$BeSO_4$	No
Beryllium sulfate tetrahydrate	7787-56-6	$BeSO_4$ $4H_2O$	No
Beryllium carbonate basic	1319-43-3	$BeCO_3$, $Be(HO)^2$	No
Beryllium nitrate	13597-99-4	$Be(NO_3)^2$	No
Beryllium nitrate trihydrate	7787-55-5	$Be(NO_3)2$, $3H_2O$	No
Beryllium nitrate tetrahydrate	13510-48-0	$Be(NO_3)2$ $4H_2O$	No
Beryllium phosphate	13598-15-7	$BeHPO_4$	No
Beryllium silicate	13598-00-0	$Be_{2(}SiO_{4)}$	No
Zinc beryllium silicate	39413-47-3	n.A.	No

Beryllium metal (CAS 7440-41-7) and Beryllium oxide (BeO) (CAS 1304-56-9) are classified under the CLP regulation (Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging) with the following entries:[1]

- Carc. 1B (Carcinogenicity) - H350i (May cause cancer by inhalation)
- Acute Tox. 2 (Acute toxicity, inhalation) - H330 (Fatal if inhaled)
- Acute Tox. 3 (Acute toxicity, oral) - H301 (Toxic if swallowed)
- STOT RE 1 (Specific Target Organ Toxicity Repeated Exposure) - H372 (Causes damage to organs through prolonged or repeated exposure).
- Eye Irrit. 2 (Serious eye damage/eye irritation)- H319 (Causes serious eye damage)
- STOT SE 3 (Specific target organ toxicity, single exposure; Respiratory tract irritation - H335 (May cause respiratory irritation
- Skin Irrit. 2 (Skin corrosion/irritation) - H315 (Causes skin irritation)
- Skin Sens. 1 (Sensitisation, skin- H317 (May cause an allergic skin reaction)

In light of their classification as carcinogens, entry 28 of REACH Annex XVII applies to beryllium metal and beryllium oxide and prohibits the supply to the general public of each of the listed substances: as a substance, as a mixtures or as a constituent of other mixtures.

Beryllium metal was included in 2013 in the Community Rolling Action Plan (CoRAP) by the German Federal Institute for Occupational Safety and Health (BAUA). The inclusion was based on the concern of a possible risk of exposure for workers. In the Substance Evaluation Conclusion Document submitted by BAUA in March 2014[2], it was explained that beryllium is classified a as carcinogen known to provoke chronic beryllium disease (CBD) and beryllium sensitization (BeS). BAuA estimated up to 65,000 workers being potentially exposed throughout the EU, though data did not allow estimating the actual workers in risk. Due to its classification as Carc. 1B, according to Annex VI of CLP, beryllium was said to fulfil the Article 57(a) criteria for identification as a substance of very high concern (SVHC)

[1] https://echa.europa.eu/de/information-on-chemicals/annex-vi-to-clp, last viewed 19.04.2018

[2] BAUA (2014), Substance Evaluation Conclusion Document, available under: https://echa.europa.eu/documents/10162/f76365ec-ce93-4422-bdf6-519517cc68be, last viewed 19.04.2018

and authorisation was recommended as the best way to regulate beryllium. Setting and enforcing an EU-wide binding occupational exposure limit was also regarded as an important step to enhance worker protection throughout the EU, parallel to the authorisation.

In the Water Framework Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, beryllium is listed as a substance for which water pollution has to be reduced. Member States are thus required to establish environmental quality standards for this purpose.

Beryllium metal and beryllium oxide are listed in the SIN list and on several other restricting substance lists, i.e. the Global Automotive Declarable Substance List (GADSL), US EPA Extremely Hazardous Substances List.

Beryllium is listed on the 2017 list of Critical Raw Materials for the EU (COM(2017) 490 final)[3]. Materials appearing on this list have been identified as critical for the EU because possible risks of supply shortage (scarcity) and their impacts on the economy are higher than those of most of the other raw materials. Additional aspects (e.g. environmental, social) are not mentioned in the communication in this regard.

2. Uses and quantities

Beryllium and its compounds include three primary forms of beryllium: beryllium metal, beryllium oxide for ceramic parts and beryllium alloys combining beryllium with metals such as copper, nickel, or aluminium. For the major part, beryllium

m is used as a component of alloys. Following is a tabular list of all identified uses of beryllium.

Table 2: Identified uses of beryllium

Sector	Applications
Aerospace	· Engines and rockets · Brakes and landing gear · Satellites and gyroscopes · Precision tools · Altimeters · Mirrors
Energy and electrical equipment	· Heat exchanger tubes · Microelectronics · Microwave devices · Nuclear reactor components · Oil field drilling devices · Relays and Switches

[3] EU COM (2017), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the 2017 list of Critical Raw Materials for the EU, Brussels, 13.9.2017, COM(2017) 490 final, available under: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2017:0490:FIN, last viewed 19.04.2018

Sector	Applications
Telecommunications	· Undersea repeater housings · Mobile phones · Personal computers · Transistor mountings · Electrical connectors · Switches and springs · Electromagnetic shielding
Biomedical	· X-ray tube windows · Scanning electron microscopes · Dental prostheses · Medical laser
Defence	· Tank mirrors · Springs on submarine hatches · Mast mounted sights · Missile guidance · Nuclear triggers
Fire prevention	· Non-sparking tools · Sprinkler systems
Automotive	· Air-bag triggers · Anti-lock braking systems · Steering wheel connectors
Miscellaneous	· Plastic moulds · Bellows · Jewellery –aquamarine and emerald · Golf clubs · Bicycle frames · Camera shutters · Fishing rods · Pen clips · Scrap metal recovery and recycling · Ceramics

