LEAD CAMES OF A STAINED GLASS WINDOW 52583 – PB SB ALLOY – UNKNOWN – SWITZERLAND

Artefact name Lead cames of a stained glass window 52583

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Url /artefacts/1266/

The object

Credit Museum zu Allerheiligen.

Fig. 1: Stained glass panel "Stokar" both sides,

Description and visual observation

Description of the artefact

Stained Glass panel from the 16th century representing prominent families of Schaffhausen (CH) through coat-of-arms. Object typically swiss called "Wappenscheiben".

The object is made of incolor and colored glass (light blue, pink and red) decored with grisaille, silver yellow stain and blue enamel. The glass parts are crimpted with lead-alloy cames. The cames are fastened to one another by welding points of a lead-tin alloy on both side of the panel (Fig. 1).

Type of artefact Supporting structure

Origin Schaffhausen, Schaffhausen, Switzerland

Recovering date Unknown

Chronology category Unknown

chronology tpq 1501 A.D.

chronology taq 1600 A.D.

Chronology comment 16th century AD

Burial conditions / environment	Outdoor to indoor atmosphere
Artefact location	Museum zu Allerheiligen, Schaffhausen
Owner	Museum zu Allerheiligen, Schaffhausen
Inv. number	52583
Recorded conservation data	Restauration in 2009 by Urs Wohlgemuth (Boniswil)

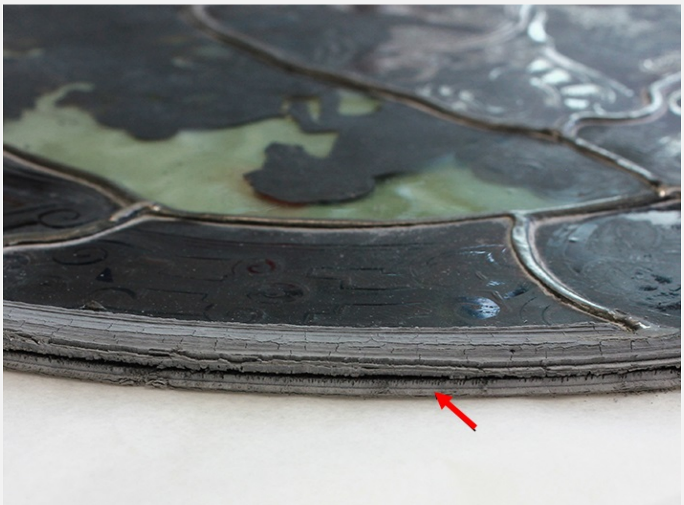
Complementary information

In 2009 two stained glass panels were placed in a showcase for a permanent exhibition, the lead cames were then in a good conservation condition. In 2018, the lead showed voluminous efflorescence of white, powdery corrosion products.

The environment of this showcase contained a high level of acetic acid. Lead being sensitive to organic acids, it corroded strongly. This is not new, but what is interesting here is that the two objects corroded in a very heterogeneous way. One lead came may be deformed and completely covered with bulky white efflorescences, and the one next to it shows no corrosion.

The "stokar" window, which is of interest here, was restored in 2008, just before it was put on display. The restoration consisted of replacing some of the lead cames. Thus, while the object is dated to the 16th century, the replaced cames were new when they entered the display case. In 2018, they were completely corroded. In comparison, the other stained glass panel, with older lead cames, was placed in the same display case at the same time. For this second panel, the cames are slightly corroded in 2018, but not as badly as those of the 'Stokar' panel. The metal chosen by the restorer reacted more strongly with the corrosive environment (the display case) than the historical metal.

Study area(s)



Credit Museum zu Allerheiligen.

Fig. 2: Corroded "modern" lead came on the "Stokar" stained glass panel with location of the sampling area,

Fig. 3: Detail of the corroded lead came,

Credit Museum zu Allerheiligen.

Binocular observation and representation of the corrosion structure

None.

