

Bioaccessibility of antimony released from four different antimony compounds in synthetic biological media.

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Final report

June 28, 2010

Commissioned by
International Antimony Association (i2a)

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Executive summary

Human exposure to particulate matter in our daily environment has become an issue of increased interest. The potential for adverse effects induced by human interaction with metal containing particles, for example through inhalation, skin contact and/or ingestion of metal particles or metal compounds and following the release of metals need further investigations.

Four antimony compounds, antimony metal (Sb) (1), sodium hexahydroxoantimonate ($NaSb(OH)_6$) (2), antimony trisulfide (Sb_2S_3) (3), and diantimony tris(ethylene glycolate) ($Sb_2(O_2(CH_2)_2)_3$) (4) were exposed to five different synthetic body fluids, artificial gastric fluid (GST, pH 1.6), artificial lysosomal fluid (ALF, pH 4.5), artificial sweat (ASW, pH 6.5), phosphate buffered saline (PBS, pH 7.4), and Gamble's solution (GMB, pH 7.4), at two different time periods, 2 and 24 hours. In parallel to the generation of bioaccessibility data, particle and surface characterisations were conducted. Information on oxidation state, complexation, and interactions with organisms, essential to assess potential toxicity is given elsewhere (Canmet 2010). The following main conclusions were drawn:

- Particles of Sb were dissolved to a high extent in all test media (42 to 82% after 24 hours of exposure), with the exception of GST, pH 1.6 (14% after 24 hours of exposure). The release rate of antimony decreased with time. Particles of Sb were dissolved to the highest extent in ALF, pH 4.5 (82% after 24 hours of exposure) compared with the other media investigated.
- Particles of $NaSb(OH)_6$ particles were dissolved to a high extent in the more acidic media (GST, pH 1.6, 94%, ALF, pH 4.5, 71%, ASW, pH 6.5, 61%, after 24 hours of exposure, respectively), and to a lower extent in the pH neutral media (PBS and GMB, pH 7.4, around 31% after 24 hours of exposure). The release rate of antimony for particles of $NaSb(OH)_6$ is fairly constant with time, indicating some or no formation of any protective surface layer against further dissolution.
- Particles of Sb_2S_3 dissolved between 3.6% (ASW, pH 6.5) and 8.5% (PBS, pH 7.4).
- Particles of $Sb_2(O_2(CH_2)_2)_3$ dissolved to a very low extent, about 1 to 2% in GST (pH 1.6) and with released concentrations of antimony below detection limit in all other test media.
- A high pH dependence but also a solution composition dependence were observed for particles of both Sb and $NaSb(OH)_6$. For both test items, the release rate of antimony decreased to a lower extent or increased in ALF (pH 4.5) and in GMB (pH 7.4), both complex media containing organic species and simulating lung fluid, compared with the other test media investigated. For particles of Sb_2S_3, no clear pH or solution composition dependence can be observed.
- Particle characterisation revealed different surface morphology, particle size, and particle size distribution for particles of Sb, $NaSb(OH)_6$, Sb_2S_3, and $Sb_2(O_2(CH_2)_2)_3$. Particles of Sb, $NaSb(OH)_6$, and Sb_2S_3 revealed a large number of smaller sized particles (about 1µm) and large size distributions (up to > 100µm). Particles of $Sb_2(O_2(CH_2)_2)_3$ were significantly larger (about 10 to several 1000 µm).

Introduction

Overall aim

The aim of this research project is to generate quantitative bioaccessibility data for commercially available antimony compounds exposed to different synthetic biological media. Generated results form a unique set of data that aim to improve the current knowledge on release/dissolution properties of such particles. In parallel, the particles have been physically and chemically characterized by determining the specific surface area, the particle size distribution, particle morphology and surface oxide composition. A schematic illustration of the experimental strategy to generate bioaccessibility data focusing on release rates of antimony and parallel particle characteristics is presented in Figure 1.

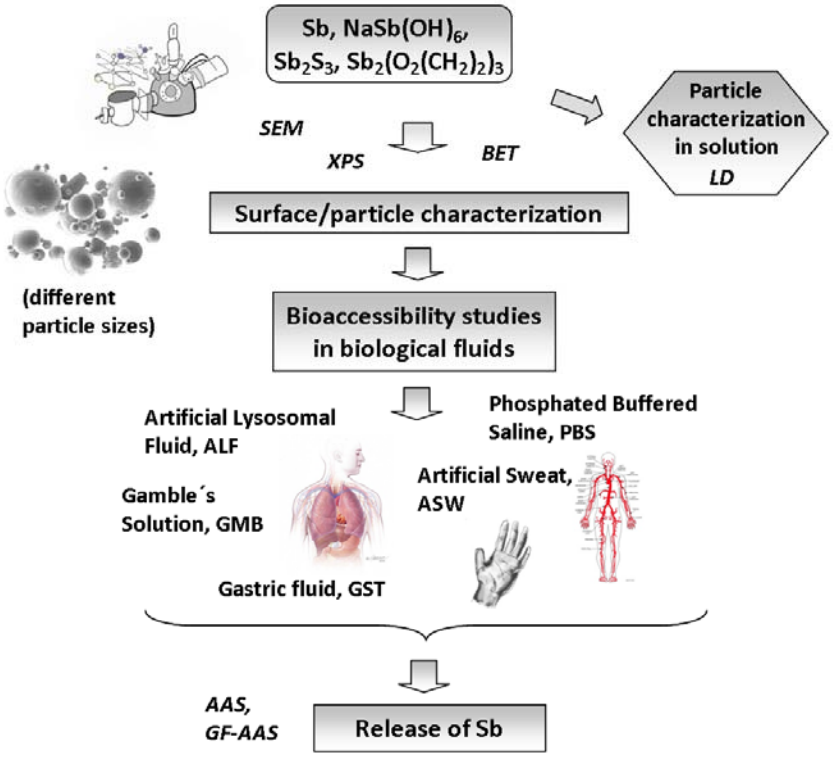


Figure 1. Schematic description of the experimental strategy.

Materials and methods

Test items

Four different test items have been investigated in this study, antimony metal (Sb), sodium hexahydroxoantimonate ($NaSb(OH)_6$), antimony trisulfide (Sb_2S_3), and diantimony tris(ethylene glycolate) ($Sb_2(O_2(CH_2)_2)_3$).

(1) Antimony metal (Sb)

CAS-No:	7440-36-0
Purity:	99.79 %
Producer:	Campine, Belgium
Batch no.:	41081
Certificate of analysis:	dated January 28, 2009
Physical state:	grey powder
Storage conditions:	ambient temperature, dry, well ventilated place
Stability:	January 23, 2010

(2) Sodium hexahydroxoantimonate ($NaSb(OH)_6$)

CAS-No:	33908-66-6
Purity:	> 99.5 %
Producer:	Umicore Precious Metals Refining, Belgium
Lot no.:	61049-070901J100000
Certificate of analysis:	dated January 21, 2009 (physico-chemical data)
Storage conditions:	tightly closed, well ventilated place
Physical state:	White powder
Stability:	September 2010

(3) Antimony trisulfide (Sb_2S_3)

CAS-No:	1345-04-6
Purity:	99.50 %
Producer:	Metaloxide, S.A., Spain
Lot no.:	V156/MO/SB-188/R-b
Certificate of analysis:	dated 2001
Storage conditions:	well ventilated dry area
Physical state:	grey-black powder
Stability:	December 2010

(4) Diantimony tris(ethylene glycolate) ($Sb_2(O_2(CH_2)_2)_3$)

CAS-No:	29736-75-2
Purity:	99 %
Producer:	Antraco Chemie-Handelsges.mbH, Germany
Lot no.:	ATG280502
Certificate of analysis:	Antraco (see appendix)
Storage conditions:	closed containers
Physical state:	white to off white crystals with no characteristic odor

Stability: May 2010

The test items were supplied to KTH. Certificates of analysis (CoA) provided from the suppliers are attached in the appendix of this report.

Particle characterization

Certificates of analysis were provided by the suppliers. Further characterisation of the test items by BET-analysis, XPS, SEM, and particle size distribution measurement in PBS was made by the Division of Surface and Corrosion Science, KTH. The total surface area of particles per weight was measured by the Brunauer-Emmet-Teller method (Instrument: Micromeritics GEMINI V) which is based on the absorption of gas (nitrogen) at the surface at cryogenic conditions. The gas adsorption is pressure-dependent and by knowing of the gas pressure and the adsorbed gas volume, the specific surface area (m^2/g) can be determined (Brunauer et al, 1938). Measurements of nitrogen adsorption were performed at five different partial pressures at five different local points for each test item (standard BET method). The standard deviation for these replicas was less than 1%. In the case of test item 4, $Sb_2(O_2(CH_2)_2)_3$, no result could be obtained by means of the BET method. The standard cleaning procedure prior to the analysis resulted in a dissolved particles. Without this cleaning procedure, negative results were obtained. One explanation could also be the large (about 1 mm, some particles up to 5 mm diameter) particle size, difficult to measure with the BET method.

Particle size distributions in phosphate buffered saline, PBS, were measured by a laser diffraction technique, LD, using a Malvern Mastersizer 2000 equipment with a Hydro SM dispersion unit. The instrumental software uses the Mie theory to predict the particle size as the diameter of the "equivalent sphere" which gives the same light scattering response as the particles being measured. The Mie theory also accounts for the difference between the refractive indices of the test item under investigation and the dispersion medium. Refractive indexes for antimony and water (since it is the solvent for the test media) were used as input parameters for the size measurements. Standard operational conditions were applied for the measurements.

Surface compositional analyses were performed using x-ray photoelectron spectroscopy, XPS. Spectra were recorded using a Kratos AXIS UltraDLD x-ray photoelectron spectrometer (Kratos Analytical, Manchester, UK) using a monochromatic Al x-ray source (150 W) on areas approximately sized 700 x 300 µm. Wide spectra were run to detect elements present in the outermost surface of the test items. Wide and detailed high resolution spectra (20 eV pass energy) were acquired for carbon (C 1s), oxygen (O 1s), Sb 3d.
The test items were fixed on copper tape to avoid any dispersion of the powder particles in the vacuum inside the instrument chamber. All binding energies were calibrated by assigning the carbon C1s contamination peak to 285 eV. All peak areas were determined by assigning a linear base line.

Differences in surface morphology of the investigated particles were studied using a tabletop scanning electron microscope (SEM) with backscattered electrons (Hitachi TM-1000). The maximal magnification of the instrument is 10,000-fold. The powder samples were fixed on

carbon tape to avoid any dispersion of powder particles inside the instrument chamber and to assure appropriate conduction.

Test media

The test items were exposed to five different test media at a pH range from 1.6 to 7.4. The following synthetic biological fluids were used:

- Phosphate-buffered saline (PBS, pH 7.4), which is a standard physiological solution that mimics the ionic strength of human blood serum. It is widely used in the research (e.g. Norlin et al, 2002) and medical health care community (e.g. Hanawa et al, 2004, Okazaki and Gotoh, 2005) as a reference test solution for comparison of data under simulated physiological conditions.
- Gamble's solution (GMB, pH 7.4) which mimics the interstitial fluid within the deep lung under normal health conditions (Stopford et al, 2004).
- Artificial sweat (ASW, pH 6.5) which simulates the hypoosmolar fluid, linked to hyponatraemia (loss of Na^+ from blood), which is excreted from the body upon sweating. The fluid is recommended in the available standard for testing of nickel release from nickel containing products (EN 1811, 1998).
- Artificial lysosomal fluid (ALF, pH 4.5), which simulates intracellular conditions in lung cells occurring in conjunction with phagocytosis and represents relatively harsh conditions (Stopford et al, 2004).
- Artificial gastric fluid (GST, pH 1.6), which mimics the very harsh digestion milieu of high acidity in the stomach (Hamel et al, 1998; ASTM, 2003).

The test media were selected in order to simulate human exposure as far as possible, e.g. skin contact. Ingestion to the gastro-intestinal tract can either be direct, or previously inhaled particles can be translocated from the respiratory tract to the gastro-intestinal tract by mucociliary clearance. It should be stressed though, that the different test media only simulate physiological conditions to a limited extent, as the complexity and function of the real body fluids are difficult to simulate. For example, citrate in Gamble's solution replaces proteins and acetate is added to represent organic acids (Kuhn and Rae, 1988; Moss, 1979, Stopford et al, 2004). However, *in vitro* results in such synthetic biological media can, in a simple way, provide information that could be relevant for a real situation.

The test solutions were prepared using ultra-pure water and chemicals of analytical grades. All vessels were acid-cleaned (10% HNO_3 for at least 24 hours, rinsed four times with ultrapure water and dried in ambient air in the fume hood within a few hours) to avoid any risk of contamination.
The chemical composition of ALF and GMB are presented in Table I. The composition of ASW and PBS are presented in Tables II and III, respectively. The pH of ALF and GMB was adjusted using 50% NaOH and 25% HCl, respectively. The pH of ASW and PBS was adjusted with 1% ammonia solution and 50% NaOH, respectively. Artificial gastric fluid, pH 1.6, was prepared according to the ASTM standard using 4 g of 25% HCl solution diluted with ultra-pure water to 1 L (ASTM D5517, 2003).

Table I. *Composition (g/L) and pH of artificial lysosomal fluid (ALF) and Gamble's solution (GMB).*

Chemical	**ALF**	**GMB**
$MgCl_2$	0.0497	0.0953
NaCl	3.210	6.0193
KCl	-	0.2982
Na_2HPO_4	0.071	0.126
Na_2SO_4	0.039	0.063
$CaCl{\cdot}2H_2O$	0.128	0.3676
$C_2H_3O_2Na{\cdot}H_2O$ (sodium acetate)	-	0.7005
$NaHCO_3$	-	2.6043
$C_6H_5Na_3O_7{\cdot}2H_2O$ (sodium citrate)	0.077	0.097
NaOH	6.000	-
Citric acid	20.80	-
Glycine	0.059	-
$C_4H_4O_6Na_2{\cdot}2H_2O$ (Na_2Tartrate$\cdot 2H_2O$)	0.090	-
$C_3H_5NaO_3$ (NaLactate)	0.085	-
$C_3H_5O_3Na$ (NaPyruvate)	0.086	-
pH	**4.5**	**7.4**

Table II. *Composition (g/L) and pH of artificial sweat (ASW).*

Chemical	**ASW**
NaCl	5.0
$(NH_2)_2CO$ (urea)	1.0
$CH_3CHOHCO_2H$ (lactic acid)	1.0
pH	**6.5**

Table III. *Composition (g/L) and pH of phosphate-buffered saline (PBS).*

Chemical	**PBS**
NaCl	8.77
Na_2HPO_4	1.28
KH_2PO_4	1.36
pH	**7.4**

Experimental Procedure

Triplicate samples were prepared for exposure in different test media, each for two different time periods. In addition, one blank sample (without addition of any test item) containing only the test solution was incubated together with the triplicate samples for each time period. 5 ± 0.5 mg of each test item was weighed using a Mettler AT20 balance with readability of 2 µg, and placed in a PMP Nalgene® jar. 50 mL of the test solution (no adjustment of solution volume to powder mass was made) was then added to the Nalgene® jar containing the test item, before incubated in a Platform-Rocker incubator SI 80 regulated at 37 ± 2°C. The solution was gently shaken (bi-linearly) with an intensity of 25 cycles per minute for 2 and 24 hours, respectively. After exposure, the samples were allowed to cool to ambient room temperature before the final pH of the test solution was measured. The test medium was then separated from the powder particles by centrifugation at 3000 rpm for 10 minutes, resulting in a visually clear supernatant with remaining particles in the bottom of

the centrifuging tube. The supernatant solution was decanted into a polypropylene storage flask and acidified to a pH less than 2 (not needed in the case of artificial gastric fluid) with 65% pure HNO_3 prior to solution analysis (a standard procedure for metal analysis). All vessels for exposure, centrifugation and storage of samples were acid-cleaned in 10% HNO_3 for at least 24 hours, then rinsed four times with ultra-pure water and dried in ambient air in the fume hood within a few hours to avoid any risk of contamination.

The particle loading is a very important parameter which is intimately related to the surface area per volume ratio, and crucial for the prediction/comparison of metal release data from particles. Since the surface area increases dramatically with smaller particle dimensions, the use of small particles and large volumes drives the transformation/dissolution equilibrium towards higher total release. Moreover, the risk for agglomeration of particles, and hence a reduced, uncontrolled surface area of particles, is enhanced with a high particle loading especially if inadequate mixing/agitation is provided (Midander et al, 2006). This would lead to a reduced release of metals.

It is acknowledged that the loading should have physiological relevance, i.e. be comparable to realistic exposure conditions of the lung, on the skin or in the gastro-intestinal tract. However, actual exposure scenarios depend on a variety of parameters which cannot be considered in a model experimental system. For example, the real deposition of particles in the human lung when inhaled depends on several factors such as particle concentration in the air, size of particles and respiratory intensity. Also the site of deposition depends on these factors and at specific “hot spots”, the total amount of particles deposited may locally become relatively high (Martonen, 1992a, Martonen et al, 1992b, Miki et al,1992, Balashazy et al, 2003).
Therefore, in consideration of this variability, a “standard loading” of 0.1 g/L was selected, which has some physiological relevance. It further allows a comparison of the generated data with results from the OECD Transformation/Dissolution test (OECD, 2001) and similar bioaccessibility tests conducted with other materials under the same conditions (e.g. Midander et al, 2007a,b).

The time periods for exposure of the different test items were selected to have some relevance to the inhalation/ingestion scenario and to enable comparison with other reported metal release/dissolution data generated for similar time periods. The approximate time for the gastric phase of digestion is about 2 hours, and therefore this exposure time period was considered relevant for testing in artificial gastric fluid (Hamel et al, 1998). The 24 hour exposure was selected as a standard time duration that is relatively easy to compare with existing metal release/dissolution data as well as toxicity data for further evaluation of the bioaccessibility of released metals. Moreover, it can be assumed that human exposure to particles last no longer than 24 hours at ambient conditions.

Metal analysis

The antimony concentrations of the solution samples were analyzed by means of atomic absorption spectroscopy (AAS) using the oxidizing air/acetylene-flame technique. The standard method for antimony analysis developed for the instrument (Perkin Elmer AAnalyst 800, Perkin Elmer Instruments LLC, 2000) was followed using calibration standards of

concentration 30, 60 and 90 mg/L, or 3, 10, and 30 mg/L (depending on the sample concentration). The standards were prepared from a stock solution (1 g/L, Inorganic Ventures, Inc., in 0.7% nitric acid and 3% tartaric acid, Lot.no. Z-QS B02037) by pipetting (certified Brand Transferpette®) the stock solution into 1% nitric acid (ultra pure water, nitric acid of analytical grade) in acid-cleaned volumetric flasks. If µg/L standards were needed, the dilution was carried out in a two-step procedure (first 10 mg/L which was further diluted) to avoid the adding of very small volumes (< 100 µL) of standard solution with higher uncertainty. A calibration coefficient of 1.000000 (best possible) was accepted for the analysis that was performed at the wavelength of 217.6 nm having the highest sensitivity for antimony. The detection limit (3*standard deviation of blank samples) was less than 0.34 mg/L for all sample solutions (matrixes), for most solutions around 0.1 mg/L. A detailed list is found in the appendix. The results of concentrations were based on triplicate readings of each sample and quality control samples were analyzed consecutively. If the quality control samples (every tenth sample or 5 minutes) deviated more than 10% (normally decreasing due to an increase in flame temperature over time), a new calibration curve was performed. All solution samples were acidified (< 2pH) as the standards were to avoid differences in absorption due to different pH values and to dissolve any metal complexes in the solution or at vessel walls.

In the case of antimony analysis for test item 3 (some samples) and 4, Sb_2S_3 and $Sb_2(O_2(CH_2)_2)_3$), analysis has been done by graphite furnace atomic absorption spectroscopy (GF-AAS). The standard method for antimony analysis for the instrument (Perkin Elmer AAnalyst 800, Perkin Elmer Instruments LLC, 2000) was followed with a slightly longer analysis time (6 seconds instead of 5 seconds) and higher analysis temperature (2600°C) for an optimised method. The calibration standards of 50, 100, and 500 µg/L were used. If the sample concentration was higher than the highest standard, the instrument automatically diluted the samples by the autosampler. A calibration coefficient of 1.000000 (best possible) was accepted for the analysis that was performed at the wavelength of 217.6 nm having the highest sensitivity for antimony. The detection limit (3*standard deviation of blank samples) was less than 1 µg/L for all sample solutions (matrixes), except Gamble's solution (3 to 6 µg/L). The results of concentrations were based on triplicate readings of each sample and quality control samples as well as ultra pure water samples (mainly for cleaning purposes) were analyzed every ninths sample.

Depending on the sample concentration, the mode of atomic absorption spectroscopy (graphite furnace or flame) and the calibration standards were chosen.

Detailed information on recovery, external standards as quality control, and certification of the instrument and analysis are attached in the appendix.

Results and discussion

Particle characterisation – surface area, particle size distribution and morphology

The specific surface area of all test items (except test item 4, see experimental) measured by BET-analysis is presented in Table IV.

