

**DETOX Program
Hazardous Substances Fact Sheet**

Heavy Metals and Metalloids

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1 Background

Heavy metals and metalloids are constituents of specific dyes and pigments, tanning chemicals for leather, catalysts in fiber production, printing pastes, as part of flame retardants and many more. They can also be found in natural fibers due to absorption by plants through soil or from fertilizers. Metals may also be introduced into textiles through finishing processes.¹

Heavy metals as chemical elements are not biodegradable. Some heavy metals are highly toxic, they can affect the immune system, alter genetic and enzyme systems, damage the nervous system, cause cancer etc. Each metal has a very individual effect on human health and the environment. They are regularly found in waste waters from textile industries and they can be extracted or released from textiles or metal parts.

2 Definition

The term „heavy metal“ refers particularly to [cadmium](#), [mercury](#), [lead](#) and [arsenic](#), known to be the top chemical elements and compounds of public concern. A common definition is that heavy metals are the group of metals with atomic numbers between 22 and 34 and 40 and 52. In textiles industry heavy metals and metalloids like the ones listed next are of importance^{2,3}:

CAS Number	Name
7440-43-9	Cadmium (Cd)
7439-92-1	Lead (Pb)
7439-97-6	Mercury (Hg)
7440-02-0	Nickel (Ni)
7440-47-3	Chromium (Cr)
18540-29-9	Chromium VI (Cr VI)
7440-50-8	Copper (Cu)
7440-66-6	Zinc (Zn)
7440-48-4	Cobalt (Co)
7439-96-5	Manganese (Mn)

Metalloids are the elements found along the stair-step line of the periodic system that distinguishes metals from non-metals. Metalloids have properties of both metals and non-metals⁴. Metalloids covered by the Detox-program are:

CAS Number	Name
7440-36-0	Antimony (Sb)
7440-38-2	Arsenic (As)

¹ Intertek, undated. For brands that care from make to wear. Online available: http://www.intertek.com/uploadedFiles/Intertek/Divisions/Consumer_Goods/Media/PDFs/Services/Eco-Textiles.pdf

² GarmentsTech 2013. Uses of Toxic Heavy Metals in textile, leather product & Its Effect of human body & environment. Online available: <http://garmentstech.com/uses-of-toxic-heavy-metals-in-textile-leather-product-its-effect-of-human-body-environment/>

³ Organo-Tin-compounds are covered by fact sheet no. 8

⁴ <http://www.chemicalelements.com/groups/metalloids.html>

3 Legal Aspects

Cadmium and its compounds are restricted in [Annex XVII](#) to REACH Regulation (EC) No 1907/2006 and are listed as [SVHC](#) due to their carcinogenic effects (Article 57a) and equivalent level of concern (Article 57 f).^{5 6} Lead is restricted in the United States under the Consumer Product Safety Improvement Act and children's products which contain more lead than 600 ppm have been banned in the United States since 10 February 2009, whilst the permissible lead content in paint and similar surface coating materials for consumer use has been reduced from 600 to 90 ppm⁷; there are similar European regulations controlling the content under REACH Annex XVII. Mercury is also restricted in [Annex XVII](#) just as the release of Nickel.⁸

Suppliers of the REWE Group must ensure that they produce in full accordance with the legal requirements of the country where the production takes place, and the legal provisions of the European Union regarding final products. A comprehensive list with international regulation for individual hazardous substances can be found on the website of the American Apparel & Footwear Association (AAFA).⁹

4 Hazardous Properties and Exposure

4.1 Hazardous Properties

There are different toxic effects of heavy metals and metalloids on human health. The most relevant of them being listed in the following table. In the case of humans, they may enter the body through food, via water, air or by absorption through the skin. Heavy metals are persistent and can bio-accumulate for example by forming organo-metallic compounds that accumulate within cells and organs. Furthermore, heavy metals can bio-accumulate in aquatic life, natural water-bodies, and also possibly become trapped in the soil. They do not degrade by nature but build up in the food chain and can cause severe acute and chronic diseases if regularly consumed. At the same time, some elements like Manganese, Copper and Zinc are essential trace elements for human health.