MiCorr stratigraphy(ies) – Bi

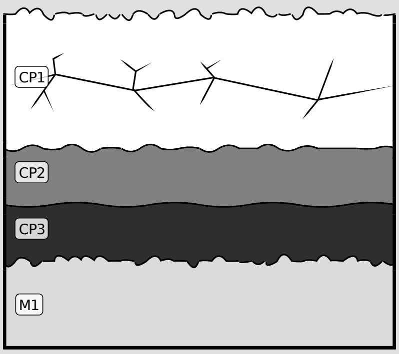
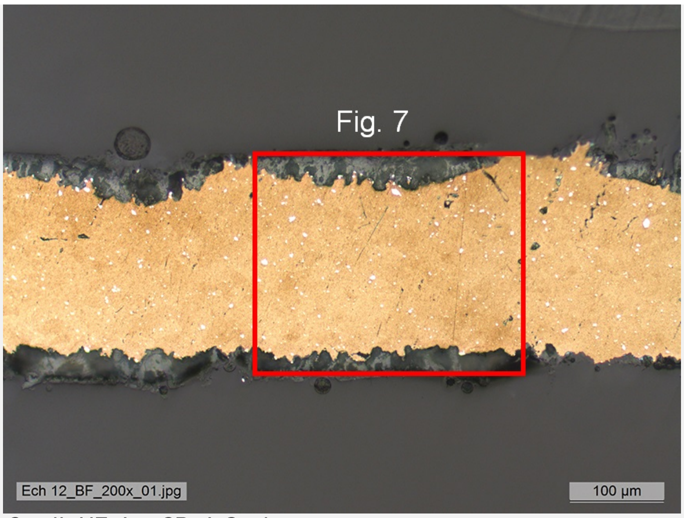


Fig. 4: Stratigraphic representation of the corrosion structure of the lead came observed macroscopically under binocular microscope using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, Credit HE-Arc CR, A.Gerber.

Sample(s)

Fig. 5: Micrograph of the cross-section of the corroded lead came with location of Fig. 7, unetched, dark field. The grains of the metal are slightly visible, and the light-coloured dots in the alloy are inclusions,



Credit HE-Arc CR, A.Gerber.

Description of sample	The sample is a piece of metal taken from the corroded lead came of the stained glass (Fig. 2). This came was replaced during the 2009 restoration. The purpose was to understand why this new metal has been completely corroded in a few years (Fig. 2, 3 and 5), while the historical metal next to it is not affected at all.
Alloy	Pb Sb alloy
Technology	Cast and cold worked
Lab number of sample	None
Sample location	HE-Arc CR, Neuchâtel, Neuchâtel
Responsible institution	HE-Arc CR, Neuchâtel, Neuchâtel
Date and aim of sampling	None

Complementary information

None.

Analyses and results

Metallography: hand polishing (grit sizes 200, 500, 1000, 1200, 2500, with water), then machine polishing Struers® LaboForce-3 with diamond oil solution (grit sizes 3 µm and 1 µm). Finally, chemical and mechanical polishing (same machine), with Struers® OP-S solution (0.04 µm grit size) with 10% H2O2.

X-ray Fluorescence, in ***General Metals*** mode, acquisition time 60s (filters: M20/Lo20/Li20).

Fourier transform IR spectroscopy (FTIR) to identify the various corrosion products found on the object.

Scanning electron microscope/Energy-dispersive X-ray spectroscopy (SEM/EDX).

Non invasive analysis

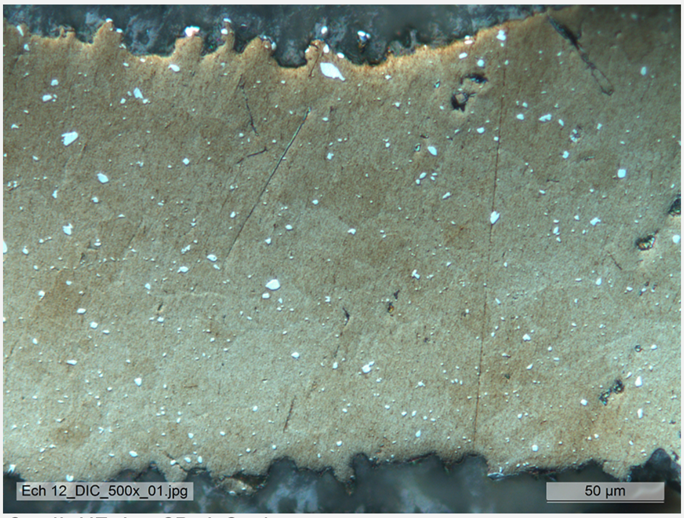
XRF analyses of the different lead cames of the "Stokar" stained glass panel showed that the tin (Sn) content is very variable from one came to another (Fig. 6). Those with a very low Sn but a high Sb (1.4%) contents are much more corroded.