Beryllium metal

Beryllium is registered under REACH, indicating a total tonnage band of 10 to 100 tonnes per year. The publicly available registration information indicates the uses as formulation of beryllium containing

alloys at industrial sites or in beryllium oxide ceramics. The EEE specific sectors of end use are the manufacture of computer, electronic and optical products, and electrical equipment. [4]

The Oeko-Institut 2008 study[5] listed the following uses for beryllium metal and estimated a total volume of use of 2 tonnes per year:

- Beryllium metal and composites: optical instruments, X-ray windows;
- Beryllium-containing alloys: current carrying springs, integrated circuitry sockets;

The quantities used in EEE in the EU, mentioned in the 2014 study by Beryllium Science & Technology Association BeST [6], accounted for 2 to 10 tonnes per annum; it was estimated by stakeholders that thereof approximately 0.2 tonnes per annum were used in EEE applications. The following uses relevant for EEE were detailed:

- Audio devices: High fidelity audio loudspeaker diaphragms;
- Medicine: X-Ray windows allowing advances in imaging equipment, diagnostics and laser medicine.

According to BeST the amount of beryllium-containing alloys was indicated to be around 50 to 55 tonnes per annum in total and the use of beryllium-containing alloys in EEE was indicated to be around 25 to 28 tonnes per annum. The following uses of possible relevance to EEE were detailed:

- Current and signal conductive spring terminals, used in electrical and electronic connectors for communications equipment, mobile phones, cell phone systems;
- Medical device connections;
- Fire suppression sprinkler systems and emergency rescue equipment.

BeST provided further specific information for uses of copper beryllium structural components:

- Oil, Gas & Alternative Energy (non magnetic structural components of oil and gas drilling, extraction and production equipment, e.g. Directional drilling steering; Blow-out protectors);
- Thermally conductive, high hardness mold and die applications to reduce cycle time, lower energy consumption and improve dimensional integrity;

In the context of the 2014 Oeko study, the European Semiconductor Industry Association (ESIA) stated[7] that beryllium metal is used in wires as an alloy element and that beryllium oxide and beryllium metal possess specific physical properties able to confer peculiar characteristics to the semi-conductor devices, stating that the compounds are essential and cannot be substituted without changing the semiconductor behaviour.

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[4] ECHA Registered Substance Database: Entry for beryllium; http://apps.echa.europa.eu/registered/data/dossiers/DISS-9ea3c1bc-9f6c-1bb2-e044-00144f67d031/DISS-9ea3c1bc-9f6c-1bb2-e044-00144f67d031_DISS-9ea3c1bc-9f6c-1bb2-e044-00144f67d031.html, last viewed 06.08.2014

[5] Oeko-Institut (2008): Study on Hazardous Substances in Electrical and Electronic Equipment, Not Regulated by the RoHS Directive by Groß, R.; Bunke, D.; Gensch, C.-G.; Zangl, S.; Manhart, A.; Contract No. 070307/2007/476836/MAR/G4; Final Report 17 October 2008; http://hse-rohs.oeko.info/fileadmin/user_upload/Documents/RoHS_Hazardous_Substances_Final_Report.pdf, last viewed 19.04.2018

[6] Beryllium Science & Technology Association - BeST (2014): Contributions submitted on 04.04.2014; http://rohs.exemptions.oeko.info/index.php?id=213, last viewed 06.08.2014

[7] European Semiconductor Industry Association ESIA (2014): Contribution submitted during stakeholder consultation on 04.04.2014; http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Substance_Review/Substance_Profiles/last_contributions/20140404_RoHS_ESIA_Substance_Prioritisation_OKO-Institut_ESIA_April_4_2014.pdf, last viewed 06.08.2014

The Japanese Business Council in Europe (JBCE) stated[8] in the course of the Oeko 2014 study that beryllium copper, a beryllium alloy, is largely used in EEE. The reason for this use was said to be because beryllium copper has high conductivity and high strength to contribute to make parts small and lighten, and has durability to be used in the applications in which reliability is indispensable.

Beryllium oxide (Bo)

Beryllium oxide is registered under REACH for a total tonnage band of 1 to 10 tonnes per year for production of special industrial ceramic articles. The following are relevant for EEE:

- Machinery, mechanical appliances, electrical/electronic articles;
- Other: Offshore industries, medical and optical products, general manufacturing (machinery, tools, equipment, marine, aeronautic and space transport equipment, nuclear power plants, defence applications, R&D); and
- Electrical batteries and accumulators[9].

The Oeko-Institut study of 2008 noted the application of laser bores and tubes for Beryllium oxide ceramics and the amounts of up to 1.5 tonnes per year of beryllium for beryllium oxide ceramics.

The quantities of beryllium oxide used in the EU that were indicated in stakeholder contributions account for two to three tonnes per annum[10]. BesT specified that beryllium oxide ceramics (containing 20% to 37% beryllium) are used in applications that require combinations of: high thermal conductivity; high electrical resistance / insulation; readily machined and polished; high hardness and strength. Beryllium oxide was explained to typically be applied to high-end products and rarely to consumer EEE. Typical applications of relevance to EEE were specified as:

- Substrates for high power electronic devices (e.g. high power transistors; integrated circuitry);
- Laser beam guidance (e.g for medical surgical devices such as excimer laser bores and tubes).

ESIA stated that beryllium oxide is used as a primary constituent of semiconductor devices.

[8] Japan Business Council in Europe JBCE (2014): Contributions submitted during stakeholder consultation on 04.04.2014; http://rohs.exemptions.oeko.info/index.php?id=213, last viewed 06.08.2014

[9] Though batteries and accumulators are used in some EEE, they are understood not to be in the scope of the directive, but rather to be covered by the substance restrictions specified in the Batteries Directive.

[10] Op. cit. Oeko-Institut (2014)