Metal/ Metalloid	Associated health hazard
Lead (Pb)	High amounts of lead can cause damage to the brain, nervous system, and kidneys (in mild cases insomnia, restlessness, loss of appetite, and gastrointestinal problems). Lead is classified as “possibly carcinogenic to humans” (Group 2 B) by the International Agency for the Research on Cancer (IARC).
Mercury (Hg)	Easily absorbed through the skin or inhalation of contaminated dust. Chronic exposure can affect the immune system, alter genetic and enzyme systems, damage the nervous system. Particularly damaging to developing embryos. Mercury can form organic mercury compounds in rivers and oceans, which are even more toxic than the element itself.
Cadmium (Cd)	Extremely toxic to humans. Cadmium is classified as

⁵ REACH candidate list of substances of very high concern; <https://echa.europa.eu/de/candidate-list-table>

⁶ REACH, Annex XVII; <https://echa.europa.eu/addressing-chemicals-of-concern/restrictions/substances-restricted-under-reach>

⁷ <https://www.cpsc.gov/business--manufacturing/business-education/lead/total-lead-content/>

⁸ REACH, Annex XVII; <https://echa.europa.eu/addressing-chemicals-of-concern/restrictions/substances-restricted-under-reach>

⁹ <https://www.wewear.org/rsl/> https://www.wewear.org/assets/1/7/RSL_v16_final_UPLOAD.pdf

	“carcinogenic to humans” (Group 1) by the International Agency for the Research on Cancer (IARC). Prolonged or repeated exposure may cause testicular damage and male sterility, disorders of the respiratory system, kidneys, and lungs.
Chromium (Cr) and Chromium (VI)	Exposure to high amounts of Chromium can have effects on metabolism and a sensitizing effect. Through oxidation of chromium (III) chromium (VI) can be formed that is classified as “carcinogenic to humans” (Group 1) by the International Agency for the Research on Cancer (IARC). Small amounts of chromium (VI) can trigger allergic skin reactions, higher amounts can cause respiratory disorders, ulceration of skin and cancer of the respiratory tract, e.g. squamous cell carcinoma of the lung.
Nickel (Ni)	Some people are allergic to nickel and may experience serious skin irritation when coming into direct contact with nickel-containing accessories for an extended period.
Copper (Cu)	Long-term exposure can cause fatigue, insomnia, osteoporosis, heart disease, cancer, migraine headaches, seizures. Mental disorders include depression, anxiety, mood swings, phobias, panic attacks and attention deficit disorders.
Arsenic (As)	Exposure of high doses of inorganic arsenic can cause skin cancer, hyper-pigmentation, kurtosis, and black foot disease.
Antimony (Sb)	Antimony compounds have been associated with dermatitis and irritation of the respiratory tract, as well as interfering with normal function of the immune system. Antimony trioxide is classified as “possibly carcinogenic to humans” (Group 2 B) by the International Agency for the Research on Cancer (IARC). Antimony chloride has been reported to have high estrogenicity in vitro, suggesting that trivalent antimony may have the potential to be disruptive to the estrogenic system. Where released to the aquatic environment, toxicity has been reported for a range of aquatic organisms.

4.2 Exposure

The risk of a chemical for human health and the environment is not only determined by its toxicity but by the degree of exposure, too.

a) Workers

Workers can be exposed to heavy metals at their workplace, in industries using or producing material that contain heavy metals. They could be exposed during handling chemical preparations as metal-based pigments and metal-complex dyes¹⁰. Applications like spraying of lacquers or preparation of dusty colorant formulations bear the risk of inhalation. For processing materials such as printing pastes or finishing formulations handled manually, appropriate Personal Protective Equipment is necessary.

b) Environment

Heavy metals and metalloids are widespread and highly harmful environmental pollutants. They enter the environment from man-made fiber manufacturing plants, and

¹⁰ http://onlinelibrary.wiley.com/doi/10.1002/14356007.a16_299/abstract

from effluents discharged from dyeing or further finishing processes. They are regularly found in effluent samples collected from textile industries¹¹. For example, antimony within the fiber can be released into processing water and enter wastewaters.¹²

c) Consumers

The uptake of heavy metals happens through contamination of food, drinking-water, ambient air near emission sources, skin absorption – and in the case of crawling children, from inhaling carpet particles, house dust or other abraded textiles in dust¹³ or because of the higher rate of hand-mouth contacts.

Some heavy metals like lead are easily absorbed through the skin or by inhalation of contaminated dust.¹⁴

Cadmium is absorbed by plants from the soil and it easily enters the food chain¹⁵.