Table IV. *BET specific surface area [m²/g] of the different test items investigated. Each sample was measured at five different partial pressures at five different local points, with a standard deviation of less than 1%.*

Test items	(1) Sb	(2) $NaSb(OH)_6$	(3) Sb_2S_3	(4) $Sb_2(O_2(CH_2)_2)_3$
BET area	0.42	0.25	0.36	Data not available

It should be underlined that this specific surface area is measured by nitrogen absorption and includes also the surface of surface pores. The diameter of particles of test item 4, $Sb_2(O_2(CH_2)_2)_3$, was up to 5 mm (visible by eye) which was confirmed by particle size distribution. The specific surface area increased according the following sequence:

$$Sb_2(O_2(CH_2)_2)_3 < NaSb(OH)_6 < Sb_2S_3 < Sb$$

Morphology observations of the test items using scanning electron microscopy, SEM, are displayed in Figure 2. The different test items reveal large variations in primary particle size and morphology. For Sb, a large size distribution was observed from the SEM images. Sb particles have sharp edges whereas $NaSb(OH)_6$ particles are cuboid-formed and of larger size with a wider size distribution. Energy dispersive spectroscopy (EDS), which analyses the elemental composition for elements with an atomic number larger than, or equal to sodium, and which has an information depth of about 1 µm, showed that the particles of Sb contained low amounts of aluminium. Aluminium was also locally detected in particles of $NaSb(OH)_6$ (between 1 and 2 wt% and therefore slightly above the limit of detection of approximately 1 wt% for this instrument). For particles of Sb_2S_3, the morphology is similar to particles of Sb, with sharp edges and large variations in particle size. Both antimony and sulphur have been found by means of EDS analysis. Particles of $Sb_2(O_2(CH_2)_2)_3$ reveal significantly larger particles, difficult to image with SEM, of up to several millimetres. In parallel to XPS analysis, no antimony could be detected by means of EDS (information depth about 1 µm). The surface of these particles is rough and porous.

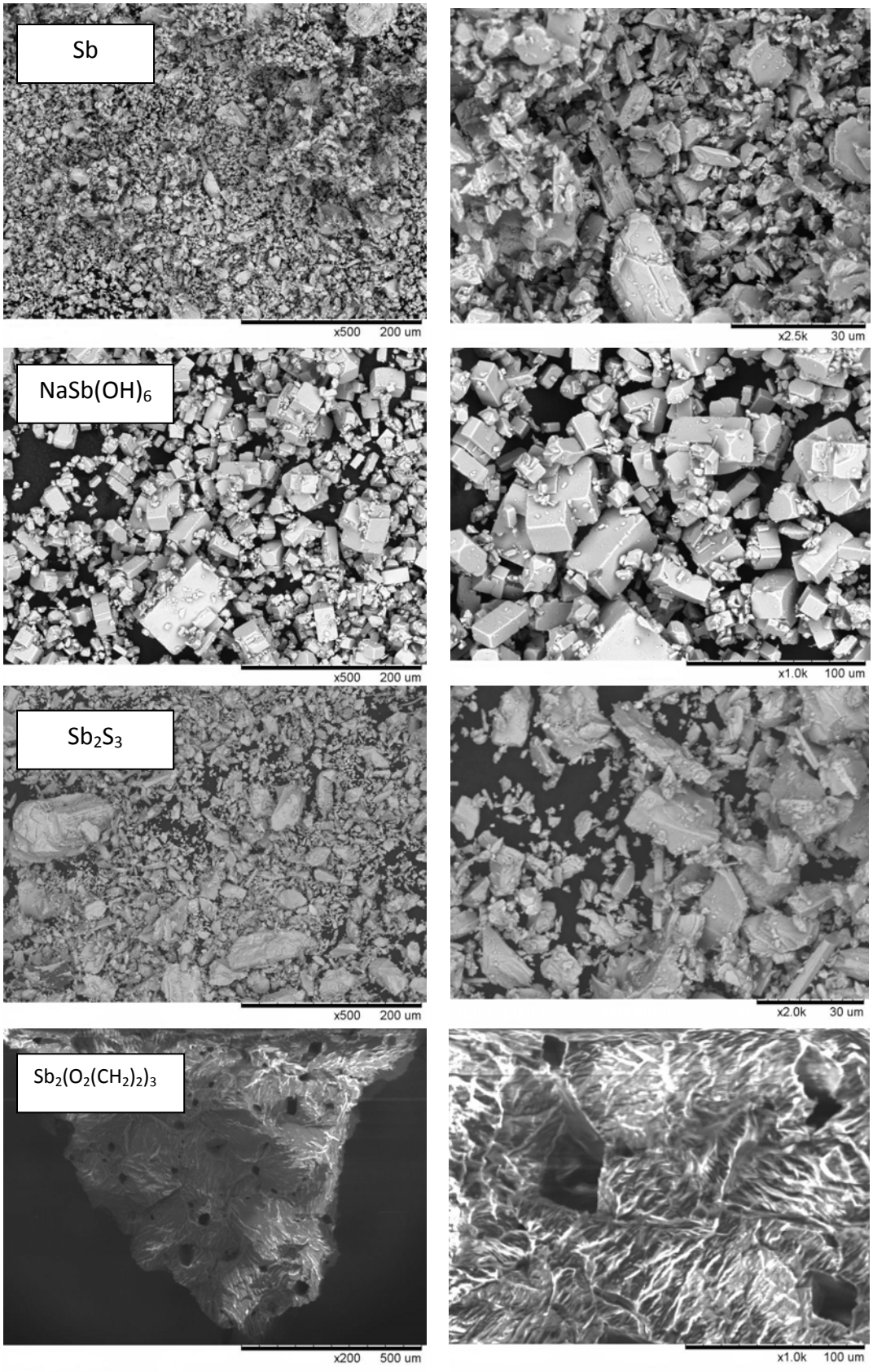


Figure 2. *SEM images showing differences in appearance and surface morphology for the different test items; Sb(top), $NaSb(OH)_6$ (bottom). Note: magnification is different to the right and for $Sb_2(O_2(CH_2)_2)_3$ to the left (as reported on the bottom of each figure)!*

To investigate the behaviour of the test items when dispersed in a relevant test solution (high ionic strength), the size distribution was determined when immersed in phosphate buffered saline (PBS) by means of laser diffraction. These measurements illustrate in a more realistic way how the different test items behave in the biological fluids investigated. Measurements of the particle size distribution in solution are conducted when dispersed particles are continuously pumped through the laser diffraction system. The results reflect the stability of possible clusters formed due to agglomeration/aggregation. The measured median particle size ($d_{0.5}$) is compiled in Table V together with 10% ($d_{0.1}$) and 90% ($d_{0.9}$) percentile values as the percentage in volume (mass). The results are reported as the average value of three replicate measurements (6 measurements in the case of Sb and $NaSb(OH)_6$ particles). The particle size distribution of each test item is also graphically illustrated in Figure 3. In the case of particles of $Sb_2(O_2(CH_2)_2)_3$ and Sb_2S_3, measurements were very difficult to conduct since these particles swim on the water or PBS surface. By stirring in PBS prior to analysis, measurements could be conducted though with worse reproducibility.

Table V. *Measured median particle diameter ($d_{0.5}$) and the 10% ($d_{0.1}$) and 90% ($d_{0.9}$) size distribution percentiles, presented as a percentage of volume (mass) of the different test items in PBS using a laser diffraction technique, as average results of 6 individual measurements. The standard deviation was approximately 1% for $d_{0.1}$, $d_{0.5}$, and $d_{0.9}$, for Sb and $NaSb(OH)_6$, respectively, and approximately 5% for Sb_2S_3 and 30% for $Sb_2(O_2(CH_2)_2)_3$. The individual standard deviation can be found in figure 3 and the appendix.*

	$d_{0.1}$ µm	$d_{0.5}$ µm	$d_{0.9}$ µm
Sb (1)	3.3	8.7	26.3
$NaSb(OH)_6$ (2)	8.7	30.2	79.4
Sb_2S_3 (3)	5.8	26.2	83.9
$Sb_2(O_2(CH_2)_2)_3$	64.7	345	1147

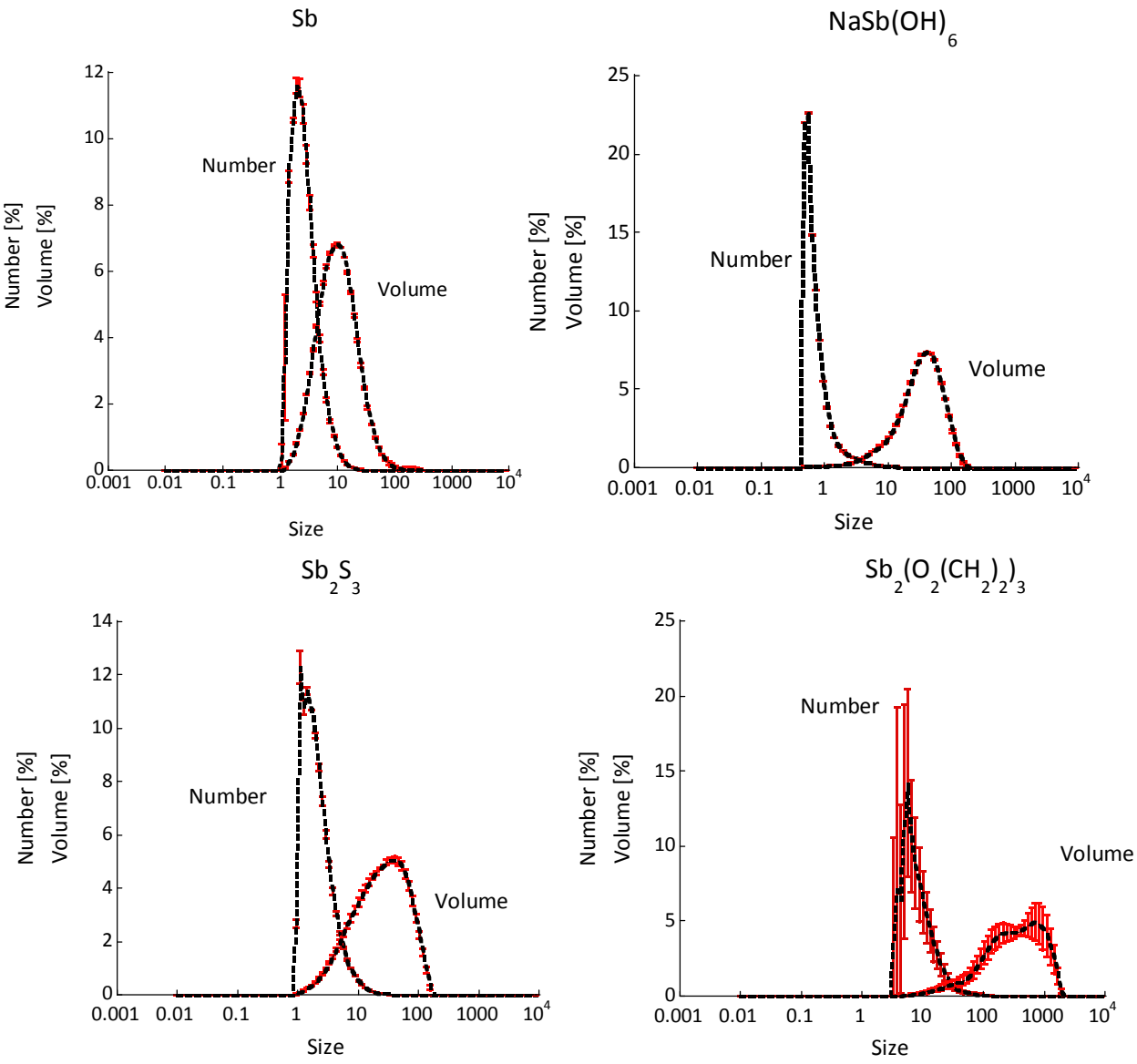


Figure 3. *Particle size distribution in PBS, for the different test items, in terms of volume (mass) percentage and number percentage. The error bars show the standard deviation between 6 individual measurements (3 measurements for Sb_2S_3 and $Sb_2(O_2(CH_2)_2)_3$).*

The measured median particle diameter in PBS increased according to the following sequence:

$$Sb < Sb_2S_3 < NaSb(OH)_6 << Sb_2(O_2(CH_2)_2)_3$$

There are no indications for agglomeration during the exposure to the different synthetic biological fluids investigated. The particle size distribution measurements and SEM images indicate a relatively large particle size distribution without any agglomerates at higher particle sizes. Especially for $NaSb(OH)_6$ and $Sb_2(O_2(CH_2)_2)_3$ particles, there is a large number of small particles and there are relatively large particles as well. The particle size distribution for antimony metal (Sb) is smaller compared with all other test items. Particles of $Sb_2(O_2(CH_2)_2)_3$ reveal significantly higher particle sizes compared with all other test items, also observed by eye and means of SEM.

Particle characterisation – X-ray photoelectron spectroscopy

The composition of the outermost surface oxide was investigated at five different areas (locations) of particles of each test item by means of X-ray photoelectron spectroscopy. A small peak corresponding to carbon contamination was observed. A surface contamination layer of carbon (285 eV) is always observed to different extent due to the surface history, and its source is usually atmospheric.

Test item 1 - antimony (Sb)

The Sb 3d peak and O 1s peak were considered. The Sb $3d_{3/2}$ peak could not be taken into consideration, since it is overlapped with the oxygen O 1s peak. Oxidized antimony was clearly observed (since there was no peak visible corresponding to metallic antimony) on the outermost surface layer with a thickness of at least several nm. This oxidized layer can serve as a barrier against corrosion. However, the structural, physical, and chemical properties of this antimony oxide layer are of high importance for the release/dissolution process. It was not possible to specify the specific antimony oxide in terms of the antimony oxidation state (Sb_2O_3 or Sb_2O_5) due to overlapping binding energies for the oxides and the overlapping peak of oxygen.
The surface composition is illustrated in figure 4.

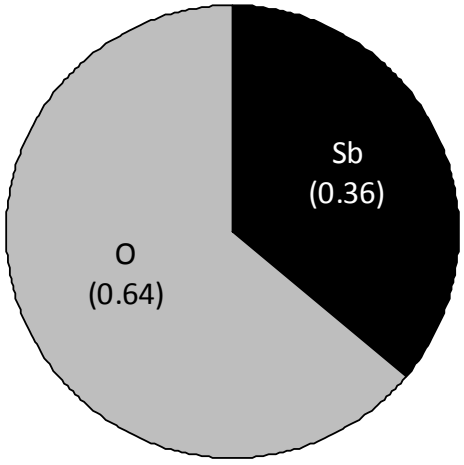


Figure 4. *Relative composition of antimony and oxygen in the outermost surface oxide determined with XPS of particles of test item 1, Sb.*

Test item 2 – sodium hexahydroxoantimonate, $NaSb(OH)_6$

The Sb 3d, O 1s, Na 1s, and Cl 2p peaks were considered. No peak corresponding to metallic Sb was observed. Antimony was present in its oxidized state in the outermost surface layer. As for test item 1, Sb, the state of oxidation could not be determined due to peak overlapping for different antimony oxides and the oxygen peak. Sodium and a small amount of chloride were also detected on the surface. The relative surface composition of antimony,

oxygen, sodium and chloride in the surface layer of particles of $NaSb(OH)_6$ is illustrated in figure 5.

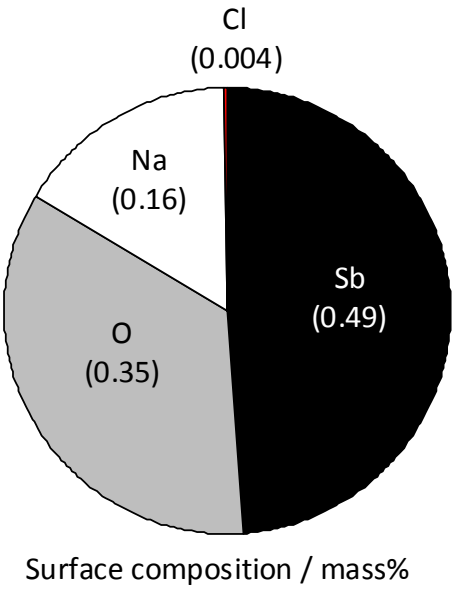


Figure 5. *Relative composition of antimony, oxygen, sodium and chloride in the outermost surface layer determined with XPS of particles of test item 2, $NaSb(OH)_6$.*

Test item 3 – Antimony trisulfide, (Sb_2S_3)

The Sb 3d, O 1s, and S 2p peaks were considered. No peak corresponding to metallic Sb was observed. Beside Sb_2S_3, also oxidised Sb could be present in the outermost surface. However, this cannot be stated with evidence, since the oxygen signal also can be caused by contamination (organic compounds) as well (but probably not at such large extent). As for test item 1, Sb, and 2, $NaSb(OH)_6$, the state of oxidation could not be determined due to peak overlapping for different antimony oxides and the oxygen peak. The relative surface composition of antimony, oxygen, and sulphur in the surface layer of particles of Sb_2S_3 is illustrated in figure 6.

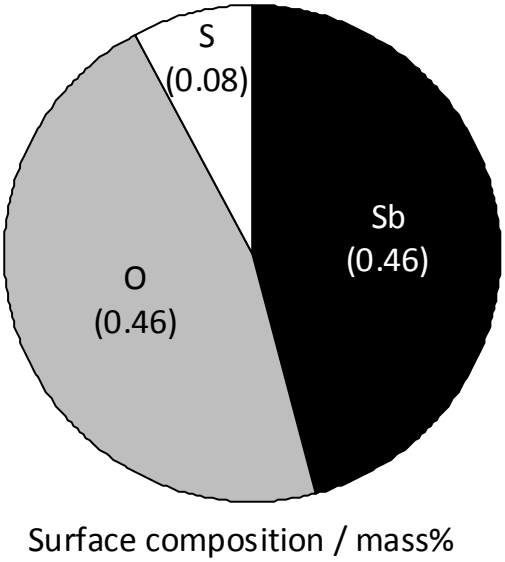


Figure 6. *Relative composition of antimony, oxygen, and sulphur in the outermost surface layer determined with XPS of particles of test item 3, Sb_2S_3.*

Test item 4 – Diantimony tris(ethylene glycolate), ($Sb_2(O_2(CH_2)_2)_3$)

The O 1s, C 1s, and S 2p peaks were considered. No peaks corresponding to metallic Sb or oxidized Sb were observed. As by means of energy dispersive spectroscopy (EDS) with an information depth of about 1 µm, no antimony could be detected in the outermost surface (about 5 nm). The relative surface composition of carbon, oxygen, and sulphur in the surface layer of particles of $Sb_2(O_2(CH_2)_2)_3$ is illustrated in figure 7.

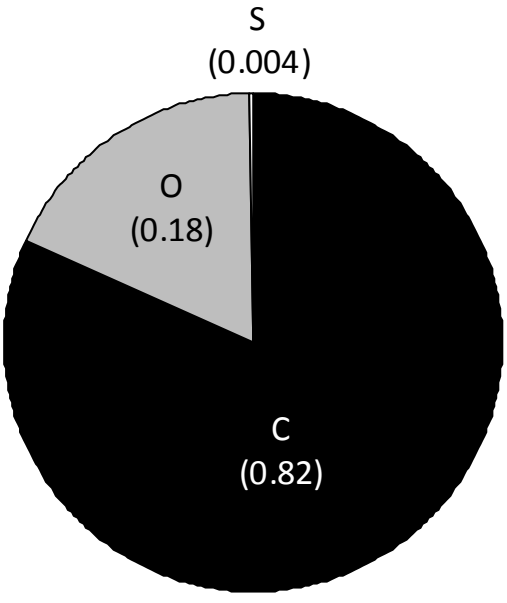


Figure 7. *Relative composition of carbon, oxygen, and sulphur in the outermost surface layer determined with XPS of particles of test item 4, $Sb_2(O_2(CH_2)_2)_3$.*

Bioaccessibility data – metal release

Metal release units and calculations

To calculate the amount of antimony which was transformed/dissolved (figure 8, table VII (appendix)), the following formula was used.

$$\text{Sb transformed [mass\%]} = \frac{c\left[\frac{mg}{L}\right] \cdot V\,[L] \cdot 100}{m[g] \cdot 1000}$$

When c is the measured Sb concentration, V is the solution volume (50 mL), and m is the mass of particles weighed in (5 mg). For the $NaSb(OH)_6$ particles, this number was divided by 0.493 giving the antimony content of the pure $NaSb(OH)_6$ particles.