Credit HE-Arc CR, A.Gerber.

Fig. 6: XRF analyses of a selection of the cames,

Metal

The lead alloy contains approximatly 1.5% antimony. The grains of the metal are slightly visible, even without etching. The light-coloured dots in the alloy are Sb-rich inclusions (Fig. 7).



Credit HE-Arc CR, A.Gerber.

Fig. 7: Micrograph (detail of Fig. 5), unetched, dark field,

Microstructure	Polygonal grains with inclusions
First metal element	Pb
Other metal elements	Sb

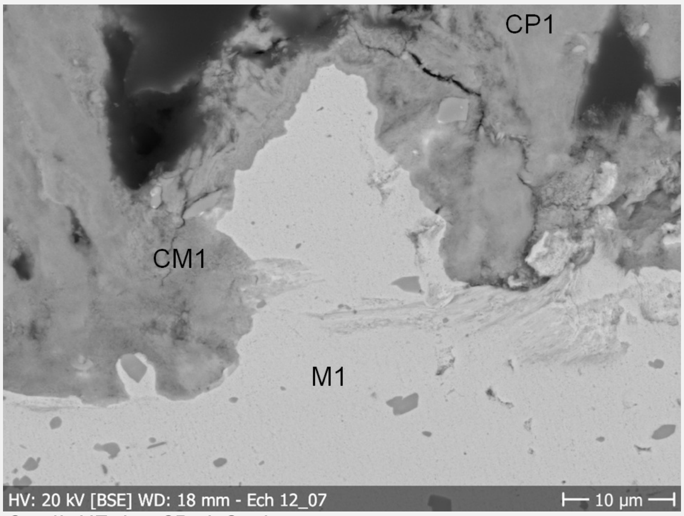
Complementary information

None.

Corrosion layers

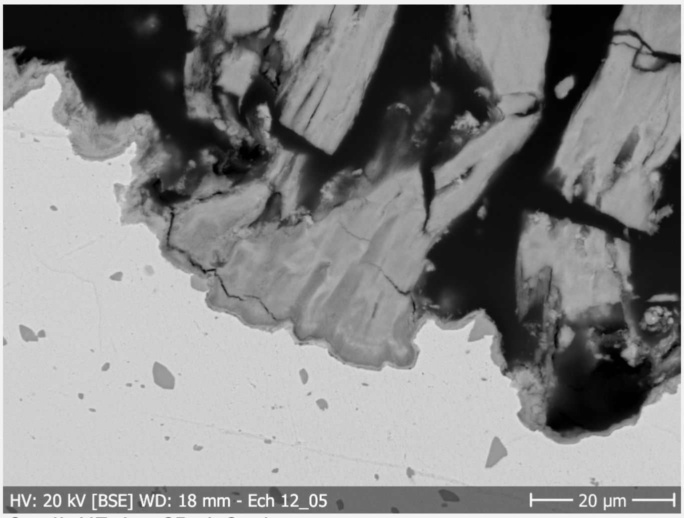
Corrosion develops specificilly on cames made of a lead-antimony alloy, where antimony inclusions constitute the cathode (0.150 V/SHE) versus lead (-0.125 V/SHE) which corrodes as an anode in presence of lead acetate (the electrolyte). Fig. 8 shows that corrosion does not attack the antimony nodules in the alloy, it progresses by mineralizing the lead around these nodules.

CP1 seems to be an heterogeneous compound as indicated on Figs. 8 and 9. It is heavily cracked (Fig. 9). EDX analyses do not indicate a significant difference in composition. The attack of lead by organic acids causes the formation of salts, such as lead acetate which are then transformed into basic lead carbonates by the action of CO2 from the environment as indicated by FTIR analysis of CP1.



Credit HE-Arc CR, A.Gerber.