An exposure to antimony compounds can occur through skin contact with garment items when wearing polyester textiles as underwear, middlewear, outerwear, bathing togs and other textiles. An additional exposure is possible by oral uptake and by inhalation of material abrasion.¹⁶ Contact with leather items can cause exposure to hexavalent chromium if it is built after tanning and remain on the goods. Hexavalent chromium is harmful in general due to its carcinogenic and allergenic potential.

Nickel may be used in metal accessories and cause allergies through repeated skin contacts.¹⁷

5 Sources for Heavy Metals and Metalloids in production of textiles

a) Processing chemicals used in the factory

Chemical preparations such as dyes¹⁸ and pigments (heavy metals are constituents of dyestuff classes such as metal-complex dyes or specific pigments) may contain heavy metals and metalloids in significant concentrations.

b) Raw materials used in the factory

In the synthesis of polyester fibers, antimony trioxide is used as a catalyst.¹⁹ Nickel is being used in alloys used for metal accessories on garments such as buttons, zippers, and rivets²⁰. It is necessary to ensure the Nickel release does not exceed the customer's and legal requirements. Leather trims can contain chromium from the tanning process and oils being used on metal parts can contain metal impurities such as lead. Materials and pre-products that are bought by a factory and used in production also contain heavy metals and should be controlled.

¹¹ Biddut Chandra Sarker, et al undated. Heavy Metals Concentration in Textile and Garments Industries' Wastewater of Bhaluka Industrial Area, Mymensingh, Bangladesh. Online available: <http://www.cwejournal.org/vol10no1/heavy-metals-concentration-in-discharged-textile-wastewater-of-bhaluka-industrial-area-mymensingh-bangladesh>

¹² Greenpeace 2014. Hazardous chemicals in branded luxury textile products on sale during 2013. Online available: <http://www.greenpeace.org/international/Global/international/publications/toxics/2014/Technical-Report-01-2014.pdf>

¹³ <https://oecotextiles.wordpress.com/tag/heavy-metals/>

¹⁴ Ecotextil 2010. Dyes – synthetic and “natural”. Online available: <https://oecotextiles.wordpress.com/tag/heavy-metals/>

¹⁵ Ecotextil 2010. Dyes – synthetic and “natural”. Online available: <https://oecotextiles.wordpress.com/tag/heavy-metals/>

¹⁶ Federat Institut for Risk Assessment (BfR) 2012. Introduction to the problems surrounding garment textiles <http://www.bfr.bund.de/cm/349/introduction-to-the-problems-surrounding-garment-textiles.pdf>

¹⁷ <http://www.webmd.com/allergies/guide/nickel-jewelry-allergy>

¹⁸ http://onlinelibrary.wiley.com/doi/10.1002/14356007.a16_299/abstract

¹⁹ Global Healing Center 2012. The Health Dangers of Antimony. Online available: <http://www.globalhealingcenter.com/natural-health/health-dangers-of-antimony/>

²⁰ S. S. Muthu: Roadmap to Sustainable Textiles and Clothing, Hong Kong 2014

c) Contamination

Some possible sources of heavy metals in textile operations are incoming fiber/yarn/fabrics, dyestuffs with heavy metal impurities, impurities in reactants or raw materials, machine oils and lubricants, corrosion of manufacturing plant equipment and the plumbing fittings used in dyeing and finishing plants or residues in incoming water.

6 Alternative and Substitute Substances

All alternatives used as substitutes for hazardous substances must be free of hazardous properties. Some tools to identify hazardous properties of chemicals and to find safer alternatives are listed in the factsheet about hazardous substances.

Alternatives for the use of antimony in the production of synthetic fibers are on the market, mainly based on titanium compounds, and are reported to be in use, albeit limited compared to antimony trioxide.²¹

Furthermore sources for heavy metal release or extraction can be prevented by using metal-complex dyes that are bound 1:2, by using tanning agents without chromium or metal alloys for trimming material without lead or nickel.

In order to minimize environmental and health effects and to use resources efficiently the use of best available technology (BAT²²) in textiles industry is a standard requirement.

The Chemsec Textile Guide offers access to a list of hazardous and safer chemicals and should be taken into account for the selection and purchase of chemical products²³.

²¹ Greenpeace 2014. Hazardous chemicals in branded luxury textile products on sale during 2013. Online available: <http://www.greenpeace.org/international/Global/international/publications/toxics/2014/Technical-Report-01-2014.pdf>

²² European Commission: Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for the Textiles Industry July 2003

²³ ChemSec, undated. Textiles come with a toxic footprint. <http://textileguide.chemsec.org/find/textiles-come-with-a-toxic-footprint/>