The metal release rate is defined as the released amount of metal per test time unit and surface area of the test item (e.g. mg/cm²·h) and calculated from the measured released concentration of metal c [mg/L], the solution volume V [L], the BET specific surface area BET [m²/g], mass weighed in m [g] and the exposure time t [h] using the following formula:

$$\text{Sb release rate}\left[\frac{mg}{cm^2 \cdot h}\right] = \frac{c\left[\frac{mg}{L}\right] \cdot V\,[L]}{m[g] \cdot BET\left[\frac{m^2}{g}\right] \cdot 10000 \cdot t[h]}$$

However, calculations of metal release rates are only suitable for particles when the material is sparingly soluble or dissolved. In this study, since a large percentage of particles were dissolved/released upon exposure in the different test media, the normalisation to the original (non-exposed) particle surface area is highly erroneous. To illustrate this problem and to illustrate a more accurate presentation of release rates of antimony, three different approaches are in the following used to recalculate release rates of antimony (figure 9 to 11, tables VIII to X (appendix)). The first one is the traditional way of calculating, when normalised to the original surface area as given in the previous formula. The second and third way of calculating release rates of antimony take into account that the particles are dissolving with time and, hence, the surface area decreases. In the following, it is assumed that all particles are cubic and have the same volume. Furthermore, it is assumed that all individual particles are dissolved to the same extent (with the same rate of dissolution). These assumptions are obviously erroneous; however, this theoretical approach results in more realistic release rates of antimony, and in agreement with the measured percentage for transformed antimony. Based on these assumptions, the expected surface area after 2 hours and 24 hours of exposure can be calculated, considering the percentage of particles that is not dissolved.
When the amount of particles that are left for a certain time period are x% of the original amount of particles (5mg), the surface is $(\sqrt[3]{(x\%)})^2$ compared with the original surface for cubic particles, since the volume of particles is proportional to the mass (total volume =

[number of particles]*a³, when a = edge length; total surface area = [number of particles]*6a²). More information about this calculation can be found in the appendix.
Since, in this study, two different time periods were investigated, 2 hours and 24 hours of exposure, three different surface areas are known/estimated for each test item: the original surface area, obtained from the BET surface area (5mg/1000*BET), 0.002m² for the pure antimony (Sb) particles and 0.001246m² for the $NaSb(OH)_6$ particles, and, in addition, the surface area estimated after 2 hours and after 24 hours of exposure.
Since the dissolution process is a dynamic and normally (as in this case) a non-linear process, it is difficult to obtain the optimal surface to which the metal release rate can be calculated. Therefore, three different ways of calculating are presented and compared in this study, to illustrate this problem and to have a wider image of the most reliable interpretation possible.
The first way is the "traditional" way of presenting metal release rates, normalized to the original surface area for all exposure time periods, suitable for sparingly soluble particles (< 1% dissolved). This is, in the same time, the least real and reliable data in this study where both test items are dissolved to a relatively large extent in each solution.
The second way of presenting data, denoted "startpoint surface recalculated", metal release rates are normalized to a known surface area at the beginning of the time period (in this study to the original BET area after 2 hours of exposure), and normalized to the estimated surface area calculated from the 2 hour release data, after the longer exposure period (in this study 24 hours).
The third way of presenting metal release rates, denoted "endpoint surface recalculated", is by normalising metal release rates to the latest known (calculated) surface area, i.e. the calculated surface area after a short time of exposure (in this study: 2 hours), and to the calculated surface area after a longer exposure period (in this study: 24 hours). As will be shown, this approach is the most realistic way to calculate release rates, as obtained from the measured antimony that is transformed [%]. The following formula was used, when A = the recalculated surface area.

$$\text{Sb release rate } \left[\frac{mg}{cm^2 \cdot h}\right] = \frac{c\left[\frac{mg}{L}\right] \cdot V\,[L]}{A\,[m^2] \cdot 10000 \cdot t[h]}$$

Bioaccessibility data

In general, the antimony (Sb) particles and $NaSb(OH)_6$ particles were both relatively easily dissolved, to a high (> 10%) extent, in the synthetic body fluids investigated. However, both test items were not dissolved completely within 2 hours of exposure in any of the media investigated, as the case would have been for easily soluble metal compounds. In general, particles of Sb_2S_3 are dissolved to a significant less extent (< 9%) and particles of $Sb_2O_2(CH_2)_2)_3$ to a very low extent (GST: < 2%, otherwise below detection limit). The transformed/dissolved mass percentage is compiled for all test items, test media and exposure times investigated, in figure 8. The metal release rate, in this case equivalent to dissolution rate, provides information on whether protective (oxide) layers are formed, or if the particles are dissolved to a less extent with time, as will be discussed later. The three different calculated release rates, based on different surface areas (see section "metal

release units and calculations"), are compiled for the different test items, test media and exposure times investigated, in figures 9 to 11. In the case of particles of Sb_2S_3, only the first approach of calculating the metal release rate was applied (since these particles dissolved to a low extent). In the case of particles of $Sb_2O_2(CH_2)_2)_3$, no metal release rate could be calculated, since no data on specific surface area was available.

Changes in pH for all test items, time periods and test media, are compiled in table VI (appendix). Media of PBS and ALF were best buffered and, hence, no large change in pH could be observed for any test item or time period investigated. The pH in GST decreased with approximately 0.2 units for all test items and time periods. In ASW, the pH decreased with approximately 0.03 to 0.3 units after 2 hours and with about 0.6 to 0.9 units after 24 hours, reaching a final pH of about 5.6 - 5.9. In GMB, pH increased with approximately 0.4 units after 2 hours and with about 1 unit with relatively large standard deviation after 24 hours. This means that in practise that GMB has a higher pH compared with PBS. None of the samples had a significantly different pH compared with the blank.

The dissolution of particles of pure antimony (Sb) (test item 1) was strongly dependent on the test media and exposure time. In GST, the most acidic media (pH 1.6), particles of Sb were dissolved to the lowest extent (16% after 2 hours of exposure, 14% after 24 hours of exposure) compared with the other media investigated. This is probably due to a lower chemical solubility and/or precipitation of antimony ionic species at such low pH. In ALF (pH 4.5), particles of Sb were dissolved to the highest extent (37% after 2 hours of exposure and 82% after 24 hours of exposure). This has previously been observed and reported for antimony trioxide particles (Midander et al, 2007a). In ASW (pH 6.5), the particles dissolved to a relatively high extent (26% after 2 hours of exposure and 61% after 24 hours of exposure), followed by PBS and GMB, both pH 7.4 (PBS – 21% (2h), 42% (24h), GMB – 17% (2h), 57% (24h)). The release rate of antimony from particles of Sb decreased in all test media with time, independent on the way of calculating the surface area. Release rates of antimony in GST, pH 1.6, and in PBS, pH 7.4, strongly decreased with time. The release rate of antimony decreased with time to a lower extent in ASW, pH 6.5, and decreased relatively slow (the release rate after 24 hours of exposure was still approximately half the release rate measured after 2 hours of exposure) in ALF, pH 4.5, and in GMB, pH 7.4, the two test media most complex in terms of composition (chemicals and organic components). A similar trend for the release rate of antimony was observed for $NaSb(OH)_6$ particles, indicating that the solution composition is of high importance for these antimony compounds. Compared with the $NaSb(OH)_6$ particles, particles of Sb were dissolved to a higher extent in all test media (pH 4.5 to 7.4) with the exception of GST (pH 1.6).

The dissolution of the $NaSb(OH)_6$ particles was strongly pH and time dependent, but also dependent on the solution composition. In GST (pH 1.6), the most acidic test media, the $NaSb(OH)_6$ particles dissolved to the highest extent and were nearly completely dissolved after 24 hours of exposure (73% (2h), 94% (24h)). In ALF (pH 4.5), the particles were also dissolved to a relatively high extent (20% (2h), 71% (24h)). In ASW (pH 6.5), the particles were dissolved to 15% after 2 hours of exposure and to 61% after 24 hours of exposure. In the weakly alkaline media, PBS and GMB (pH 7.4), the $NaSb(OH)_6$ particles were dissolved to a significant lower extent (PBS: 9% (2h), 29% (24h) and GMB: 3% (2h) and 33% (24h)). In general, the release rate of antimony from particles of $NaSb(OH)_6$ decreased to a lower extent with time when compared with particles of Sb. Since the particles were nearly

completely dissolved in GST (pH 1.6), it is difficult to interpret the release rate of antimony (since no or little material is left to be dissolved). In ALF (pH 4.5) and ASW (pH 6.5), the release rate of antimony decreased slightly with time (the release rate of antimony was after 24 hours of exposure more than half of the release rate determined after 2 hours of exposure), indicating non or sparse formation of a protective surface layer of low barrier properties to hinder or reduce the extent of chemical dissolution with time. In PBS (pH 7.4), the release rate of antimony decreased to a slightly higher extent, indicating the formation of some surface barrier/ protection formed with time hindering further dissolution. In GMB (pH 7.4), the release rate of antimony did not decrease with time, in fact the release rate increased slightly when calculated based on the last known surface area approach (the surface area at 24 hours of exposure for the release rate at 24 hours of exposure). These calculations show that no protective surface layer was formed to hinder/reduce further dissolution and/or an additional dissolution processes caused for instance by chemical salts in the complex solution of GMB, after a certain exposure time period. As shown for particles of Sb, the release rate of antimony decreased with the lowest extent (or even slightly increased) in GMB (pH7.4) and in ALF (pH 4.5), the most complex test media, both simulating lung fluids. The solution composition is, hence, beside the acidity (pH value), of high importance for the dissolution behaviour of antimony compounds.

The dissolution of the Sb_2S_3 particles did not reveal a clear trend in pH dependence, but was time dependent and also dependent on the solution composition. In GST (pH 1.6), the most acidic test media, the Sb_2S_3 particles dissolved to about 4% after 24 hours of exposure (1.6% after 2 hours). In ALF (pH 4.5), the particles were dissolved to a slightly higher extent (2.4% (2h), 5.1% (24h)). In ASW (pH 6.5), the particles were dissolved to 1.7% after 2 hours of exposure and to 3.6% after 24 hours of exposure. In the weakly alkaline media PBS (pH 7.4), the Sb_2S_3 particles were dissolved to the highest extent (1.7% (2h), 8.5% (24h)). In GMB, 0.9% of the particles were dissolved after 2 hours of exposure and 3.9% after 24 hours. The release rate of antimony from particles of Sb_2S_3 decreased strongly with time, indicating some protective surface barrier formed. The dissolution process of particles of Sb_2S_3 is weakly depending on pH and solution composition, particles are dissolved between 3.6 and 8.5% in the different test media.

The dissolution of the $Sb_2O_2(CH_2)_2)_3$ particles was pH dependent. These particles dissolved only in GST (pH 1.6), the most acidic test media (1.8% (2h), 1.2% (24h)). In all other test media, ALF (pH 4.5), ASW (pH 6.5), PBS (pH 7.4), and GMB (pH 7.4), measured antimony concentrations were below the detection limit of 3 (ALF, ASW, PBS) or 6 (GMB) µg/L. The release rate of antimony could not be calculated, since the BET specific surface area could not be measured (see experimental). The particles were significantly larger in size compared with the other test items, one possible reason for less antimony release. No antimony could be detected in the outermost surface (by XPS) or the 1 µm deep surface (EDS), so that this could be an explanation for the very low antimony release in absence of organic solvents.

Presented bioaccessibility data provides a conservative measure and information of the possible uptake of antimony by humans. However, for toxicity, significantly more factors have to be taken into account, such as the oxidation state of antimony, the bioavailability, and the actual interaction with the organism through different routes. Especially for antimony, it is important to consider the oxidation state, since antimony(III) is generally more toxic than antimony(V) (Fowler and Goering, 1991; EU Risk Assessment report, 2008).

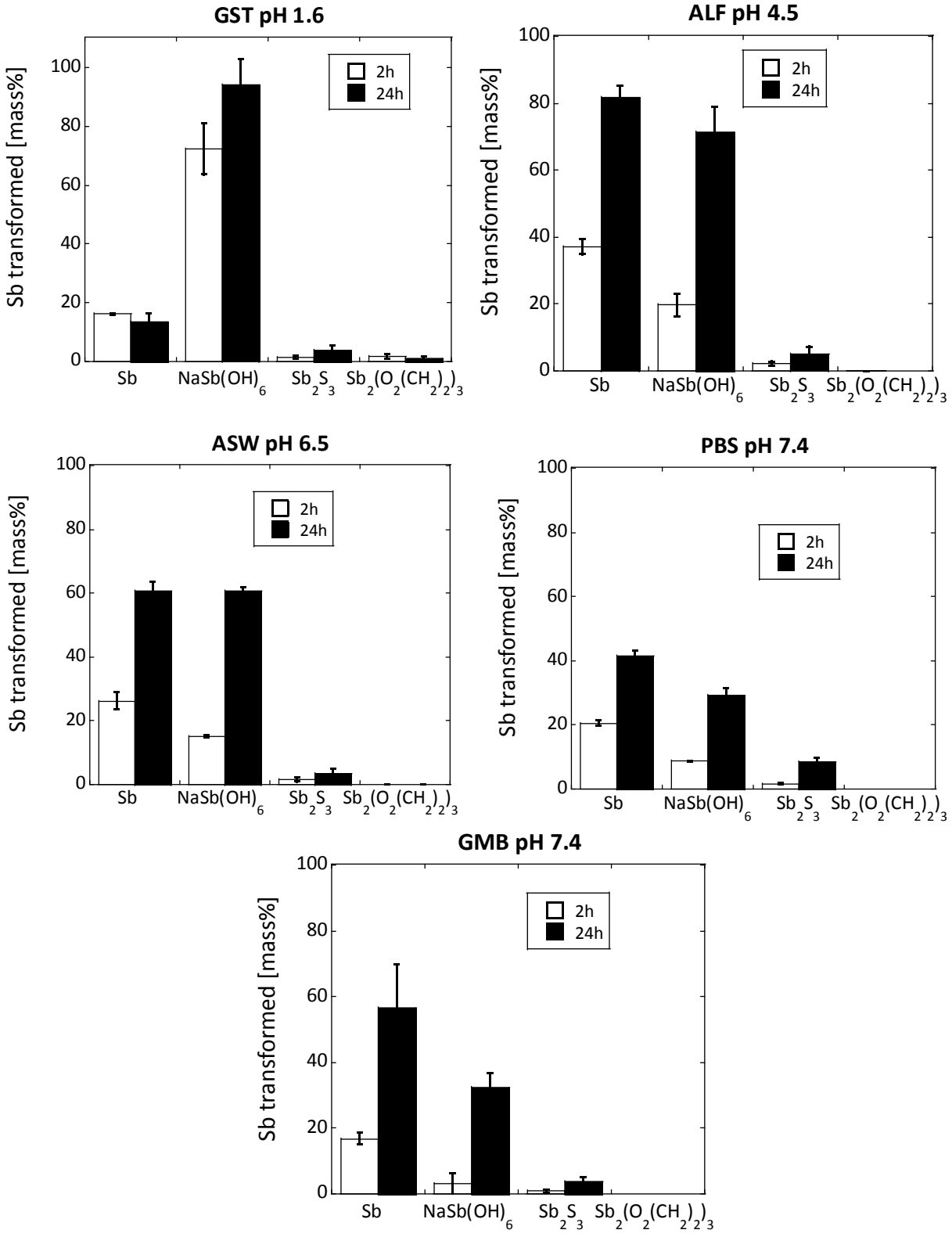


Figure 8. *Antimony transformed [mass%], equivalent to percentage of the amount particles dissolved since normalized to the antimony content in each test item. Data presented as average of values of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted. Abbreviations: GMB-Gamble´s solution, PBS-phosphate buffered saline, ASW-artificial sweat, ALF-artificial lysosomal fluid, GST-gastric fluid.*

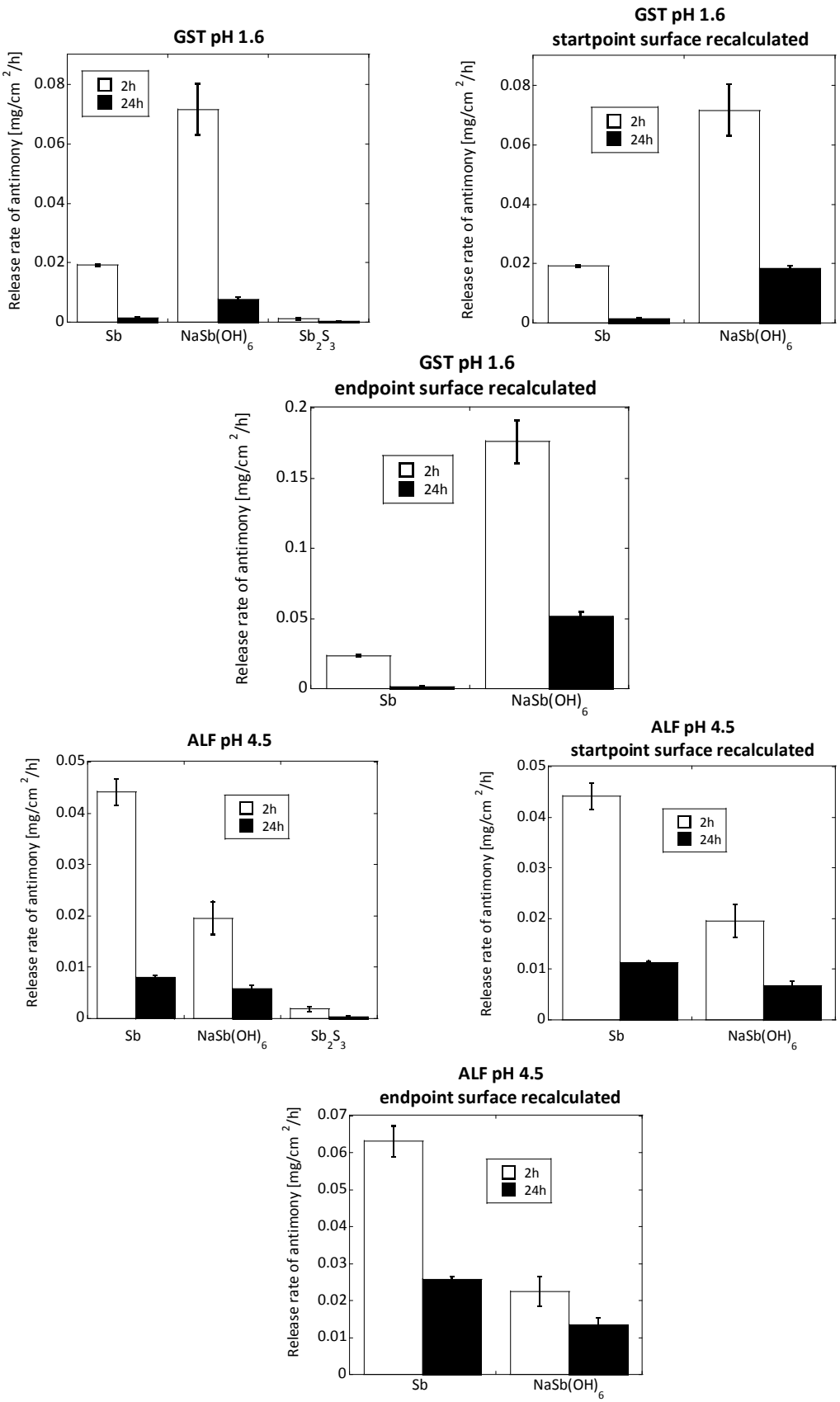


Figure 9. *Release rates of antimony [mg/cm²/h] and the standard deviation of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted. The "recalculated metal release" is normalized to the start (0 or 2 hours) or end time (2 or 24 hours) calculated surface area of the particles, respectively. More information is given in section "metal release units and calculations".*

Abbreviations: ALF-artificial lysosomal fluid, GST-gastric fluid.

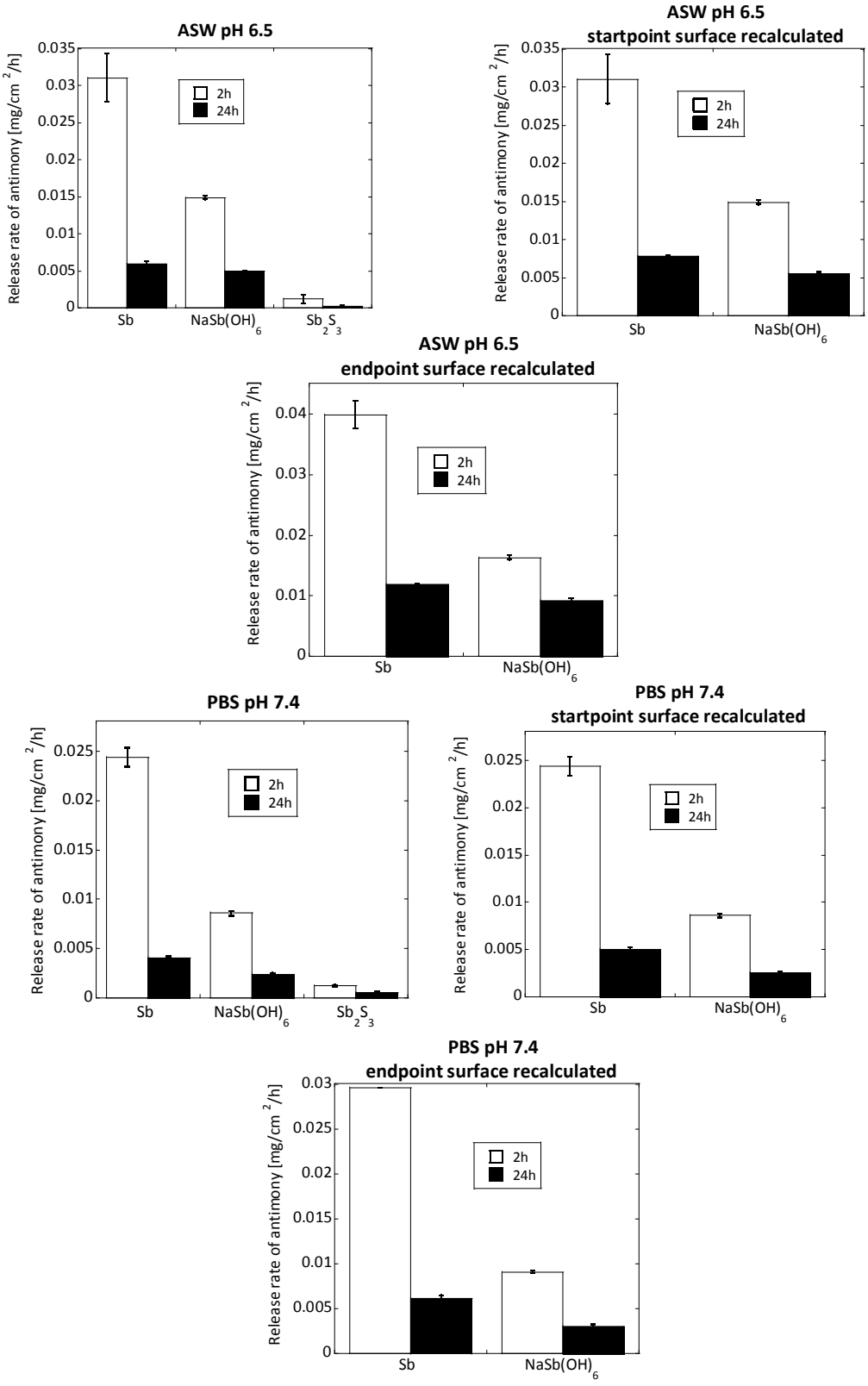


Figure 10. *Release rates of antimony [mg/cm²/h] and the standard deviation of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted. The "recalculated metal release rate" is normalized to the start (0 or 2 hours) or end time (2 or 24 hours) surface of the particles, respectively. More information is given in section "metal release units and calculations".*

Abbreviations: ASW-artificial sweat, PBS-phosphate buffered saline.