Fig. 8: SEM image (BSE mode) of a detail of the cross-section of the corroded lead came. The area in light grey is the metal, the corrosion is in darker grey with a blurred appearance. Sb-dots are dark grey. Corrosion progresses around them, without mineralising them,



Credit HE-Arc CR, A.Gerber.

Fig. 9: SEM image (BSE mode) of the cross-section of the corroded lead came,

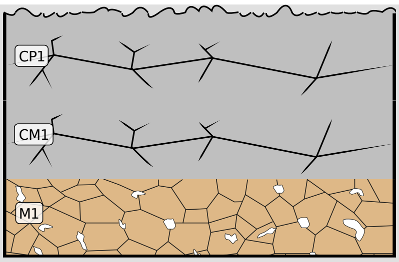
Corrosion form	Uniform - transgranular
Corrosion type	Active corrosion of lead

Complementary information

None.

MiCorr stratigraphy(ies) – CS

Fig. 10: Stratigraphic representation of the lead came in cross-section (dark field) using the MiCorr application with

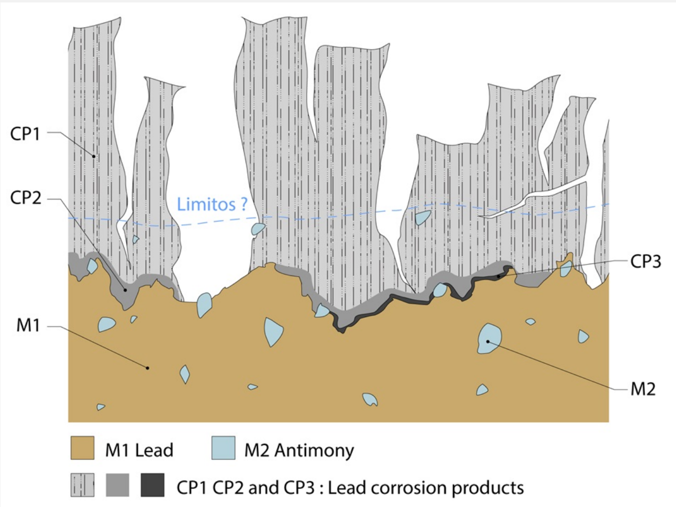


reference to Fig. 8. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, Credit HE-Arc CR, A.Gerber.

Synthesis of the binocular / cross-section examination of the corrosion structure

Fig. 11 shows an optimised stratigraphic representation of the corrosion structure. It is to be noted that CP1, CP2 and CP3 although visible on some cross-sections (Fig. 9) could not be differentiated by analysis.

The limit of the original surface lies somewhere in the corrosion layers. Antimony nodules are inferior markers of the limit of the original surface.



Credit HEI Arc, A.Gerber

Fig. 11: Optimised stratigraphic representation of a corroded lead came integrating additional information based on the analyses carried out,

Conclusion

The lead came is a lead-antimony alloy. Lead is a metal that is very sensitive to organic acids. But it can be alloyed with elements that can either increase its resistance to corrosion (tin) or make it more sensitive to organic acids. Antimony (Sb) is such an element that enhances active corrosion due to the galvanic effect between this element and lead.

The lead came is heavily corroded and its original surface contained in the thick and very fragile corrosion layer might get lost easily in case of any physical shock.

References

References on object and sample

References object

1. Hasler (2010). Die Schaffhauser Glasmalerei : des 16. bis 18. Jahrhunderts. Corpus Vitrearum, Vitrocentre Romont, Peter Lang, 2010.

References sample

2. Gerber (2018). Corrosion du sertissage en plomb de vitraux - Recherches autour de la dégradation de deux objets dans leur vitrine au Museum zu Allerheiligen de Schaffhouse. Haute Ecole Arc Neuchâtel, travail de diplôme de Bachelor, non-publié, 2018.

References on analytic methods and interpretation

3. Costa and Urban (2005). Lead and its alloys: metallurgy, deterioration and conservation. In Studies in Conservation, 50:sup1, 2005, 48-62.
4. Tétreault et al. (2003). Corrosion of copper and lead by formaldehyde, formic and acetic acid vapours, 4, Studies in conservation, 48, 4, 2003, 237-250.
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