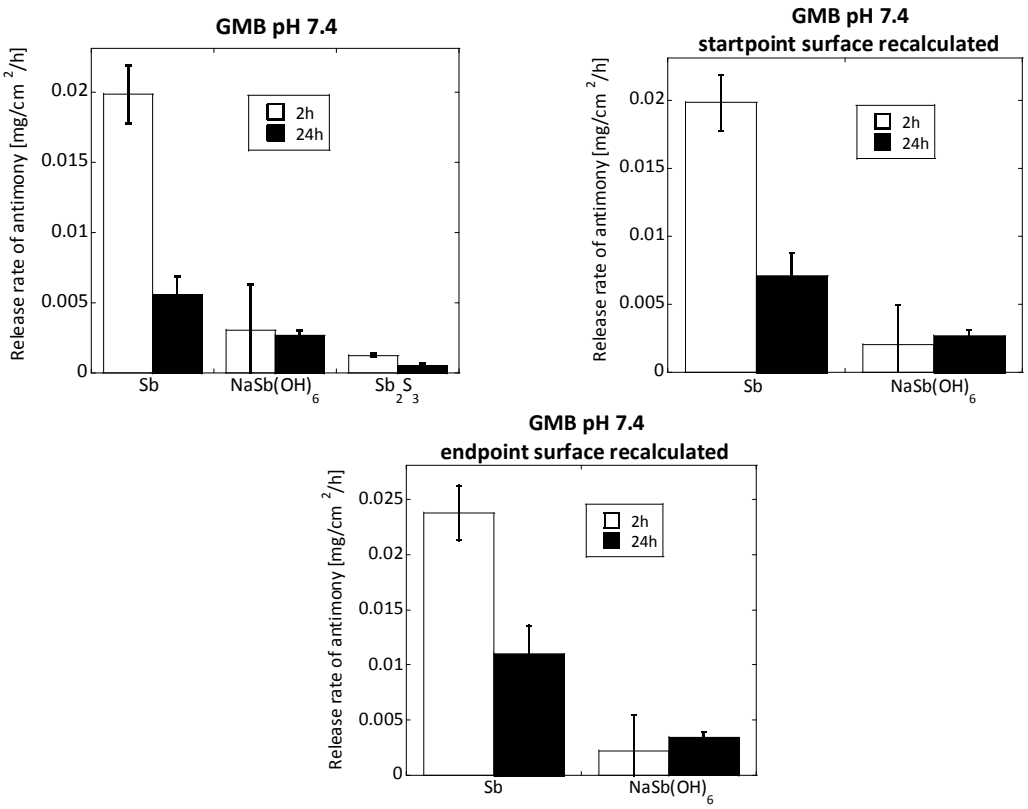


Figure 11. *Release rates of antimony [mg/cm²/h] and the standard deviation of triplicate samples in the GMB. Blank values for each individual media and exposure period have been subtracted. The "recalculated metal release rate" is normalized to the start (0 or 2 hours) or end time (2 or 24 hours) surface of the particles, respectively. More information is given in section "metal release units and calculations".*

Abbreviations: GMB-Gamble's solution.

Conclusion

Four antimony compounds, antimony metal (Sb) (1), sodium hexahydroxoantimonate ($NaSb(OH)_6$) (2), antimony trisulfide (Sb_2S_3) (3), and diantimony tris(ethylene glycolate) ($Sb_2(O_2(CH_2)_2)_3$) (4) were exposed to five different synthetic body fluids, artificial gastric fluid (GST, pH 1.6), artificial lysosomal fluid (ALF, pH 4.5), artificial sweat (ASW, pH 6.5), phosphate buffered saline (PBS, pH 7.4), and Gamble's solution (GMB, pH 7.4), for two different time periods, 2 and 24 hours. In parallel to the generation of bioaccessibility data, particle and surface characterisations were conducted. Information on oxidation state, complexation, and interactions with organisms, essential to assess potential toxicity is given elsewhere (Canmet 2010). The following main conclusions were drawn:

- Particles of Sb were dissolved to a high extent in all test media (42 to 82% after 24 hours of exposure), with the exception of GST, pH 1.6 (14% after 24 hours of exposure). The release rate of antimony decreased with time. Particles of Sb were dissolved to the highest extent in ALF, pH 4.5 (82% after 24 hours of exposure) compared with the other media investigated.
- Particles of $NaSb(OH)_6$ particles were dissolved to a high extent in the more acidic media (GST, pH 1.6, 94%, ALF, pH 4.5, 71%, ASW, pH 6.5, 61%, after 24 hours of exposure, respectively), and to a lower extent in the pH neutral media (PBS and GMB, pH 7.4, around 31% after 24 hours of exposure). The release rate of antimony for particles of $NaSb(OH)_6$ is fairly constant with time, indicating some or no formation of any protective surface layer against further dissolution.
- Particles of Sb_2S_3 dissolved between 3.6% (ASW, pH 6.5) and 8.5% (PBS, pH 7.4).
- Particles of $Sb_2(O_2(CH_2)_2)_3$ dissolved to a very low extent, about 1 to 2% in GST (pH 1.6) and with released concentrations of antimony below detection limit in all other test media.
- A high pH dependence but also a solution composition dependence were observed for particles of both Sb and $NaSb(OH)_6$. For both test items, the release rate of antimony decreased to a lower extent or increased in ALF (pH 4.5) and in GMB (pH 7.4), both complex media containing organic species and simulating lung fluid, compared with the other test media investigated. For particles of Sb_2S_3, no clear pH or solution composition dependence can be observed.
- Particle characterisation revealed different surface morphology, particle size, and particle size distribution for particles of Sb, $NaSb(OH)_6$, Sb_2S_3, and $Sb_2(O_2(CH_2)_2)_3$. Particles of Sb, $NaSb(OH)_6$, and Sb_2S_3 revealed a large number of smaller sized particles (about 1µm) and large size distributions (up to > 100µm). Particles of $Sb_2(O_2(CH_2)_2)_3$ were significantly larger (about 10 to several 1000 µm).

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Appendix

Metal analysis – quality control and uncertainties

The calibration curves can change slightly from date to date and depend on potential contamination in the graphite furnace. Therefore, all measurements are based on new calibrations. The calibration is repeated when quality control measurements decrease by more than 10% (flame mode). In the following table, the absorbance dependence to the standard concentration is shown for the different modes, calibration standards and occasions.

Mode	*Date*	*Standard concentrations*	*Absorbance*	*Date*	*Absorbance*	*Date*	*Absorbance*
Flame	*2009-09-25*	30 mg/L	0.2302	*2010-05-10*	0.2049		
		60 mg/L	0.4262		0.3821		
		90 mg/L	0.5964		0.5332		
		Correlation coefficient	1.000000		1.000000		
		Slope	0.00838		0.00730		
	2010-01-20	3 mg/L	0.0299	*2010-05-10*	0.0225		
		10 mg/L	0.0920		0.0749		
		30 mg/L	0.2323		0.2065		
		Correlation coefficient	1.000000		1.000000		
		Slope	0.01036		0.00752		
Graphite furnace	*2010-01-10*	50 µg/L	0.0448	*2010-05-10*	0.0407	*2010-05-10*	0.0346
		100 µg/L	0.0863		0.0800		0.0671
		500 µg/L	0.2977		0.3104		0.2764
		Correlation coefficient	1.000000		1.000000		1.000000
		Slope	0.00093		0.00083		0.00071

External standards (certified reference material, CRM; prepared by Ultra Scientific Analytical Solutions, USA, in 5% nitric acid and trace tartaric acid in low TOC water (<50ppb), Lot-no. L00353 and L00354), were tested in both the graphite furnace and the flame mode of atomic absorption spectrometry (AAS). The CRM standards were based on a matrix of 5% nitric acid, and trace tartaric acid in low TOC water (< 50 ppb), and metal concentrations were based on gravimetric analytical methods.

In the **graphite furnace mode**, a CRM of 500 ± 2.5 µg/L was tested. It revealed a concentration of 488.6 ± 9.31 µg/L which corresponds to 97.7 ± 1.8 % of 500 µg/L. The uncertainty of data obtained by the graphite furnace AAS is therefore **less than 2.5%**.

In the **flame mode**, a CRM of 10.00 ± 0.05 mg/L was tested. The linear range for antimony at the wavelength of 217.6 nm as used in this study ranges up to 30 mg/L, according to Perkin Elmers Instruments. In the calibration with 3, 10, and 30 mg/L standards, a concentration of 9.866 ± 0.052 mg/L was measured, which corresponds to 98.66 ± 0.5 % of 10 mg/L. In the calibration with 30, 60, and 90 mg/L, a concentration of 9.988 ± 0.068 mg/L which corresponds to 99.88 ± 0.7 % of 10 mg/L. Both calibrations used in the flame mode are therefore very similar and have an uncertainty of **less than 1.5 %**. However, the uncertainty can increase when very low concentrations close to the limit of detection are measured.

In addition, automated recovery measurements in the five different sample matrixes used in this study were performed. Results should according to Perkin Elmers Instruments be between 85 and 115%. The following recoveries have been obtained for the different sample matrixes by spiking with 500 µg/L: Gastric fluid (GST): 105.8%, artificial lysosomal fluid (ALF): 91.4%, artificial sweat (ASW): 96.5%, phosphate buffered saline (PBS): 95.9%, and Gamble's solution (GMB): 105.4%.

To conclude, the uncertainties obtained by certified reference materials when measured in the different modes and with different standards as used in this study, are less than 2.5% which is less than the normal standard deviation between replicate readings, replicate samples, or samples measured at different times. Automated recovery measurements in the five different sample matrixes used in this study obtained no significant errors due to the matrixes or the automated dilution of the instrument.
Significant errors due to the preparation of the standards or the automated sample dilution of the instrument (in the graphite furnace mode) can therefore be excluded.

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Letter of recognition

Perkin Elmer is a global leader in Atomic Absorption Spectroscopy for over 40 years .....

The Division of Surface and Corrosion Science, KTH, Stockholm, Sweden, leases since 2005 a Perkin Elmer AAnalyst 800 Atomic Absorption Spectrometer (AAS) for flame and graphite furnace analysis of metals in concentrations ranging from ppm to sub-ppb levels.

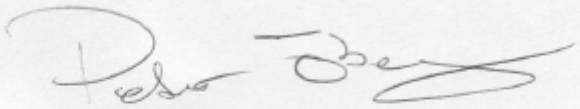
The AAS spectrometer at KTH is used by Perkin Elmer as a demonstration instrument for customers since we are confident that KTH maintains the instrument at the highest possible standard. Regular service and maintenance of the instrument is conducted by Perkin Elmer and by qualified personnel at the Division of Surface and Corrosion Science.

The person in charge of the instrument at KTH (Dr. Gunilla Herting, Ph.D.) and of all metal analytical procedures and operational protocols has been educated by experts at Perkin Elmer. Dr. Herting is continuously in dialog with experts at Perkin Elmer to ensure updated and informed about recent developments within the area of AAS analysis. The numbers of operators at KTH are limited and are only allowed to use the instrument after careful training and introduction to the field of AAS analysis by Dr. Herting.

To ensure reliable and reproducible methods and procedures for metal analysis, all methods used for preparing standards for calibration and quality control solutions at the Division of Surface and Corrosion Science are in agreement with procedures recommended by Perkin Elmer. The analytical procedure for metal analysis is performed according to recommended state-of-the-art practice enabling the Division of Surface and Corrosion Science to achieve highly accurate and reproducible results.

Perkin Elmer confirms that the Division of Surface and Corrosion Science conducts metal analysis by means of AAS with the same high quality and accuracy as required for an accredited commercial laboratory or institute. All measurements are in our view conducted according to Good Laboratory Practice, GLP.

Med vänlig hälsning



Peter Öberg
Service Team Leader Sweden

Bioaccessibility data

Calculation of the new surface area after significant dissolution of particles:

Assumptions:
- cubic particles
- all particles have the same size
- particles are dissolving with exactly the same rate

The original surface S_1 = 5mg (mass loaded) / 1000 * BET, when BET is the measured specific surface area by the BET method [m^2/g]. Furthermore, the original volume $V_1 = Y*a^3$, when Y = number of particles and a = edge length (cube).
Decreased volume after dissolution $V_2 = Y*b^3 = Y*x\%\ a^3$, when b is the new (decreased) edge length and x% is the average of the amount of particles not dissolved, obtained by the AAS metal analysis. That means, that $b = \sqrt[3]{(x\%a^3)}$.
The original surface $S_1 = Y*6a^2$, and the decreased surface after dissolution $S_2 = Y*6b^2 = Y*6(\sqrt[3]{(x\%a^3)})^2 = Y*6a^2*(\sqrt[3]{(x\%)})^2 = S_1*(\sqrt[3]{(x\%)})^2$.
Hence, $(\sqrt[3]{(x\%)})^2$ is the factor which is used for obtaining the new surface after dissolution.

Table VI. *Changes in pH. Original pH, see raw data.*

Test item	Exposure time	GMB pH 7.4	PBS pH 7.4	ASW pH 6.5	ALF pH 4.5	GST pH 1.6
Sb	**2h**	0.39±0.02 Blank 0.33	0.04±0.01 Blank 0.04	-0.15±0.04 Blank -0.07	-0.05±0.01 Blank -0.06	-0.16±0.01 Blank -0.16
	24h	0.94±0.41 Blank 1.02	0.03±0 Blank 0.04	-0.64±0.01 Blank -0.54	-0.06±0.01 Blank -0.05	-0.17±0.01 Blank -0.16
$NaSb(OH)_6$	**2h**	0.46±0.09 Blank 0.36	0.04±0.01 Blank 0.04	-0.03±0.05 Blank -0.07	-0.06±0.01 Blank -0.05	-0.16±0.01 Blank -0.16
	24h	1.08±0.17 Blank 0.86	0.03±0.01 Blank 0.04	-0.3±0.03 Blank -0.56	-0.05±0 Blank -0.05	-0.17±0.01 Blank -0.17
Sb_2S_3	**2h**	0.32±0.07 Blank 0.29	-0.07±0.02 Blank -0.07	-0.28±0.12 Blank -0.44	-0.06±0.01 Blank -0.06	-0.26±0.01 Blank -0.26
	24h	0.77±0.28 Blank 0.43	0.04±0.01 Blank 0.04	-0.84±0.05 Blank -0.87	-0.04±0.02 Blank -0.04	-0.24±0.01 Blank -0.24
$Sb_2(O_2(CH_2)_2)_3$	**2h**	0.37±0.08 Blank 0.27	-0.07±0.02 Blank -0.09	-0.3±0.03 Blank -0.31	-0.06±0.01 Blank -0.07	-0.23±0 Blank -0.22
	24h	0.78±0.25 Blank 1.19	0.04±0.02 Blank 0.03	-0.86±0.05 Blank -0.9	-0.05±0 Blank -0.05	-0.25±0.01 Blank -0.26

Table VII. *Antimony transformed [mass%], equivalent to percentage of the amount particles dissolved, since normalized to the antimony content in the test item; shown as average of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted. Abbreviations: GMB-Gamble´s solution, PBS-phosphate buffered saline, ASW-artificial sweat, ALF-artificial lysosomal fluid, GST-gastric fluid.*

Test item	**Exposure time**	**GMB pH 7.4**	**PBS pH 7.4**	**ASW pH 6.5**	**ALF pH 4.5**	**GST pH 1.6**
Sb	**2h**	16.7±1.8	20.6±0.9	26.3±2.8	37.3±2.2	16.3±0.2
	24h	56.7±13.2	41.5±1.5	60.8±2.9	81.7±3.5	13.6±2.7
$NaSb(OH)_6$	**2h**	3.1±3.3	8.7±0.3	15.1±0.3	19.8±3.3	72.5±8.8
	24h	32.5±4.5	29.2±2.5	60.8±1.1	71.4±7.7	94.3±8.7
Sb_2S_3	**2h**	0.9±0.4	1.7±0.2	1.7±0.8	2.4±0.7	1.6±0.5
	24h	3.9±1.1	8.5±1.3	3.6±1.7	5.1±2.4	4±1.7
$Sb_2(O_2(CH_2)_2)_3$	**2h**	0±0	0±0	0±0	0.001±0.01	1.8±0.7
	24h	0±0	0±0	0±0	0±0	1.2±0.8

Table VIII. *Release rate of antimony [mg/cm²/h] and the standard deviation of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted. BET surface area data for test item 4,* $Sb_2(O_2(CH_2)_2)_3$, not available, see experimental.

Abbreviations: GMB-Gamble´s solution, PBS-phosphate buffered saline, ASW-artificial sweat, ALF-artificial lysosomal fluid, GST-gastric fluid.

Test item	**Exposure time**	**GMB pH 7.4**	**PBS pH 7.4**	**ASW pH 6.5**	**ALF pH 4.5**	**GST pH 1.6**
Sb	**2h**	0.0198±0.0021	0.0245±0.001	0.0311±0.0033	0.0442±0.0026	0.02±0.001
	24h	0.0056±0.0014	0.0041±0.0002	0.006±0.0003	0.0081±0.0004	0.002±0.001
$NaSb(OH)_6$	**2h**	0.0031±0.0033	0.0086±0.0003	0.015±0.0003	0.0196±0.0033	0.0717±0.0087
	24h	0.0027±0.0004	0.0025±0.0002	0.0051±0.0001	0.0059±0.0007	0.008±0.001
Sb_2S_3	**2h**	0.0007±0.0003	0.0013±0.0002	0.0013±0.0006	0.0019±0.0005	0.002±0.001
	24h	0.0003±0.0001	0.0006±0.0001	0.0003±0.0002	0.0004±0.0002	0.0003±0.0002

Table IX. *Release rate of antimony [mg/cm²/h] after recalculation of the surface after dissolution (the start time values have been used, i.e. the original surface for the 2 hour exposure metal release rate and the surface after 2 hours of exposure for the 24 hour exposure metal release rates) and the standard deviation of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted.*

Abbreviations: GMB-Gamble´s solution, PBS-phosphate buffered saline, ASW-artificial sweat, ALF-artificial lysosomal fluid, GST-gastric fluid.

Test item	**Exposure time**	**GMB pH 7.4**	**PBS pH 7.4**	**ASW pH 6.5**	**ALF pH 4.5**	**GST pH 1.6**
Sb	**2h**	0.02±0.003	0.025±0.001	0.032±0.004	0.045±0.003	0.02±0.001
	24h	0.008±0.002	0.006±0.001	0.008±0.001	0.012±0.001	0.002±0.001
$NaSb(OH)_6$	**2h**	0.003±0.003	0.009±0.001	0.015±0.001	0.02±0.004	0.072±0.009
	24h	0.003±0.001	0.003±0.001	0.006±0.001	0.007±0.001	0.019±0.002

Table X. *Release rate of antimony [mg/cm²/h] after recalculation of the surface after dissolution (the end time values have been used, i.e. the surface after 2 hours of exposure for the 2 hour exposure metal release rate and the surface after 24 hours of exposure for the 24 hour exposure metal release rates) and the standard deviation of triplicate samples in the different media. Blank values for each individual media and exposure period have been subtracted.*

Abbreviations: GMB-Gamble´s solution, PBS-phosphate buffered saline, ASW-artificial sweat, ALF-artificial lysosomal fluid, GST-gastric fluid.

Test item	**Exposure time**	**GMB pH 7.4**	**PBS pH 7.4**	**ASW pH 6.5**	**ALF pH 4.5**	**GST pH 1.6**
Sb	**2h**	0.024±0.003	0.03±0.001	0.04±0.003	0.064±0.005	0.024±0.001
	24h	0.011±0.003	0.007±0.001	0.012±0.001	0.026±0.001	0.002±0.001
$NaSb(OH)_6$	**2h**	0.003±0.004	0.01±0.001	0.017±0.001	0.023±0.004	0.176±0.016
	24h	0.004±0.001	0.004±0.001	0.01±0.001	0.014±0.002	0.052±0.003

Raw data (experimental conditions, measured concentrations, calculated data, BET and particle size distribution data)

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
GST-Sb-Blank2	2	0.00000	0.000000	1.68	1.52	0.966	x			x		
GST-Sb- 2a	2	0.00522	0.002202	1.68	1.52	17.89	16.924			0.01921		
GST-Sb -2b	2	0.00515	0.002173	1.68	1.53	17.48	16.514			0.01900		
GST-Sb -2c	2	0.00493	0.002080	1.68	1.53	17.14	16.174	16.537	0.376	0.01944	0.01922	0.00022
GST-Sb -Blank24	24	0.00000	0.000000	1.68	1.52	1.076	x			x		
GST-Sb -24a	24	0.00486	0.002050	1.68	1.51	15.64	14.564			0.00148		
GST-Sb -24b	24	0.00507	0.002139	1.68	1.51	11.82	10.744			0.00105		
GST-Sb -24c	24	0.00471	0.001987	1.68	1.52	15.41	14.334	13.214	2.142	0.00150	0.00134	0.00026
GST-NaSb(OH)6-Blank2	2	0.00000	0.000000	1.68	1.52	1.122	x			x		
GST-NaSb(OH)6 -2a	2	0.00506	0.001261	1.68	1.52	42.03	40.908			0.08111		
GST-NaSb(OH)6 -2b	2	0.00547	0.001363	1.68	1.53	36.12	34.998			0.06419		
GST-NaSb(OH)6 -2c	2	0.00511	0.001273	1.68	1.53	36.64	35.518	37.141	3.272	0.06973	0.07167	0.00863
GST-NaSb(OH)6 -Blank24	24	0.00000	0.000000	1.68	1.51	1.015	x			x		
GST-NaSb(OH)6 -24a	24	0.00498	0.001241	1.68	1.51	44.55	43.535			0.00731		
GST-NaSb(OH)6 -24b	24	0.00473	0.001179	1.68	1.52	49.66	48.645			0.00860		
GST-NaSb(OH)6 -24c	24	0.00530	0.001321	1.68	1.52	47.98	46.965	46.382	2.604	0.00741	0.00777	0.00072

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00016		
0.00016		
0.00016	0.00016	0.00000
x		
0.00015		
0.00011		
0.00015	0.00014	0.00003
x		
0.00040		
0.00032		
0.00035	0.0003572	0.00004
x		
0.00044		
0.00051		
0.00044	0.00046	0.00004

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]			Amount Sb transformed	
16.21072797	83.789				
16.03300971	83.967				
16.40365112	83.596	83.784	0.1853727	16.215796	0.1853727
14.98353909	85.016				
10.59566075	89.404				
15.21656051	84.783	86.401	2.6032188	13.598587	2.6032188
81.93276993	18.067				
64.84191126	35.158				
70.44132392	29.559	27.595	8.7130573	72.405335	8.7130573
88.59497972	11.405				
104.2262168	-4.226				
89.80455477	10.195	5.791	8.6965796	94.208584	8.6965796

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
ALF-Sb-Blank2	2	0.00000	0.000000	4.38	4.32	0.537	x			x		
ALF-Sb- 2a	2	0.00506	0.002135	4.38	4.32	40.35	39.813			0.04662		
ALF-Sb -2b	2	0.00487	0.002055	4.38	4.33	36.92	36.383			0.04427		
ALF-Sb -2c	2	0.00499	0.002105	4.38	4.34	35.48	34.943	37.046	2.502	0.04149	0.04413	0.00257
ALF-Sb -Blank24	24	0.00000	0.000000	4.38	4.33	0.428	x			x		
ALF-Sb -24a	24	0.00502	0.002118	4.38	4.32	78.36	77.932			0.00767		
ALF-Sb -24b	24	0.00470	0.001983	4.38	4.33	78.95	78.522			0.00825		
ALF-Sb -24c	24	0.00491	0.002072	4.38	4.33	82.72	82.292	79.582	2.365	0.00828	0.00806	0.00034
ALF-NaSb(OH)6-Blank2	2	0.00000	0.000000	4.38	4.33	0.546	x			x		
ALF-NaSb(OH)6 -2a	2	0.00504	0.001256	4.38	4.33	12.11	11.564			0.02302		
ALF-NaSb(OH)6 -2b	2	0.00486	0.001211	4.38	4.32	9.813	9.267			0.01913		
ALF-NaSb(OH)6 -2c	2	0.00497	0.001239	4.38	4.33	8.763	8.217	9.683	1.712	0.01659	0.01958	0.00324
ALF-NaSb(OH)6 -Blank24	24	0.00000	0.000000	4.38	4.33	0.651	x			x		
ALF-NaSb(OH)6 -24a	24	0.00483	0.001204	4.38	4.33	30.67	30.019			0.00520		
ALF-NaSb(OH)6 -24b	24	0.00523	0.001303	4.38	4.33	40.84	40.189			0.00642		
ALF-NaSb(OH)6 -24c	24	0.00486	0.001211	4.38	4.33	35.71	35.059	35.089	5.085	0.00603	0.00588	0.00063

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00039		
0.00037		
0.00035	0.00037	0.00002
x		
0.00078		
0.00084		
0.00084	0.00082	0.00003
x		
0.00011		
0.00010		
0.00008	0.0000976	0.00002
x		
0.00031		
0.00038		
0.00036	0.00035	0.00004

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]		Amount Sb transformed			
39.340909	60.659					
37.354209	62.646					
35.013026	64.987	62.764	2.1663597	37.236048	2.1663597	
77.621514	22.378					
83.534043	16.466					
83.800407	16.200	18.348	3.4930328	81.651988	3.4930328	
23.252918	76.747					
19.324257	80.676					
16.755477	83.245	80.222	3.2723522	19.777551	3.2723522	
62.986721	37.013					
77.876319	22.124					
73.107707	26.892	28.676	7.6034443	71.323582	7.6034443	

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
ASW-Sb-Blank2	2	0.00000	0.000000	6.44	6.38	0.587	x			x		
ASW-Sb- 2a	2	0.00520	0.002194	6.44	6.26	25.36	24.773			0.02823		
ASW-Sb -2b	2	0.00503	0.002122	6.44	6.32	26.36	25.773			0.03036		
ASW-Sb -2c	2	0.00474	0.002000	6.44	6.32	28.27	27.683	26.076	1.479	0.03461	0.03107	0.00325
ASW-Sb -Blank24	24	0.00000	0.000000	6.44	5.90	0.608	x			x		
ASW-Sb -24a	24	0.00503	0.002122	6.44	5.81	62.13	61.522			0.00604		
ASW-Sb -24b	24	0.00473	0.001996	6.44	5.80	60.58	59.972			0.00626		
ASW-Sb -24c	24	0.00531	0.002240	6.44	5.80	61.88	61.272	60.922	0.832	0.00570	0.00600	0.00028
ASW-NaSb(OH)6-Blank2	2	0.00000	0.000000	6.44	6.38	0.689	x			x		
ASW-NaSb(OH)6 -2a	2	0.00497	0.001239	6.44	6.46	8.21	7.521			0.01518		
ASW-NaSb(OH)6 -2b	2	0.00496	0.001236	6.44	6.37	7.917	7.228			0.01462		
ASW-NaSb(OH)6 -2c	2	0.00485	0.001209	6.44	6.43	7.91	7.221	7.323	0.171	0.01494	0.01491	0.00028
ASW-NaSb(OH)6 -Blank24	24	0.00000	0.000000	6.44	5.88	0.802	x			x		
ASW-NaSb(OH)6 -24a	24	0.00480	0.001196	6.44	6.15	29.11	28.308			0.00493		
ASW-NaSb(OH)6 -24b	24	0.00513	0.001278	6.44	6.16	31.5	30.698			0.00500		
ASW-NaSb(OH)6 -24c	24	0.00481	0.001199	6.44	6.12	30.18	29.378	29.461	1.197	0.00511	0.00501	0.00009

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load	Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]			Amount Sb transformed	
x								
0.00024			23.820192	76.180				
0.00026			25.619284	74.381				
0.00029	0.00026	0.00003	29.201477	70.799	73.786	2.739436	26.213651	2.739436
x								
0.00061			61.15507	38.845				
0.00063			63.395349	36.605				
0.00058	0.00061	0.00003	57.694915	42.305	39.252	2.8718885	60.748445	2.8718885
x								
0.00008			15.336247	84.664				
0.00007			14.7685	85.232				
0.00007	0.0000743	0.00000	15.088828	84.911	84.935	0.2846531	15.064525	0.2846531
x								
0.00029			59.767881	40.232				
0.00030			60.644668	39.355				
0.00031	0.00030	0.00001	61.898063	38.102	39.230	1.0706252	60.770204	1.0706252

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
PBS-Sb-Blank2	2	0.00000	0.000000	7.35	7.39	1.023	x			x		
PBS-Sb- 2a	2	0.00512	0.002160	7.35	7.38	21.32	20.297			0.02349		
PBS-Sb -2b	2	0.00495	0.002088	7.35	7.39	21.36	20.337			0.02435		
PBS-Sb -2c	2	0.00474	0.002000	7.35	7.38	21.34	20.317	20.317	0.020	0.02540	0.02441	0.00096
PBS-Sb -Blank24	24	0.00000	0.000000	7.35	7.38	0.875	x			x		
PBS-Sb -24a	24	0.00514	0.002169	7.35	7.37	42.36	41.485			0.00399		
PBS-Sb -24b	24	0.00504	0.002126	7.35	7.37	44.39	43.515			0.00426		
PBS-Sb -24c	24	0.00477	0.002012	7.35	7.37	39.86	38.985	41.328	2.269	0.00404	0.00409	0.00015
PBS-NaSb(OH)6-Blank2	2	0.00000	0.000000	7.35	7.39	0.876	x			x		
PBS-NaSb(OH)6 -2a	2	0.00502	0.001251	7.35	7.39	5.213	4.337			0.00867		
PBS-NaSb(OH)6 -2b	2	0.00486	0.001211	7.35	7.39	5.124	4.248			0.00877		
PBS-NaSb(OH)6 -2c	2	0.00504	0.001256	7.35	7.38	5.074	4.198	4.261	0.070	0.00836	0.00860	0.00022
PBS-NaSb(OH)6 -Blank24	24	0.00000	0.000000	7.35	7.38	0.964	x			x		
PBS-NaSb(OH)6 -24a	24	0.00503	0.001253	7.35	7.38	14.28	13.316			0.00221		
PBS-NaSb(OH)6 -24b	24	0.00482	0.001201	7.35	7.38	16.02	15.056			0.00261		
PBS-NaSb(OH)6 -24c	24	0.00513	0.001278	7.35	7.37	15.61	14.646	14.339	0.910	0.00239	0.00240	0.00020

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00020		
0.00021		
0.00021	0.00021	0.00001
x		
0.00040		
0.00043		
0.00041	0.00041	0.00001
x		
0.00004		
0.00004		
0.00004	0.0000428	0.00000
x		
0.00013		
0.00016		
0.00014	0.00014	0.00001

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]			Amount Sb transformed		
19.821289	80.179					
20.542424	79.458					
21.431435	78.569	79.402	0.80653	20.598383	0.80653	
40.355058	59.645					
43.169643	56.830					
40.86478	59.135	58.537	1.4996719	41.46316	1.4996719	
8.7555939	91.244					
8.8582543	91.142					
8.441348	91.559	91.315	0.2172175	8.6850654	0.2172175	
26.829076	73.171					
31.656469	68.344					
28.93354	71.066	70.860	2.4202908	29.139695	2.4202908	

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
GMB-Sb-Blank2	2	0.00000	0.000000	7.39	7.72	1.032	x			x		
GMB-Sb- 2a	2	0.00505	0.002131	7.39	7.76	19.9	18.868			0.02214		
GMB-Sb -2b	2	0.00510	0.002152	7.39	7.79	16.74	15.708			0.01825		
GMB-Sb -2c	2	0.00498	0.002101	7.39	7.77	16.98	15.948	16.841	1.759	0.01898	0.01979	0.00207
GMB-Sb -Blank24	24	0.00000	0.000000	7.39	8.41	1.164	x			x		
GMB-Sb -24a	24	0.00594	0.002506	7.39	8.38	64.73	63.566			0.00528		
GMB-Sb -24b	24	0.00508	0.002143	7.39	7.90	73.48	72.316			0.00703		
GMB-Sb -24c	24	0.00495	0.002088	7.39	8.71	46.09	44.926	60.269	13.989	0.00448	0.00560	0.00130
GMB-NaSb(OH)6-Blank2	2	0.00000	0.000000	7.39	7.74	1.431	x			x		
GMB-NaSb(OH)6 -2a	2	0.00544	0.001356	7.39	7.91	4.315	2.884			0.00532		
GMB-NaSb(OH)6 -2b	2	0.00481	0.001199	7.39	7.75	1.779	0.348			0.00073		
GMB-NaSb(OH)6 -2c	2	0.00486	0.001211	7.39	7.87	1.237		1.616	1.793		0.00302	0.00325
GMB-NaSb(OH)6 -Blank24	24	0.00000	0.000000	7.39	8.24	1.813	x			x		
GMB-NaSb(OH)6 -24a	24	0.00497	0.001239	7.39	8.45	20.04	18.227			0.00307		
GMB-NaSb(OH)6 -24b	24	0.00513	0.001278	7.39	8.64	17.9	16.087			0.00262		
GMB-NaSb(OH)6 -24c	24	0.00470	0.001171	7.39	8.32	14.92	13.107	15.807	2.571	0.00233	0.00267	0.00037

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load	Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]		Amount Sb transformed	
x							
0.00019			18.681188	81.319			
0.00015			15.4	84.600			
0.00016	0.00017	0.00002	16.012048	83.988	83.302	1.7447591	16.697745	1.7447591
x							
0.00054			53.506734	46.493			
0.00071			71.177165	28.823			
0.00045	0.00057	0.00013	45.379798	54.620	43.312	13.189613	56.687899	13.189613
x							
0.00003			5.3727454	94.627			
0.00000			0.7332196	99.267			
	0.0000151	0.00002			96.947	3.2806402	3.0529825	3.2806402
x							
0.00018			37.167103	62.833			
0.00016			31.780272	68.220			
0.00014	0.00016	0.00002	28.26216	71.738	67.597	4.4850321	32.403178	4.4850321

Limits of detection/quantification = 3*blank concentration of respective sample

Average LOD:	Average LOQ:
GST (AAS): 0.29 mg/L	GST (AAS): 0.97 mg/L
ALF (AAS): 0.13 mg/L	ALF (AAS): 0.43 mg/L
ASW (AAS): 0.14 mg/L	ASW (AAS): 0.47 mg/L
PBS (AAS): 0.21 mg/L	PBS (AAS): 0.70 mg/L
GMB (AAS): 0.20 mg/L	GMB (AAS): 0.67 mg/L

KANTHAL

Michael Lundberg

Yolanda Hedberg Dipl.-Ing.

PROTOKOLL PARTIKELANALYS

2009-09-01

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Anders Magnusson

Provid	Yta [m^2/g] 5 punkter	d10 [µm]	d50 [µm]	d90 [µm]	Densitet [g/cm^3]	Anm	
Sb	0,4219					"	0,3996
$Na_x Sb_y$	0,2492					"	0,2438

2009-09-01

Michael Lundberg

Analysinstrumenten ingår i Kanthal ISO9001 och genomgår årliga service och kalibrering mot spårbara referenser

	Analysmetod	Media	Analysinstrument
	Laserdiffraktion	Air, $H_2O_{dispergerad}$	Malvern 3000
	Sedimentation, röntgenabsorbtion	Spec, $H_2O_{dispergerad}$	Micromeretics Sedigraph 5100
X	Kväveadsorbtion, BET, flerpunkt	N_2 instrument	Micromeretics Gemini V
	Pyknometri	Ar instrument	Micromeritics Accupyc

Sizes	Sb_a - Average	Sb_b - Average	Average Sb	SD	NaSb(OH)6_a - Average	NaSb(OH)6_b - Average	Average NaSb(OH)6	SD
	40046.488	40046.492			40046.498	40046.503		
0.01	0	0	0	0	0	0	0	0
0.011482	0	0	0	0	0	0	0	0
0.013183	0	0	0	0	0	0	0	0
0.015136	0	0	0	0	0	0	0	0
0.017378	0	0	0	0	0	0	0	0
0.019953	0	0	0	0	0	0	0	0
0.022909	0	0	0	0	0	0	0	0
0.026303	0	0	0	0	0	0	0	0
0.0302	0	0	0	0	0	0	0	0
0.034674	0	0	0	0	0	0	0	0
0.039811	0	0	0	0	0	0	0	0
0.045709	0	0	0	0	0	0	0	0
0.052481	0	0	0	0	0	0	0	0
0.060256	0	0	0	0	0	0	0	0
0.069183	0	0	0	0	0	0	0	0
0.079433	0	0	0	0	0	0	0	0
0.091201	0	0	0	0	0	0	0	0
0.104713	0	0	0	0	0	0	0	0
0.120226	0	0	0	0	0	0	0	0
0.138038	0	0	0	0	0	0	0	0
0.158489	0	0	0	0	0	0	0	0
0.18197	0	0	0	0	0	0	0	0
0.20893	0	0	0	0	0	0	0	0
0.239883	0	0	0	0	0	0	0	0
0.275423	0	0	0	0	0	0	0	0
0.316228	0	0	0	0	0	0	0	0
0.363078	0	0	0	0	0	0	0	0
0.416869	0	0	0	0	0	0	0	0
0.47863	0	0	0	0	0.060297	0.061135	0.060716	0.0005926
0.549541	0	0	0	0	0.081001	0.081914	0.0814575	0.0006456
0.630957	0	0	0	0	0.092645	0.093575	0.09311	0.0006576
0.724436	0	0	0	0	0.100665	0.101603	0.101134	0.0006633
0.831764	0	0	0	0	0.108624	0.109719	0.1091715	0.0007743
0.954993	0	0	0	0	0.113611	0.114951	0.114281	0.0009475
1.096478	0.002746	0.015619	0.0091825	0.0091026	0.117957	0.11969	0.1188235	0.0012254
1.258925	0.0419	0.09054	0.06622	0.0343937	0.123073	0.125366	0.1242195	0.0016214
1.44544	0.257731	0.269542	0.2636365	0.0083516	0.131663	0.134688	0.1331755	0.002139
1.659587	0.475771	0.496418	0.4860945	0.0145996	0.147149	0.151079	0.149114	0.0027789
1.905461	0.791713	0.814493	0.803103	0.0161079	0.173039	0.178005	0.175522	0.0035115
2.187762	1.196156	1.222968	1.209562	0.0189589	0.213043	0.219116	0.2160795	0.0042943
2.511886	1.691761	1.723662	1.7077115	0.0225574	0.270119	0.277277	0.273698	0.0050615
2.884031	2.271436	2.309242	2.290339	0.0267329	0.346068	0.354185	0.3501265	0.0057396
3.311311	2.92127	2.965931	2.9436005	0.0315801	0.441732	0.450612	0.446172	0.0062791
3.801894	3.611397	3.663346	3.6373715	0.0367335	0.555328	0.564759	0.5600435	0.0066687
4.365158	4.316471	4.375564	4.3460175	0.0417851	0.686027	0.695892	0.6909595	0.0069756
5.011872	4.990432	5.055336	5.022884	0.0458941	0.829913	0.840301	0.835107	0.0073454
5.754399	5.607697	5.675754	5.6417255	0.0481236	0.988979	1.000329	0.994654	0.0080257
6.606934	6.122275	6.189262	6.1557685	0.047367	1.162909	1.176083	1.169496	0.0093154
7.585776	6.516857	6.577211	6.547034	0.0426767	1.363984	1.380396	1.37219	0.011605
8.709636	6.75789	6.8056	6.781745	0.0337361	1.600029	1.621436	1.6107325	0.015137
10	6.834291	6.863314	6.8488025	0.0205224	1.896519	1.925053	1.910786	0.0201766
11.481536	6.7323	6.738544	6.735422	0.0044152	2.262648	2.300099	2.2813735	0.0264819

13.182567	6.447198	6.428273	6.4377355	0.013382	2.724902	2.772783	2.7488425	0.033857
15.135612	5.997347	5.954445	5.975896	0.0303363	3.27822	3.336823	3.3075215	0.0414386
17.378008	5.399716	5.336408	5.368062	0.0447655	3.929734	3.998315	3.9640245	0.0484941
19.952623	4.707346	4.629904	4.668625	0.0547598	4.643814	4.719972	4.681893	0.0538518
22.908677	3.959379	3.87518	3.9172795	0.0595377	5.390594	5.470572	5.430583	0.056553
26.30268	3.218175	3.135197	3.176686	0.0586743	6.101094	6.179753	6.1404235	0.0556203
30.199517	2.521999	2.448064	2.4850315	0.0522799	6.71235	6.783595	6.7479725	0.0503778
34.673685	1.909617	1.85156	1.8805885	0.0410525	7.147334	7.204773	7.1760535	0.0406155
39.810717	1.397489	1.360088	1.3787885	0.0264465	7.345579	7.383141	7.36436	0.0265603
45.708819	0.991274	0.97638	0.983827	0.0105316	7.265121	7.277871	7.271496	0.0090156
52.480746	0.684447	0.69156	0.6880035	0.0050297	6.89499	6.879864	6.887427	0.0106957
60.255959	0.460618	0.488156	0.474387	0.0194723	6.254557	6.210704	6.2326305	0.0310088
69.183097	0.30233	0.348387	0.3253585	0.0325672	5.402678	5.332129	5.3674035	0.0498857
79.432823	0.194399	0.249551	0.221975	0.0389984	4.407207	4.31432	4.3607635	0.065681
91.201084	0.113813	0.180038	0.1469255	0.0468281	3.374557	3.266356	3.3204565	0.0765097
104.71286	0.072096	0.120007	0.0960515	0.0338782	2.38257	2.267426	2.324998	0.0814191
120.22644	0.065522	0.068462	0.066992	0.0020789	1.525962	1.413432	1.469697	0.0795707
138.03843	0.067268	0.005992	0.03663	0.0433287	0.859538	0.757744	0.808641	0.0719792
158.48932	0.075737	0	0.0378685	0.0535541	0.371019	0.288413	0.329716	0.0584113
181.97009	0.08414	0	0.04207	0.059496	0.121157	0.06475	0.0929535	0.0398858
208.92961	0.081388	0	0.040694	0.05755	0	0	0	0
239.88329	0.067224	0	0.033612	0.0475345	0	0	0	0
275.42287	0.038099	0	0.0190495	0.0269401	0	0	0	0
316.22777	0.003282	0	0.001641	0.0023207	0	0	0	0
363.07806	0	0	0	0	0	0	0	0
416.86938	0	0	0	0	0	0	0	
478.63009	0	0	0	0	0	0	0	0
549.54087	0	0	0	0	0	0	0	0
630.95734	0	0	0	0	0	0	0	0
724.43596	0	0	0	0	0	0	0	0
831.76377	0	0	0	0	0	0	0	0
954.99259	0	0	0	0	0	0	0	0
1096.4782	0	0	0	0	0	0	0	0
1258.9254	0	0	0	0	0	0	0	0
1445.4398	0	0	0	0	0	0	0	0
1659.5869	0	0	0	0	0	0	0	0
1905.4607	0	0	0	0	0	0	0	0
2187.7616	0	0	0	0	0	0	0	0
2511.8864	0	0	0	0	0	0	0	0
2884.0315	0	0	0	0	0	0	0	0
3311.3112	0	0	0	0	0	0	0	0
3801.894	0	0	0	0	0	0	0	0
4365.1583	0	0	0	0	0	0	0	0
5011.8723	0	0	0	0	0	0	0	0
5754.3994	0	0	0	0	0	0	0	0
6606.9345	0	0	0	0	0	0	0	0
7585.7758	0	0	0	0	0	0	0	0
8709.6359	0	0	0	0	0	0	0	0
10000								

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	GF-AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
GST-SbS3-Blank2	2	0.00000	0.000000	1.67	1.41	0.428	x			x		
GST-SbS3- 2a	2	0.00491	0.001778	1.67	1.41	1.005	0.577			0.00081		
GST-SbS3 -2b	2	0.00464	0.001680	1.67	1.41	1.256	0.828			0.00123		
GST-SbS3 -2c	2	0.00454	0.001644	1.67	1.40	1.396	0.968	0.791	0.198	0.00147	0.00117	0.00033
GST-SbS3 -Blank24	24	0.00000	0.000000	1.67	1.43	0.388	x			x		
GST-SbS3 -24a	24	0.00515	0.001865	1.67	1.43	2.906	2.518			0.00028		
GST-SbS3 -24b	24	0.00524	0.001897	1.67	1.43	1.624	1.236			0.00014		
GST-SbS3 -24c	24	0.00465	0.001684	1.67	1.44	3.096	2.708	2.154	0.801	0.00034	0.00025	0.00010
GST-Sb2(O2(CH2)2)3-Blank2	2	0.00000	0.000000	1.67	1.45	0.506	x			x		
GST-Sb2(O2(CH2)2)3 -2a	2	0.00509	0.000000	1.67	1.44	1.129	0.623			#DIVISION/0!		
GST-Sb2(O2(CH2)2)3 -2b	2	0.00523	0.000000	1.67	1.44	1.606	1.100			#DIVISION/0!		
GST-Sb2(O2(CH2)2)3 -2c	2	0.00494	0.000000	1.67	1.44	1.853	1.347	1.023	0.368	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
GST-Sb2(O2(CH2)2)3 -Blank24	24	0.00000	0.000000	1.67	1.41	0.659	x			x		
GST-Sb2(O2(CH2)2)3 -24a	24	0.00545	0.000000	1.67	1.43	1.825	1.166			#DIVISION/0!		
GST-Sb2(O2(CH2)2)3 -24b	24	0.00540	0.000000	1.67	1.41	1.45	0.791			#DIVISION/0!		
GST-Sb2(O2(CH2)2)3 -24c	24	0.00481	0.000000	1.67	1.42	0.914	0.255	0.737	0.458	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load	Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]			Amount Sb transformed	
x								
0.00001			1.051873209	98.948				
0.00001			1.597281381	98.403				
0.00001	0.00001	0.00000	1.908484238	98.092	98.481	0.4336088	1.5192129	0.4336088
x								
0.00002			4.376405647	95.624				
0.00001			2.111330671	97.889				
0.00003	0.00002	0.00001	5.212724592	94.787	96.100	1.6046099	3.9001536	1.6046099
x								
0.00001			1.064729719	98.935				
0.00001			1.829616668	98.170				
0.00001	0.0000101	0.00000	2.371973096	97.628	98.245	0.6567709	1.7554398	0.6567709
x								
0.00001			1.861106218	98.139				
0.00001			1.274241765	98.726				
0.00000	0.00001	0.00000	0.461173364	99.539	98.801	0.7030057	1.1988404	0.7030057

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	GF-AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
ALF-SbS3-Blank2	2	0.00000	0.000000	4.47	4.41	0.001967	x			x		
ALF-SbS3- 2a	2	0.00455	0.001648	4.47	4.42	1.466	1.464			0.00222		
ALF-SbS3 -2b	2	0.00458	0.001658	4.47	4.42	1.298	1.296			0.00195		
ALF-SbS3 -2c	2	0.00498	0.001803	4.47	4.41	0.9203	0.918	1.226	0.279	0.00127	0.00182	0.00049
ALF-SbS3 -Blank24	24	0.00000	0.000000	4.47	4.43	0.000903	x			x		
ALF-SbS3 -24a	24	0.00511	0.001850	4.47	4.44	4.014	4.013			0.00045		
ALF-SbS3 -24b	24	0.00480	0.001738	4.47	4.42	1.32	1.319			0.00016		
ALF-SbS3 -24c	24	0.00499	0.001807	4.47	4.43	3.13	3.129	2.820	1.373	0.00036	0.00032	0.00015
ALF-Sb2(O2(CH2)2)3-Blank2	2	0.00000	0.000000	4.47	4.40	0.00177	x			x		
ALF-Sb2(O2(CH2)2)3 -2a	2	0.00448	0.000000	4.47	4.42	0	-0.002			#DIVISION/0!		
ALF-Sb2(O2(CH2)2)3 -2b	2	0.00478	0.000000	4.47	4.41	0.007005	0.005			#DIVISION/0!		
ALF-Sb2(O2(CH2)2)3 -2c	2	0.00461	0.000000	4.47	4.40	0	-0.002	0.001	0.004	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
ALF-Sb2(O2(CH2)2)3 -Blank24	24	0.00000	0.000000	4.47	4.42	0.001408	x			x		
ALF-Sb2(O2(CH2)2)3 -24a	24	0.00555	0.000000	4.47	4.42	0.000257	-0.001			#DIVISION/0!		
ALF-Sb2(O2(CH2)2)3 -24b	24	0.00486	0.000000	4.47	4.42	0	-0.001			#DIVISION/0!		
ALF-Sb2(O2(CH2)2)3 -24c	24	0.00459	0.000000	4.47	4.42	0	-0.001	-0.001	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00002		
0.00001		
0.00001	0.00001	0.00000
x		
0.00004		
0.00001		
0.00003	0.00003	0.00001
x		
0.00000		
0.00000		
0.00000	0.0000000	0.00000
x		
0.00000		
0.00000		
0.00000	0.00000	0.00000

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]			Amount Sb transformed	
2.8801065	97.120				
2.5329094	97.467				
1.6505927	98.349	97.645	0.6338681	2.3545362	0.6338681
7.0295549	92.970				
2.459827	97.540				
5.6129032	94.387	94.966	2.3392023	5.0340951	2.3392023
-0.0034369	100.003				
0.009527	99.990				
-0.00334	100.003	99.999	0.0074569	0.0009167	0.0074569
-0.0018041	100.002				
-0.0025202	100.003				
-0.0026685	100.003	100.002	0.0004622	-0.0023309	0.0004622

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	GF-AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
ASW-SbS3-Blank2	2	0.00000	0.000000	6.49	6.06	1.393	x			x		
ASW-SbS3- 2a	2	0.00499	0.001807	6.49	6.35	2.388	0.995			0.00138		
ASW-SbS3 -2b	2	0.00470	0.001702	6.49	6.21	2.564	1.171			0.00172		
ASW-SbS3 -2c	2	0.00528	0.001912	6.49	6.13	1.876	0.483	0.883	0.357	0.00063	0.00124	0.00056
ASW-SbS3 -Blank24	24	0.00000	0.000000	6.49	5.62	1.941	x			x		
ASW-SbS3 -24a	24	0.00520	0.001883	6.49	5.70	4.8	2.859			0.00032		
ASW-SbS3 -24b	24	0.00469	0.001698	6.49	5.64	4.012	2.071			0.00025		
ASW-Sbs3 -24c	24	0.00521	0.001887	6.49	5.62	2.951	1.010	1.980	0.928	0.00011	0.00023	0.00010
ASW-Sb2(O2(CH2)2)3-Blank2	2	0.00000	0.000000	6.49	6.18	0	x			x		
ASW-Sb2(O2(CH2)2)3 -2a	2	0.00453	0.000000	6.49	6.23	0	0.000			#DIVISION/0!		
ASW-Sb2(O2(CH2)2)3 -2b	2	0.00455	0.000000	6.49	6.18	0	0.000			#DIVISION/0!		
ASW-Sb2(O2(CH2)2)3 -2c	2	0.00510	0.000000	6.49	6.18	0	0.000	0.000	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
ASW-Sb2(O2(CH2)2)3 -Blank24	24	0.00000	0.000000	6.49	5.60	0	x			x		
ASW-Sb2(O2(CH2)2)3 -24a	24	0.00461	0.000000	6.49	5.68	0	0.000			#DIVISION/0!		
ASW-Sb2(O2(CH2)2)3 -24b	24	0.00472	0.000000	6.49	5.61	0	0.000			#DIVISION/0!		
ASW-Sb2(O2(CH2)2)3 -24c	24	0.00450	0.000000	6.49	5.60	0	0.000	0.000	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00001		
0.00001		
0.00000	0.00001	0.00000
x		
0.00003		
0.00002		
0.00001	0.00002	0.00001
x		
0.00000		
0.00000		
0.00000	0.0000000	0.00000
x		
0.00000		
0.00000		
0.00000	0.00000	0.00000

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]		Amount Sb transformed			
1.7848084	98.215					
2.2301194	97.770					
0.8188084	99.181	98.389	0.7214865	1.6112454	0.7214865	
4.9213005	95.079					
3.9525405	96.047					
1.7352127	98.265	96.464	1.6333092	3.5363512	1.6333092	
0	100.000					
0	100.000					
0	100.000	100.000	0	0	0	
0	100.000					
0	100.000					
0	100.000	100.000	0	0	0	

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	GF-AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
PBS-SbS3-Blank2	2	0.00000	0.000000	7.41	7.35	0.052	x			x		
PBS-SbS3- 2a	2	0.00503	0.001821	7.41	7.37	1.021	0.969			0.00133		
PBS-SbS3 -2b	2	0.00485	0.001756	7.41	7.35	0.843	0.791			0.00113		
PBS-SbS3 -2c	2	0.00470	0.001702	7.41	7.35	0.942	0.890	0.883	0.089	0.00131	0.00125	0.00011
PBS-Sb S3-Blank24	24	0.00000	0.000000	7.30	7.33	0	x			x		
PBS-SbS3 -24a	24	0.00457	0.001655	7.30	7.34	4.674	4.674			0.00059		
PBS-SbS3 -24b	24	0.00549	0.001988	7.30	7.34	4.288	4.288			0.00045		
PBS-SbS3 -24c	24	0.00523	0.001894	7.30	7.33	5.389	5.389	4.784	0.559	0.00059	0.00054	0.00008
PBS-Sb2(O2(CH2)2)3-Blank2	2	0.00000	0.000000	7.41	7.33	0	x			x		
PBS-Sb2(O2(CH2)2)3 -2a	2	0.00493	0.000000	7.41	7.36	0	0.000			#DIVISION/0!		
PBS-Sb2(O2(CH2)2)3 -2b	2	0.00458	0.000000	7.41	7.34	0	0.000			#DIVISION/0!		
PBS-Sb2(O2(CH2)2)3 -2c	2	0.00470	0.000000	7.41	7.34	0	0.000	0.000	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
PBS-Sb2(O2(CH2)2)3 -Blank24	24	0.00000	0.000000	7.30	7.32	0	x			x		
PBS-Sb2(O2(CH2)2)3 -24a	24	0.00508	0.000000	7.30	7.35	0	0.000			#DIVISION/0!		
PBS-Sb2(O2(CH2)2)3 -24b	24	0.00453	0.000000	7.30	7.33	0	0.000			#DIVISION/0!		
PBS-Sb2(O2(CH2)2)3 -24c	24	0.00480	0.000000	7.30	7.33	0	0.000	0.000	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00001		
0.00001		
0.00001	0.00001	0.00000
x		
0.00005		
0.00004		
0.00005	0.00005	0.00001
x		
0.00000		
0.00000		
0.00000	0.0000000	0.00000
x		
0.00000		
0.00000		
0.00000	0.00000	0.00000

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]		Amount Sb transformed			
1.7243478	98.276					
1.4598352	98.540					
1.6949669	98.305	98.374	0.1449811	1.6263833	0.1449811	
9.1546465	90.845					
6.9911964	93.009					
9.2230713	90.777	91.544	1.2692822	8.4563048	1.2692822	
0	100.000					
0	100.000					
0	100.000	100.000	0	0	0	
0	100.000					
0	100.000					
0	100.000	100.000	0	0	0	

Sample ID	Exposure time [h]	Sample mass [g]	Sample surface area [m2]	Initial pH	Final pH	GF-AAS analysis conc Sb [mg/L]	conc Sb [mg/L] corrected with blank	Mean Sb conc [mg/L]	Std Sb conc	Sb release rate [mg/cm2/hour]	Mean release rate Sb [mg/cm2/hour]	Std Sb release rate
GMB-Sb-Blank2	2	0.00000	0.000000	7.42	7.71	0	x			x		
GMB-SbS3- 2a	2	0.00470	0.001702	7.42	7.82	0.2315	0.232			0.00034		
GMB-SbS3 -2b	2	0.00493	0.001785	7.42	7.74	0.4967	0.497			0.00070		
GMB-SbS3 -2c	2	0.00538	0.001948	7.42	7.70	0.7276	0.728	0.485	0.248	0.00093	0.00066	0.00030
GMB-SbS3 -Blank24	24	0.00000	0.000000	7.42	7.85	0	x			x		
GMB-SbS3 -24a	24	0.00494	0.001789	7.42	7.87	1.579	1.579			0.00018		
GMB-SbS3 -24b	24	0.00494	0.001789	7.42	8.29	2.071	2.071			0.00024		
GMB-SbS3 -24c	24	0.00470	0.001702	7.42	8.38	2.626	2.626	2.092	0.524	0.00032	0.00025	0.00007
GMB-Sb2(O2(CH2)2)3-Blank2	2	0.00000	0.000000	7.42	7.69	0.00529	x			x		
GMB-Sb2(O2(CH2)2)3 -2a	2	0.00453	0.000000	7.42	7.87	0.004669	-0.001			#DIVISION/0!		
GMB-Sb2(O2(CH2)2)3 -2b	2	0.00481	0.000000	7.42	7.75	0.006235	0.001			#DIVISION/0!		
GMB-Sb2(O2(CH2)2)3 -2c	2	0.00502	0.000000	7.42	7.72	0	-0.005	-0.002	0.003	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
GMB-Sb2(O2(CH2)2)3 -Blank24	24	0.00000	0.000000	7.42	8.61	0.005727	x			x		
GMB-Sb2(O2(CH2)2)3 -24a	24	0.00472	0.000000	7.42	8.16	0	-0.006			#DIVISION/0!		
GMB-Sb2(O2(CH2)2)3 -24b	24	0.00448	0.000000	7.42	7.97	0	-0.006			#DIVISION/0!		
GMB-Sb2(O2(CH2)2)3 -24c	24	0.00456	0.000000	7.42	8.45	0	-0.006	-0.006	0.000	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!

Sb released/amount loaded [mg/mg]	Mean Sb rel./am.load [mg/mg]	Std Sb rel./am.load
x		
0.00000		
0.00001		
0.00001	0.00000	0.00000
x		
0.00002		
0.00002		
0.00003	0.00002	0.00001
x		
0.00000		
0.00000		
0.00000	0.0000000	0.00000
x		
0.00000		
0.00000		
0.00000	0.00000	0.00000

Amount Sb transformed [mass%]	Amount Sb not transformed [mass%]		Amount Sb transformed			
0.4408818	99.559					
0.9018126	99.098					
1.210541	98.789	99.149	0.3873296	0.8510785	0.3873296	
2.8610421	97.139					
3.7525132	96.247					
5.0011046	94.999	96.128	1.0749859	3.8715533	1.0749859	
-0.0011925	100.001					
0.0017091	99.998					
-0.0091669	100.009	100.003	0.0056317	-0.0028834	0.0056317	
-0.0105549	100.011					
-0.0111203	100.011					
-0.0109253	100.011	100.011	0.0002872	-0.0108668	0.0002872	

Limits of detection/quantification = 3*SD of blank of respective matrix and exposure time:

Average LOD:
GST (AAS): 0.14 mg/L
ALF (AAS): 0.12 mg/L
ASW (AAS): 0.24 mg/L
PBS (AAS): 0.11 mg/L
GMB (AAS): 0.28 mg/L

ALF(GF-AAS): 0.61 µg/L
ASW (GF-AAS): 2.06 µg/L
PBS (GF-AAS): 2.07 µg/L
GMB (GF-AAS): 11.53 µg/L

Average LOQ:
GST (AAS): 0.47 mg/L
ALF (AAS): 0.40 mg/L
ASW (AAS): 0.80 mg/L
PBS (AAS): 0.37 mg/L
GMB (AAS): 0.93 mg/L

ALF (GF-AAS): 2.03 µg/L
ASW (GF-AAS): 6.86 µg/L
PBS (GF-AAS): 6.89 µg/L
GMB (GF-AAS): 38.4 µg/L

KANTHAL HEATINGSYSTEMS

Utförare
Michael Lundberg

Mottagare
Yolanda Hedberg Dipl.-Ing.

PROTOKOLL PARTIKELANALYS

Datum 2009-11-11 Reg.Nr 1

Kopia för
Anders Magnusson

Provid	Yta [m^2/g] 5 punkter	d10 [µm]	d50 [µm]	d90 [µm]	Densitet [g/cm^3]	Anm	
$Sb\ S_3$	**0,3621**					"	**0,3335**
Sb_2	.....					"	.....

Analysdatum	Analysansvarig
2009-11-11	Michael Lundberg

Analysinstrumenten ingår i Kanthal ISO9001 och genomgår årligen service och kalibrering mot erkända referenser

	Analysmetod	Media	Analys Instrument
	Laserdiffraktion	Air, $H_2O_{autoklaverat}$	Malvern 3000
	Sedimentation, röntgenabsorbtion	Spec, $H_2O_{autoklaverat}$	Micromeretics Sedigraph 5100

KANTHAL HEATINGSYSTEMS

Utförare
Michael Lundberg

PROTOKOLL PARTIKELANALYS

Datum 2009-11-11 Reg.Nr 2

×	Kväveadsorbtion, BET, flerpunkt	N_2 instrument	Micromeretics Gemini V
	Pyknometri	Ar instrument	Micromeritics Accupyc

	Sb2(O2(CH2)2)3	Sb2(O2(CH2)2)3	Sb2(O2(CH2)2)3	Average	SD	Sb2S3	Sb2S3	Sb2S3	Average	SD
0.01	0	0	0	0	0	0	0	0	0	0
0.011482	0	0	0	0	0	0	0	0	0	0
0.013183	0	0	0	0	0	0	0	0	0	0
0.015136	0	0	0	0	0	0	0	0	0	0
0.017378	0	0	0	0	0	0	0	0	0	0
0.019953	0	0	0	0	0	0	0	0	0	0
0.022909	0	0	0	0	0	0	0	0	0	0
0.026303	0	0	0	0	0	0	0	0	0	0
0.0302	0	0	0	0	0	0	0	0	0	0
0.034674	0	0	0	0	0	0	0	0	0	0
0.039811	0	0	0	0	0	0	0	0	0	0
0.045709	0	0	0	0	0	0	0	0	0	0
0.052481	0	0	0	0	0	0	0	0	0	0
0.060256	0	0	0	0	0	0	0	0	0	0
0.069183	0	0	0	0	0	0	0	0	0	0
0.079433	0	0	0	0	0	0	0	0	0	0
0.091201	0	0	0	0	0	0	0	0	0	0
0.104713	0	0	0	0	0	0	0	0	0	0
0.120226	0	0	0	0	0	0	0	0	0	0
0.138038	0	0	0	0	0	0	0	0	0	0
0.158489	0	0	0	0	0	0	0	0	0	0
0.18197	0	0	0	0	0	0	0	0	0	0
0.20893	0	0	0	0	0	0	0	0	0	0
0.239883	0	0	0	0	0	0	0	0	0	0
0.275423	0	0	0	0	0	0	0	0	0	0
0.316228	0	0	0	0	0	0	0	0	0	0
0.363078	0	0	0	0	0	0	0	0	0	0
0.416869	0	0	0	0	0	0	0	0	0	0
0.47863	0	0	0	0	0	0	0	0	0	0
0.549541	0	0	0	0	0	0	0	0	0	0
0.630957	0	0	0	0	0	0	0	0	0	0
0.724436	0	0	0	0	0	0	0	0	0	0
0.831764	0	0	0	0	0	0	0	0	0	0
0.954993	0	0	0	0	0	0.022585	0.026401	0.029509	0.026165	0.003468
1.096478	0	0	0	0	0	0.080918	0.093721	0.104004	0.092881	0.011566
1.258925	0	0	0	0	0	0.138759	0.156091	0.16923	0.154693	0.015284
1.44544	0	0	0	0	0	0.210234	0.232701	0.249085	0.230673	0.019505
1.659587	0	0	0	0	0	0.306642	0.335014	0.354931	0.332196	0.024268
1.905461	0	0	0	0	0	0.425521	0.460249	0.483829	0.456533	0.029331
2.187762	0	0	0	0	0	0.569105	0.610688	0.638143	0.605979	0.034759
2.511886	0	0	0	0	0	0.737222	0.786196	0.817886	0.780435	0.040639
2.884031	0	0	0	0	0	0.928871	0.985937	1.022512	0.979107	0.047193
3.311311	0	0	0.039007	0.013002	0.022521	1.143289	1.2095	1.252098	1.201629	0.05483
3.801894	0	0	0.075673	0.025224	0.04369	1.376507	1.453258	1.503547	1.444437	0.063978
4.365158	0	0.024466	0.084066	0.036177	0.043239	1.628322	1.71754	1.77786	1.707907	0.075233
5.011872	0.017303	0.074129	0.096998	0.06281	0.041036	1.892251	1.99593	2.068883	1.985688	0.08876
5.754399	0.070493	0.082516	0.118372	0.09046	0.024909	2.169779	2.290031	2.378431	2.279414	0.10473
6.606934	0.079229	0.101705	0.146386	0.109107	0.034185	2.45201	2.589874	2.695541	2.579142	0.12212
7.585776	0.098773	0.129541	0.186055	0.138123	0.044269	2.741976	2.897411	3.021015	2.886801	0.139822
8.709636	0.124592	0.165716	0.238067	0.176125	0.057449	3.02761	3.197898	3.337227	3.187578	0.155066
10	0.15815	0.213102	0.305156	0.225469	0.074279	3.312385	3.49243	3.642606	3.482474	0.165335
11.48154	0.19931	0.270113	0.384949	0.284791	0.093686	3.58195	3.763468	3.91608	3.753833	0.167273
13.18257	0.248858	0.336796	0.47733	0.354328	0.115241	3.839869	4.012181	4.156346	4.002799	0.158447

15.13561	0.304149	0.408731	0.57621	0.429697	0.137237	4.077048	4.228322	4.352328	4.219233	0.137865
17.37801	0.363969	0.483533	0.67874	0.508747	0.158893	4.300246	4.418253	4.510987	4.409829	0.105623
19.95262	0.424052	0.555361	0.777747	0.58572	0.178791	4.508057	4.582831	4.636872	4.57592	0.064685
22.90868	0.482565	0.621982	0.871406	0.658651	0.196997	4.706421	4.730243	4.74208	4.726248	0.018162
26.30268	0.537018	0.681228	0.958075	0.72544	0.213982	4.890402	4.860093	4.831587	4.860694	0.029412
30.19952	0.588759	0.736342	1.043293	0.789465	0.231877	5.052286	4.96834	4.904788	4.975138	0.073984
34.67369	0.641561	0.79429	1.136657	0.857503	0.253529	5.172466	5.039866	4.948875	5.053736	0.112439
39.81072	0.703664	0.867613	1.254091	0.941789	0.282611	5.226213	5.053293	4.94243	5.073979	0.143018
45.70882	0.78632	0.972103	1.41428	1.057568	0.322586	5.185183	4.983074	4.858591	5.008949	0.164826
52.48075	0.901957	1.123499	1.634495	1.219984	0.375679	5.023968	4.805469	4.671757	4.833731	0.177798
60.25596	1.062911	1.33505	1.928168	1.442043	0.44244	4.724566	4.502616	4.362609	4.52993	0.182518
69.1831	1.275428	1.60918	2.29464	1.726416	0.519621	4.286318	4.072513	3.928951	4.095927	0.17983
79.43282	1.543742	1.942627	2.727525	2.071298	0.60229	3.71971	3.522729	3.378493	3.540311	0.171287
91.20108	1.858055	2.312035	3.196803	2.455631	0.680828	3.066286	2.892299	2.753105	2.903897	0.156912
104.7129	2.211408	2.695845	3.677459	2.861571	0.746944	2.384033	2.233551	2.099085	2.23889	0.142549
120.2264	2.57816	3.052651	4.121286	3.250699	0.790397	1.707978	1.585149	1.462622	1.58525	0.122678
138.0384	2.945856	3.358101	4.501325	3.601761	0.805853	1.045936	0.936981	0.803257	0.928725	0.12155
158.4893	3.283251	3.579328	4.776958	3.879846	0.7909	0.337076	0.277859	0.192818	0.269251	0.072513
181.9701	3.582867	3.712429	4.937229	4.077508	0.747353	0	0	0	0	0
208.9296	3.826859	3.762561	4.974106	4.187842	0.681683	0	0	0	0	0
239.8833	4.026384	3.762499	4.903376	4.230753	0.597265	0	0	0	0	0
275.4229	4.192666	3.759739	4.755028	4.235811	0.499045	0	0	0	0	0
316.2278	4.354442	3.808666	4.561489	4.241532	0.388905	0	0	0	0	0
363.0781	4.53425	3.953399	4.359499	4.282383	0.298005	0	0	0	0	0
416.8694	4.753926	4.217106	4.169771	4.380268	0.324462	0	0	0	0	0
478.6301	5.014104	4.581047	4.003483	4.532878	0.507029	0	0	0	0	0
549.5409	5.29852	4.992661	3.85102	4.714067	0.762906	0	0	0	0	0
630.9573	5.560334	5.360253	3.68988	4.870156	1.027033	0	0	0	0	0
724.436	5.731783	5.581058	3.48691	4.93325	1.254833	0	0	0	0	0
831.7638	5.732185	5.562575	3.211331	4.835364	1.409008	0	0	0	0	0
954.9926	5.490256	5.251926	2.846909	4.529697	1.462201	0	0	0	0	0
1096.478	4.960632	4.645483	2.394646	4.000254	1.399397	0	0	0	0	0
1258.925	4.145803	3.794111	1.880439	3.273451	1.219132	0	0	0	0	0
1445.44	3.111004	2.788911	1.340994	2.413636	0.942792	0	0	0	0	0
1659.587	1.772859	1.567793	0.739692	1.360115	0.546997	0	0	0	0	0
1905.461	0.421595	0.370196	0.172979	0.32159	0.131242	0	0	0	0	0
2187.762	0	0	0	0	0	0	0	0	0	0
2511.886	0	0	0	0	0	0	0	0	0	0
2884.032	0	0	0	0	0	0	0	0	0	0
3311.311	0	0	0	0	0	0	0	0	0	0
3801.894	0	0	0	0	0	0	0	0	0	0
4365.158	0	0	0	0	0	0	0	0	0	0
5011.872	0	0	0	0	0	0	0	0	0	0
5754.399	0	0	0	0	0	0	0	0	0	0
6606.934	0	0	0	0	0	0	0	0	0	0
7585.776	0	0	0	0	0	0	0	0	0	0
8709.636	0	0	0	0	0	0	0	0	0	0
10000										

MATERIAL SAFETY DATA SHEET

(EU commisson regulation N°. 1907/2006/EC)

Antimony powder

Version: 4.0		Revision date:	June 2007
		Printing date :	3/02/2009

1. SUBTANCE/PREPARATION AND COMPANY IDENTIFICATION

1.1 Information about the substance/preparation

Antimony powder

Trade-name:	Antimony-metal fine
Productcode:	0152xx
CAS-Reg.Nr:	7440-36-0
EINECS-Nr:	231-146-5

1.2 Identification of the company

Campine nv
Nijverheidsstraat 2
2340 Beerse (Belgium)
www.campine.be
Tel. +32 (0)14 60 15 11
Fax +32 (0)14 61 29 85

1.3 Emergency contact +1 703 527 3887 (Chemtrec)

1.4 Author: hild.vandemierop@campine.be

2. HAZARDS IDENTIFICATION

Harmful if swallowed or inhaled. Causes irritation to skin, eyes, respiratory and gastrointestinal tracts.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Danger Symbol:	Xn
Risk Phrase:	R20/22
Antimony content	> 99%
max % Arsenic content:	0,1
max % Lead content:	0,8

4. FIRST - AID MEASURES

4.1 After contact with skin

Remove clothing.
Wash with plenty of soap and water.
Seek medical attention.

4.2 After contact with eye

Flush eyes thoroughly with water.
Seek medical attention.

4.3 After inhalation:

Move affected person to fresh air.
Seek medical attention.

4.4 After ingestion:
Drink a quart of water. Never give anything by mouth to an unconscious person.
Seek medical attention.

5. FIRE - FIGHTING MEASURES

5.1 Suitable extinguishing media:
Dry sand, graphite powder, dry sodium chloride based extinguishers, G-1 or Met-L-X powder

5.2 Unsuitable extinguishing media:
Water, Foam, CO2

5.3 Exposure hazards:
No special hazards.

5.4 Protective equipment for fire-fighters:
Use self-contained breathing apparatus.

6 . ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions:
Do not inhale dust. Avoid contact with skin, eyes and clothing.

6.2 Environmental precautions:
Dispose of material in accordance with all Federal, state and local air- and waterpollution and solid waste regulations.Burial in an approved hazardous waste landfill is recommended.

6.3 Methods for cleaning up/taking up:
Vacuum or sweep all spilled material without creating dust.
Place in closed plastic bags for disposal and treat material as described in 6.2 and 13.

7. HANDLING AND STORAGE

7.1 Advice on safe handling:
Avoid dust formation. Avoid contact with heat, sparks and flames.
Wear gloves, long sleeved shirt and safety glasses. Use with adequate ventilation and suitable particle filter mask. Do not eat, drink or smoke at the workplace.

7.2 Requirements for storage rooms and vessels:
Store in well ventilated dry area away from incompatible substances.
Do not store in open inadequate mislabled packaging.
Dusts or fumes may form explosive mixtures in air.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 General protective measures

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

8.2 Exposure control limits

ACGIH TLV-TWA value Sb : 0,5 mg/m³

Inhalation can cause irritation to the respiratory tract and mucous membranes in case of over-exposure.

8.3 Respiratory protection

Suitable particle filter mask, type EN149:2001, FFP2(S) is recommended.

8.4 Hand protection

Wear chemical resistant gloves (EN 374:1994). Observe the information of the glove manufacturers on permeability and breakthrough times and other workplace requirements.

8.5 Eye protection

Wear safety glasses. NBN EN 166:2002 is recommended.

8.6 Skin protection

Wear overalls and closed footwear.

9. PHYSICAL AND CHEMICAL PROPERTIES

Melting point:	630 °C	Appearance:	silver powder	
Boiling point:(sublim.)	1637°C	Odour:	none	
Viscosity:	not available	Colour:	silver white	
Solubility in water (20°C):	insoluble	Density (20°C):	6,68	g/cm³
Vapour pressure (20°C):	not available	Bulk density (20°C):	not available	
		Vapor density:	not available	
		pH - value:	not available	

10. STABILITY AND REACTIVITY

10.1 Thermal decomposition

Stable at room temperature in closed containers under normal storage and handling conditions.

10.2 Conditions to avoid

High concentrations of powders. Keep sparks, flames and other sources of ignition away that could create a potential fire or explosion hazard.

10.3 Material to avoid

Reaction with Hydrogen releases antimonyhydride (Stibine).

Can react violently with halogens (such as chlorine and bromine), oxidizers (such as peroxides, perchlorates, permanganates, chlorates and nitrates), BrF3, BrN3, HClO3, ClF3, nitric acid...

10.4 Hazard decomposition products

Stibine fumes.

MATERIAL SAFETY DATA SHEET

(EU commisson regulation N°. 1907/2006/EC)

Antimony powder

Version: 4.0	Revision date:	June 2007
	Printing date :	3/02/2009

11. TOXICOLOGICAL INFORMATION

Acute oral toxicity: LD50 (Rat-oral): 7000 mg/kg

Skin irritation : Increases by perspiration or moisture.
Prolonged or frequent contact with the skin can result in irritation.

Eye irritation: Is possible by overexposure.

12. ECOLOGICAL INFORMATION

Not available

13. DISPOSAL CONSIDERATIONS

Product disposal.
The product must be destroyed following the national and local legislative provisions, by a legally approved receiver of dangerous wastes.

Packing disposal.
The used packing is only meant for packing this product.
After usage empty the packing completely.

14. TRANSPORT INFORMATION

RID/ADR: Antimony powder
Danger Class: 6.1,PG III
UN number 2871

IMDG-Code: Antimony powder
Danger Class: 6.1
UN number 2871
Packing group III

IATA : Antimony powder
Danger Class: 6.1
UN number 2871
Packing group III : packing instruction 619

15. REGULATORY INFORMATION

Labelling in accordance with EC-directives 67/548/EC and 1999/45/EC and amendments.
Packaging and labelling.
Symbol and indication of danger.

Xn: Harmful
R20/22: Harmful by inhalation and if swallowed
S22: Do not breathe dust
S36: Wear suitable protective clothing

Test Substance Data Sheet

Antimony (metal powder)

Substance Information:

Substance name:	Antimony (metal powder)
I2a internal code:	i2a1
CAS-No.:	7440-36-0
Molecular weight:	121.75 g/mol
Appearance:	grey powder
Purity:	99.79 %
Chemical Analysis:	see attached Certificate of Analysis
Producer:	Campine Nijverheidsstraat 2 2340 Beerse Belgium
Batch no.:	41081
Production date:	4 December 2001
Homogenisation date:	23. January 2009
Stability:	23. January 2010
Storage:	ambient temp, dry, well ventilated place

Physico-chemical data:

Melting point:	630 °C
Boiling point:	1635 °C
Water solubility:	"insoluble"
Rel. density:	6,6-6,7 g/cm³

Is the sample sent to EBRC from the same lot number as the sample sent to CanMet? YES/ NO

Date :.....28 January 2009.....

Name:.....S'MANS.....FREDDY.....

Signature: .....

Please sign the document and send it back to i2a fax number: +32 (0) 2 762 82 29

campine nv

CERTIFICATE OF ANALYSIS

Inspection certificate DIN 50049/3.1.B (EN 10204/3.1.B)

CONTRACT INFORMATION

Customer:
Contract no.:
Quality: Campine Antimony metal 99.00% - Fine
Article no.: 015220
Batch no.: 41081

TEST RESULTS

These values have been taken from measurements made on a production run where this batch is a part of.

Parameter	Unit	Testmethod	Min.	Max.	Actual
Sb	%	Sparc ES	99,00		99,79
As	%	Sparc ES	0	0,10	0,07
Pb	%	Sparc ES	0	0,80	0,13
Cu	%	Sparc ES			0,003
Bi	%	Sparc ES			0,002
Cd	%	Sparc ES			0,003
S	%	Sparc ES			0,018
Sn	%	Sparc ES			0,009
Zn	%	Sparc ES			0,002
Ni	%	Sparc ES			0,002
Fe	%	Sparc ES			0,003
Se	ppm	Sparc ES			1
Na	ppm	Sparc ES			7
Ag	g/T	Sparc ES			30
Au	g/t	Sparc ES			0
Sieve refusal 63 µm	%	DIN 53 734		5	1,83
Sieve refusal 125 µm	%	DIN 53 734		1,5	0,44

We certify that this product conforms to the relevant customer product specification :
0152xx Rev.00/19-05-1995

28/01/2009

Freddy Smans
quality assurance supervisor

Doc. 10.5-4-03/L

SAFETY DATA SHEET

Sodium Hexahydroxoantimonate

1. Identification of the substance/preparation and of the company/undertaking

Identification of the substance or preparation

Product name : **Sodium Hexahydroxoantimonate**

Use of the substance/preparation : Industrial applications: Manufacture of glass.

Company/undertaking identification

Supplier or representative of supplier : Umicore Precious Metals Refining

A. Greinerstraat 14
2660 Hoboken
BE Belgium
Phone : +32 38217111

e-mail address of person responsible for this SDS : info.ipds@umicore.com

Emergency telephone number : Carechem24 : +32 3 213 15 70

Date of issue : **6/11/2008.**

Date of previous issue : **5/09/2008.**

2 . Hazards identification

The product is classified as dangerous according to Directive 1999/45/EC and its amendments.

Classification : Xn; R20/22
N; R51/53

Human health hazards : Harmful by inhalation and if swallowed.

Environmental hazards : Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

See section 11 for more detailed information on health effects and symptoms.

3 . Composition/information on ingredients

Substance/preparation : Substance

Ingredient name	CAS number	%	EC number	Classification
sodium hexahydroxoantimonate **See section 16 for the full text of the R-phrases declared above**	33908-66-6	>99.5	251-735-0	Xn; R20/22 N; R51/53

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in section 8.

4. First aid measures

First aid measures

Inhalation : If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion : Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If potentially dangerous quantities of this material have been swallowed, call a physician immediately.

Skin contact : In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation occurs.

Eye contact : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Notes to physician : Not available.

See section 11 for more detailed information on health effects and symptoms.

5. Fire-fighting measures

Extinguishing media

Suitable : Use an extinguishing agent suitable for the surrounding fire.

Not suitable : None known.

Special exposure hazards : No specific fire or explosion hazard.

Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. This material is toxic to aquatic organisms. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

See section 11 for more detailed information on health effects and symptoms.

Hazardous combustion products : Decomposition products may include the following materials:
metal oxide/oxides

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Remarks : Stibine may evolve under reducing conditions (such as contact with strong acids or alkalis in the presence of a metal) or in the presence of nascent hydrogen. Stibine is a colourless, bad smelling gas, highly toxic similar to arsine.

6. Accidental release measures

Personal precautions : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see section 8).

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods for cleaning up : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

Note: see section 8 for personal protective equipment and section 13 for waste disposal.

7. Handling and storage

Handling : Do not ingest. Avoid contact of spilled material and runoff with soil and surface waterways. Avoid exposure. Use suitable protective equipment (section 8). Avoid generation of dust.

Storage : Keep container tightly closed. Keep container in a well-ventilated area.
Stibine may evolve under reducing conditions (such as contact with strong acids or alkalis in the presence of a metal) or in the presence of nascent hydrogen. Stibine is a colourless, bad smelling gas, highly toxic similar to arsine.

Additional information : Stibine may evolve under reducing conditions (such as contact with strong acids or alkalis in the presence of a metal) or in the presence of nascent hydrogen.

Packaging materials

Recommended : Use original container.

8. Exposure controls/personal protection

Ingredient name	Occupational exposure limits
sodium hexahydroxoantimonate	**Lijst Grenswaarden / Valeurs Limites (Belgium, 3/2006). Notes: As Sb** TWA: 0,5 mg/m³, (As Sb) 8 hour(s).

Exposure controls

Occupational exposure controls : Use only with adequate ventilation. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
Recommended:
EU : disposable particulate mask or half-face mask type P3 (EN 140-143 or EN 149) .
Canada and USA : Wear NIOSH approved, properly fitted HEPA type respirator.

Skin protection / Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Recommended: Protective gloves should be worn under normal conditions of use. Use cotton or leather gloves. Rubber gloves.
Wash contaminated clothing before reusing.

Eye protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts.
Recommended:
EU : safety glasses with side-shields (EN 166) .
USA : Wear ANSI compliant safety glasses with side shields
Canada : Wear CSA approved safety glasses with side shields. Mono goggles provide better protection in dusty conditions.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Hygiene measures

General information : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Avoid contact with skin. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin.

9. Physical and chemical properties

General information

Appearance

Physical state : Solid. [Powder.]

Color : White.

Odor : Odorless.

Important health, safety and environmental information

pH : Not available.

Flash point : Not available.

Explosive properties : Non-explosive in the presence of the following materials or conditions: open flames, sparks and static discharge, heat, shocks and mechanical impacts, oxidizing materials, reducing materials, combustible materials, organic materials, metals, acids, alkalis and moisture.

Oxidizing properties : Not available.

Density : 3,25 g/cm^3

Solubility : Very slightly soluble in the following materials: cold water.

10. Stability and reactivity

Stability : The product is stable. Under normal conditions of storage and use, hazardous polymerization will not occur.

Materials to avoid : Reactive or incompatible with the following materials: acids and alkalis.
Stibine may evolve under reducing conditions (such as contact with strong acids or alkalis in the presence of a metal) or in the presence of nascent hydrogen.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

11. Toxicological information

Potential acute health effects

Inhalation : Harmful by inhalation.

Ingestion : Harmful if swallowed.

Skin contact : No known significant effects or critical hazards.

Eye contact : No known significant effects or critical hazards.

Acute toxicity

Ingredient name	Result	Dose	Route	Species
sodium hexahydroxoantimonate	LD50	>2000 mg/kg	Dermal	Rat
	LD50	>2000 mg/kg	Oral	Rat
	LC50	>5,6 ug/m³	Inhalation	Rat

Potential chronic health effects

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Reproductive toxicity : No known significant effects or critical hazards.

Additional information : **sodium hexahydroxoantimonate**: Repeated or prolonged contact with irritants may cause dermatitis.

Additional information : **sodium hexahydroxoantimonate**: Repeated or prolonged exposure to the substance can produce liver damage. Chemical pneumonitis. Irritating to eyes, respiratory system and skin.

12. Ecological information

Environmental effects : Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

13. Disposal considerations

Methods of disposal : The generation of waste should be avoided or minimized wherever possible. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

European waste catalogue (EWC) : Not available.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

14. Transport information

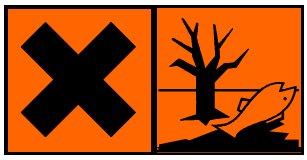
International transport regulations

Regulatory information	UN number	Proper shipping name	Class	Packing group	Label	Additional information
ADR/RID Classification	UN3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (sodium hexahydroxoantimonate)	9	III		Hazard identification number 90 Limited quantity LQ27 CEFIC Tremcard 90GM7-III
ADNR Classification	UN3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (sodium hexahydroxoantimonate)	9	III		-
IMO/IMDG Classification	Not regulated.	-	-	-		-
IATA Class	Not regulated.	-	-	-		-

15. Regulatory information

EU regulations

Hazard symbol or symbols :



Harmful, Dangerous for the environment

Risk Phrases : R20/22- Harmful by inhalation and if swallowed.
R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety phrases : S61- Avoid release to the environment. Refer to special instructions/safety data sheet.

Contains : sodium hexahydroxoantimonate 251-735-0

Product use : Industrial applications.

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II - Belgium

16. Other information

Full text of R-phrases referred to in sections 2 and 3 - Belgium : R20/22- Harmful by inhalation and if swallowed.
R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Full text of classifications referred to in sections 2 and 3 - Belgium : Xn - Harmful
N - Dangerous for the environment

History

Date of issue : **6/11/2008.**

Date of previous issue : **5/09/2008.**

Version : **7.01**

Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained in this Material Safety Data Sheet is accurate and reliable on presently available resources. However, neither the seller nor any of its subsidiaries assumes any responsibility or liability whatsoever for the accuracy or completeness of the information contained herein.
This Material Safety Data Sheet shall not constitute a guarantee for any specific product features. Final determination of suitability of this material is the sole responsibility of the user.
All materials may present unknown hazards and should be used and handled with caution and following reasonable safety procedures. Consequently the buyer assumes all risks in connection with the use and handling of this material.

Test Substance Data Sheet

Sodium hexahydroxoantimonate

Substance Information:

Substance name:	Sodium hexahydroxoantimonate
I2a internal code:	i2a10
CAS-No.:	33908-66-6
Molecular weight:	246.75 g/mol
Appearance:	White powder
Purity:	> 99.5 %
Chemical Analysis:	see attached Certificate of Analysis
Producer:	Umicore Precious Metals Refining Greinerstraat 14 2660 Hoboken, Belgium
Lot no.:	61049-070901J100000
Production date:	1/09/2007
Stability:	Stable at least three years after production, i.e. until September 2010
Storage:	Keep container tightly closed. Keep container in a well-ventilated area.

Physico-chemical data:

Melting point:	630 °C
Boiling point:	Not applicable
Water solubility:	Very slightly soluble in the following materials: cold water. [MSDS provided by the producer]
Rel. density:	3,25 g/cm3 (20 °C) [MSDS provided by the producer]

Is the sample sent to EBRC from the same lot number as the sample sent to CanMet? YES

Date : 21 January 2009

Name: E. Broekaert

Signature:

Please sign the document and send it back to i2a fax number: +32 (0) 2 762 82 29

umicore
Precious Metals
Refining

Technical Data Sheet

SODIUM ANTIMONATE

Principal uses	Fining and decolouring agent in glass In the manufacturing of some catalysts, colours, flame retardants	
Physical data	- Form	free flowing, dry whitish powder
	- Bulk density	1.7 – 2 t/m³
	- Average grain size	33 μ (sieved on 120 mesh)
	- Solubility	very slight (water 20°C)
Guaranteed analysis	Sb_2O_5	65.0 ± 0.85 wt.%
	Na_2O	13.0 ± 1.0 wt.%
	Fe_2O_3	≤ 0.055 wt.%
	PbO	≤ 0.11 wt.%
	As_2O_3	≤ 0.01 wt.%
	Cu	< 50 ppm
	Co	< 5 ppm
	Cr	< 25 ppm
	Ni	< 55 ppm
	SO_4	< 0.05 wt.%
	Cl -	≤ 0.05 wt.%
	F -	≤ 0.018 wt.%
	Mn	< 10 ppm
	V	< 10 ppm
	Sb_2O_3	≤ 0.05 wt.%
	Loss on ignition	21.9 ± 0.5 wt.% at 600°C – 1h
	Loss on drying	≤ 0.27 wt.% at 100°C – 4h

Packing

A) Standardised overseas packing

- packing unit: 2 one-way Big Bags (with interior polyethylene lining) stacked on a pallet (1m x 1m) and protected by a plastic shrink cover

Big Bag net weight: 1000 kg
Packing unit gross weight: 2035 kg
Packing unit net weight: 2000 kg
20' maritime containerload: 20 mt
(depending on maximum containerload in country of destination and / or customers requirement)

Umicore Precious Metals Refining
Commercial department

A. Greinerstraat 14
B - 2660 Hoboken
BELGIUM

Tel +32-3 821 74 80
Fax +32-3 821 78 07

e-mail: preciousmetals@umicore.com
website: www.preciousmetals.umicore.com
Version 200509

umicore
Precious Metals
Refining

B) European reusable multibag packing

- packing unit: 1 multibag
  - net weight: 1000 kg
  - gross weight: 1007 kg
- Charged on customers pallets if required (1 multibag per pallet).
- Truck loads: up to 24 mt (to customers requirement).
- With pallet-boxes (for 10-12 empty multibags) to return the empty multibags (and eventual pallets).

Additional information	Handling: dangerous substance – Avoid dust Material Safety Data Sheet (MSDS) available upon request

Umicore Precious Metals Refining
Commercial department

A. Greinerstraat 14
B - 2660 Hoboken
BELGIUM

Tel +32-3 821 74 80
Fax +32-3 821 78 07

e-mail: preciousmetals@umicore.com
website: www.preciousmetals.umicore.com
Version 200509

Antimony trisulfide

01.- IDENTIFICATION OF THE SUBSTANCE AND OF THE COMPANY:

1.1 Identification of the substance: **ANTIMONY TRISULFIDE**

1.2 Use of the substance: Used in alloys to increases the hardness and mechanical strength of lead.Vulcanizing rubber. Lesser extent in fireworks, ammunition primers and tracerbullets.

1.3 Company identification:

COPLOSA, S.A.
Sector E, Calle L, 10-20
Zona Franca Tel.: 93.335.01.49
08040-Barcelona Fax : 93.335.70.71
E-mail : m.portella@coplosa.es
a.borras@coplosa.es

1.4 Emergency phone call: **Toxicology Institute 91.562.04.20**

02.- HAZARD IDENTIFICATIONS:

On combustion forms toxic fumes of antimony trioxid and SO_2. Inhalation can cause irritation to the respiratory tract and mucous membranes. Causes eyes and skin irriration by overexposure. The substance may have carcinogenic effects category 3. Dangerous substance for environment.

03.- COMPOSITION/INFORMATION ON INGREDIENTS:

3.1 Chemical characterization:

Antimony trisulfide (Sb_2S_3): 99,5% (69% Sb , 23% S)
Arsenic: 0,2% max.
Lead : 0,5% max.

N° EINECS: 215-713-4
N° CAS : 1345-04-6

Symbols and R,S-phrases : X_n R20, R22, R40, S22, S36, S37
See Point 15 for more details

04.- FIRST AID MEASURES:

4.1 Inhalation:
Move affected person to fresh air.
Seek medical attention.

4.2 Skin contact:
Remove clothing.
Wash with plenty of soap and water.
Seek medical attention.

4.3 Eyes contact:
Wash thoroughly with clear water, in case of irritation seek medical attention.

4.4 Ingestion:
Rinse mouth with water.
Seek medical attention.
Call for your local toxicological emergency centre (in Spain Tel.: +34 91.562.04.20)

05.- FIRE FIGHTING MEASURES:

5.1 Suitable extinguishing media:
Dry chemical powder and foam. The product is not combustible and does not support the combustion.

5.2 Extinguishing media which must not be used:
Avoid contact with water and acids.

5.3 Exposure hazards :
On combustion forms toxic fumes of antimony trioxid.

5.4 Protective equipment for fire-fighters:
Wear self-contained breathing apparatus.

06.- ACCIDENT RELEASE MEASURES:

6.1 Personal precautions:
Do not breathe dust.
Avoid contact with skin, eyes and clothing.

6.2 Environmental precautions:
Dispose of material in accordance with all Federal, state and local air, water pollution and soil waste regulations.
Burial in an approved hazardous waste landfill is recommended.

6.3 Methods for cleaning up:
Vacuum or sweep all spilled material without creating dust and place in closed plastic bags for disposal.

07.- HANDLING AND STORAGE:

7.1 Handling:
Avoid dust formation. Wear gloves, long sleeved shirt and safety glasses. Do not eat, drink or smoke at the workplace.

7.2 Storage:
Store in well ventilated dry area. Do not store in open inadequate mislabelled packaging.

08.- EXPOSURE CONTROLS/PERSONAL PROTECTION:

8.1 General protective measures
Observe the usual precautions for handling chemicals.

8.2 Exposure limits values:
TLV-TWA Sb_2S_3(handling and use) expressed as Sb : 0.5 mg/m^3.

8.3 Respiratory protection:
Use local ventilation. Wear suitable particle filter mask, type EN149:2001; FFP3(S) is recommended

8.4 Hand protection:
Use appropriate gloves and resistant gloves, type EN 374:1994 is recommended.

8.5 Eyes protection:
Wear safety glasses, type NBN EN 166:2002 is recommended.

8.6 Skin protection:
Wear overalls and closed footwear.

8.7 Environment protection:
Avoid releasing to the environment.

09.- PHYSICAL AND CHEMICAL PROPERTIES:

9.1 Appearance and Physical state: grey-black powder

9.2 Odour: none

Melting point: 550 ºC

Boiling point: 1150 ºC

Relative density: 4,65g/cm^3 (20 ºC)

Solubility in water: <0,01 g/l(20 ºC)

10.- STABILITY AND REACTIVITY:

10.1 Conditions to avoid:
Contact with eater and acids.

10.2 Materials to avoid:
None

10.3 Hazardous decomposition products:
None.

11.- TOXICOLOGICAL INFORMATION:

11.1 LD $_{50}$ (Oral-Rat) >20.000 mg/kg

11.2 Skin irritation:
Increases by perspiration or moisture. Repeated or prolonged contact with skin may cause dermatitis, especially when exposed to fumes.

11.3 Eye irritation:
Is possible by overexposure.

11.4 Inhalation:
Repeated exposure with its aerosol may have effects on the respiratory tract and lungs, resulting in pneumoconiosis.

11.5 Other risks:
Carcinogen class 3.
During the bio-dynamics' chronic whole-body inhalation study, rats where exposed at 5 mg/m3 Sb2S3 dust in the air (1.5 mg/g lungcontent). In both cases was not any cancer considered.

12.- ECOLOGICAL INFORMATION:

12.1 Ecotoxicity:
EC50 - 48 h (Daphnia Magna): > 1000 mg/L (Janssen Biotech 6/8/1990)
LC50 -96 h (Brachydanio Rerio): > 1000 mg/L (Janssen Biotech 6/8/1990)

12.2 Persistence:
Antimony trisulfide is chemically and physically stable and with a low solubility in water, so it will persist in the environment.

12.4.Bioaccumulative potential :
Not applicable.

13.- DISPOSAL CONSIDERATIONS:

Incineration or landfill in accordance with local regulations.
Sweep spilled substance into containers; if appropriate, moisten first to prevent dusting. Carefully collect remainder, then remove to safe place.

14.- TRANSPORT INFORMATION:

Antimony trisulfide which do not contain more than 0.5% Arsenic are considered not-dangerous and do not need to be classified.

RID/ADR: not restricted

ADNR: not restricted

IATA: not restricted

IMDG-Code: not restricted

15.- REGULATORY INFORMATION:

Labeling in accordance with EC-directives 67/548/EC and 1999/45/EC (and amendments):



X_n Harmful

R20 Harmful by inhalation
R22 Harmful if swallowed
R40 Limited evidence of a carcinogenic effect
S22 Do not breathe dust
S36 Wear suitable protective clothing
S37 Wear suitable gloves

16.- OTHER INFORMATION:

Technical department is responsible of the safety data sheet.
Contact persons: Marco A. Portella Marti and Alfred Borras i Baldoma.

The information in this MSDS is base on the present state of our knowledge, in order to describe the product with regard to the safety requirements. It must not be considered as a product quality guarantee and it does not produce any legal contractual relationship. The consumer has the responsibility to ensure the suitability of the product, and that is properly used. We do not assume responsibility for any damage made by the use of this information.

This MSDS has been made and must be used just for this product. If the product is used as a component of other product, this information is not suitable.

Test Substance Data Sheet

Antimony trisulfide

Substance Information:

Substance name:	**Antimony trisulfide**
I2a internal code:	**i2a3**
CAS-No.:	**1345-04-6**
Molecular weight:	**217.958 g/mol**
Appearance:	**Grey-black powder**
Purity:	**99.50 %**
Chemical Analysis:	**see attached Certificate of Analysis**
Producer:	**Metaloxide, S.A.** **Avda. Diagonal, 416, 1º 1ª** **08037 Barcelona** **Spain**
Lot no.:	**V156/MO/SB-188/R-b**
Production date:	**22/12/2008**
Stability:	**The sample is valid till December 2010**
Storage:	**Store in well ventilated dry area. Do not store in open inadequate mislabelled packaging.**

Physico-chemical data:

Melting point:	**550ºC**	**[MSDS provided by the producer]**
Boiling point:	**1150ºC**	**[MSDS provided by the producer]**
Water solubility:	**< 0.01 g/L (20ºC)**	**[MSDS provided by the producer]**
Rel. density:	**4.65 g/cm3 (20ºC)**	**[MSDS provided by the producer]**

Is the sample sent to EBRC from the same lot number as the sample sent to CanMet? YES/ NO

Date : 2 of October of 2009

Name: Marco Portella Martí

Signature: .....

Please sign the document and send it back to i2a fax number: +32 (0) 2 762 82 29

METAL OXIDE, S.A.

TRISULFURO DE ANTIMONIO

FICHA TECNICA – TECNICAL DATA SHEET

Disponemos en nuestra planta de todas las instalaciones necesarias para producir cualquier tipo de **TRISULFURO DE ANTIMONIO**.

CARACTERÍSTICAS GENERALES DEL PRODUCTO

QUÍMICAS:	**Sb**	**69 % mini.**
	S	**23 % mini.**
	Pb	**0,5 % máx.**
	As	**0,2% máx.**

FÍSICAS: **Este material se sirve:**

Molido o micronizado

Según especificaciones de granulometría de nuestros clientes.

EMBALAJE: **Sacos de 25 kgs. sobre palet -como norma general-**

También existe la posibilidad de suministrar en cualquier otro tipo de embalaje, según necesidad del cliente.

(2001)

Material Safety Data Sheet

YOUNGSUN Chemicals Corp. Ltd.
16Fl., Jinlu Commecial Centra, Minzu Ave., Nanning, Guangxi, China 530022

1 PRODUCT AND COMPANY IDENTIFICATION

EMERGENCY PHONE No.:	+86-771-4015877 +86-13507712488 (Mr. Liu) +86-13507718630 (Mr. Zhu)
Chemical Family:	Antimony compound
Chemical Formula:	Sb2(02(CH2)2)3
Chemical Name:	Antimony tris-ethylene glycoxide
EPA Reg Num:	NA
Product Use:	Catalyst

2 COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient Name	CAS No.	Typical Wt.%	OSHA
Antimony tris-ethylene glycoxide	29736-75-2	>98	Y

3 HAZARDS IDENTIFICATION

Emergency Overview
White to off white crystals with no characteristic odor.

WARNING!
CAUSES EYE IRRITATION.

Potential Health Effects
Inhalation and skin contact are expected to be the primary routes of occupational exposure to this material. No specific information on the health effects of this material was found in a search of the scientific literature. However, upon contact this material may be irritating. Therefore, use of appropriate good industrial hygiene and safety precautions to control exposure is recommended when handling or using material.

4 FIRST AID MEASURES

IF IN EYES, immediately flush with plenty of water for at least 15 minutes. Get medical attention.

IN CASE OF CONTACT, immediately flush the area with plenty of water. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

IF SWALLOWED, induce vomiting immediately as directed by medical personnel. Get medical attention.
NEVER GIVE ANYTHING BY MOUTH TO UNCONSCIOUS PERSON.

IF INHALED, remove to fresh air. If breathing is difficult, get medical attention.

5 FIRE FIGHTING MEASURES

Fire and Explosive Properties

Auto-Ignition Temperature	NE	
Flash Point	NE	Flash Point Method
Flammable Limits-Upper	NE	
Lower	NE	

Extinguishing Media

Use water spray, carbon dioxide, foam or dry chemical.
Fire Fighting Instructions
Contain run-off from fire. Fire fighters and others who may be exposed to products of combustion should wear full fire fighting turn out gear (full Bunker Gear) and self-contained breathing apparatus (pressure demand NIOSH approved or equivalent). Fire fighting equipment should be thoroughly decontaminated after use.
Fire and Explosion Hazards
When burned, the following hazardous products of combustion can occur: Carbon monoxide and Carbon dioxide Antimony oxides. Avoid breathing fumes from fire exposed material.

6 ACCIDENTAL RELEASE MEASURES

In Case of Spill or Leak
Stop the leak, if possible. Ventilate the space involved. Contain, sweep up, place in container for disposal. Prevent waterway contamination. Construct a dike to prevent spreading. Collect run-off water and transfer to drums or tanks for later disposal. Consult s regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.
Clean up procedures:
Transfer to containers, in preparation for later disposal. Avoid generation of dusts. Remove from spill location. Flush area with water spray, collect rinsate.

7 HANDLING AND STORAGE

Handling
Avoid contact with eyes. Wash thoroughly after handling.
Storage
This material is not hazardous under normal storage conditions; however, material should be stored in closed containers, in a secure area to prevent container damage and subsequent spillage.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Investigate engineering techniques to reduce exposures. Provide ventilation if necessary to minimize exposures. If practical, use local mechanical exhaust ventilation at sources of air contamination such as open process equipment.
Eye/Face Protection
Where there is potential for eye contact, wear chemical goggles and have eye flushing equipment immediately available.
Skin Protection
Minimize skin contamination by following good industrial hygiene practice. Wearing rubber gloves is recommended. Wash hands and contaminated skin thoroughly after handling.
Respiratory Protection
Where airborne exposure is likely, use NIOSH approved N 95 particulate respirator. If exposures cannot be kept at minimum with engineering controls, use NIOSH approved respiratory protection equipment as noted above. Observe respirator use limitations specified by NIOSH or the manufacturer. For emergency and other conditions where there may be potential for significant exposure, use an approved full face positive-pressure, self–contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply. Respiratory protection programs must comply with 29 CFR §1910.134.

Airborne Exposure Guidelines for Ingredients

Exposure Limit		Value
Antimony tris-ethylene glycoxide		
ACGIH TWA	-Antimony compounds, as Sb	0.5 mg /m3
OSHA TWA PEL	-Antimony compounds, as Sb	0.5 mg /m3

-Only those components with exposure limits are printed in this section.
-Skin contact limits designated with a "Y" above have skin contact effect. Air sampling alone is insufficient to accurately quantitate exposure. Measures to prevent significant cutaneous absorption may be required.
-ACGIH Sensitizer designator with a value of "Y"above means that exposure to material may cause allergic reactions.
-WEEL-AIHA Sensitizer designator with a value of "Y" above means that exposure to this material may cause allergic skin reactions.

9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance / Odor	White to off white crystals with no characteristic odor.
pH	NE
Specific Gravity	NE
Vapor Pressure	NE
Vapor Density	NE
Melting Point	NA
Freezing Point	NA
Boiling Point	NA
Solubility In Water	Insoluble
Particle Size	NA
Percent Volatile	NE
Molecular Weight	423.67
Other Physical Data	NE

10 STABILITY AND REACTIVITY

Stability

This material is chemically stable under normal and anticipated storage and handling conditions.

Hazardous Polymerization

Does not occur.

Incompatibility

None known

Hazardous Decomposition Products

None Know

11 TOXICOLOGICAL INFORMATION

Toxicological Information
No data are available.

12 ECOLOGICAL IN FORMATION

Ecotoxicological Information	No data are available.
Chemical Fate Information	No data are available.

13 DISPOSAL CONSIDERATIONS

Waste Disposal
Recover, reclaim or recycle when practical. Dispose of in an approved landfill if allowed locally. Comply with federal, state, and local regulations. Dispose of in a permitted waste management facility if incineration or landfill is not practical.

14 TRANSPORT INFORMATION

DOT Name	Not regulated
DOT Technical Name	NA
DOT Hazard Class	NA
UN No.	NA
DOT Packing Group	PG NA
RQ	NE

15 REGULATORY INFORMATION

Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370)

Immediate (Acute) Health	Y	Fire	N
Delayed (Chronic) Health	N	Reactive	N
Sudden Release of Pressure	N		

Ingredient Related Regulatory Information:

SARA Reportable Quantities	CERCLA RQ	SARA TPQ
Antimony tris-ethylene glycoxide	NE	

SARA Title III, Section 313

This product does contain chemical(s) which are defined as toxic chemicals under and subject to the reporting requirements of, Section 313 of Title III of the Superfund ammendment and Reauthorization Act of 986 and 40 CFR Part 372. See Section 2
Antimony tris-ethylene glycoxide.

16 OTHER INFORMATION

Revision Information Revision Date 28 SEP 2002
Key: NE=Not Established NA=Not Applicable

YOUNGSUN Chemicals Corp. believes that information and recommendations contained herein (including data and statements) are accurate as the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN, The information provided herein relates only to the specific product designated and may not be valid where such product is used in combination with any other materials or in any process. Further, since the conditions and methods of use are beyond the control of YOUGNSUN Chemicals, YOUNGSUN Chemicals expressly disclaims any all liability as

to any results obtained or arising from any use of the product or reliance on such information.

Test Substance Data Sheet

Diantimony tris(ethylene glycolate)

Substance Information:

Substance name:	Diantimony tris(ethylene glycolate)
I2a internal code:	I2a5
CAS-No.:	29736-75-2
Molecular weight:	423.67 g/mol
Appearance:	White to off white crystals with no characteristic odor.
Purity:	99 %
Chemical Analysis:	see attached Certificate of Analysis
Producer:	Antraco Chemie-Handelsges.mbH Am Kiekenbusch 19 47269 Duisburg Germany
Lot no.:	ATG280502
Production date:	May 2008
Stability:	2 years
Storage:	This material is not hazardous under normal storage conditions; however, material should be stored in closed containers, in a secure area to prevent container damage and subsequent spillage.

Physico-chemical data:

Melting point:	Not Applicable	[MSDS provided by the producer]
Boiling point:	Not Applicable	[MSDS provided by the producer]
Water solubility:	"insoluble"	[MSDS provided by the producer]
Vapor Density:	Not Established	[MSDS provided by the producer]

Is the sample sent to EBRC from the same lot number as the sample sent to CanMet? YES/ NO

Date : 25.08.2009

Name: F. Hoffmann

Signature:

ANTRACO Chemie-Handelsgesellschaft mbH Gottschedstraße 29a/30 – 10247 Berlin

Please sign the document and send it back to i2a fax number: +32 (0) 2 762 82 29

Certificate of analysis

Supplier:	ANTRACO Chemie-Handelsges.mbH
Product:	Antimony triglycolate ATG- Diantimony tris(ethylene glycolate)
Quantity:	7 bags with different quantities
Packaging:	7 bags in a carton
Lot-Nr.:	ATG280502

Sb:	57,38 %
Arsenic:	14 ppm
Lead:	12 pm
Iron:	< 10 ppm
Through a 20 mesh screen:	98 %
Color:	
L	94,11
b	2,06
Loss on drying:	0,51 %