

AIRCRAFT FRONT FASTENING PLATE VHS-497 (2) - AL CU SN ZN SI ALLOY - MODERN TIMES

Artefact name Aircraft front fastening plate VHS-497 (2)

Authors Marianne. Senn (Empa, Dübendorf, Zurich, Switzerland) & Christian. Degrigny (HE-Arc CR, Neuchâtel, Neuchâtel, Switzerland)

Url /artefacts/917/

▼ The object



Credit HE-Arc CR.

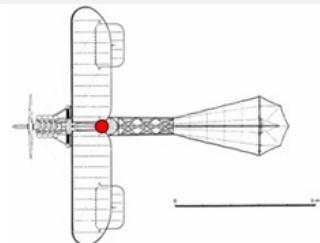


Fig. 1: Fastening plate from the front of the Dufaux IV (left) and top view of the aeroplane showing its location (red dot, right) (www.hepta.aero),

▼ Description and visual observation

Description of the artefact Metal fastening plate for the wooden construction of the front of the aeroplane, broken by use (Fig. 1) covered with a thin corrosion layer.

Type of artefact Aeroplane part

Origin Dufaux IV aeroplane

Recovering date Biplane built by Henri and Armand Dufaux in 1909/10

Chronology category Modern Times

chronology tpq A.D. ▾

chronology taq A.D. ▾

Chronology comment

Burial conditions / environment Outdoor to indoor atmosphere

Artefact location Swiss Museum of Transport, Luzern, Lucerne

Owner	Swiss Museum of Transport, Luzern, Lucerne
Inv. number	VHS-497 (2)
Recorded conservation data	N/A

Complementary information

None.

▼ Study area(s)



Fig. 2: Location of sampling area,

Credit HE-Arc CR.

▼ Binocular observation and representation of the corrosion structure

None.

▼ MiCorr stratigraphy(ies) – Bi

▼ Sample(s)

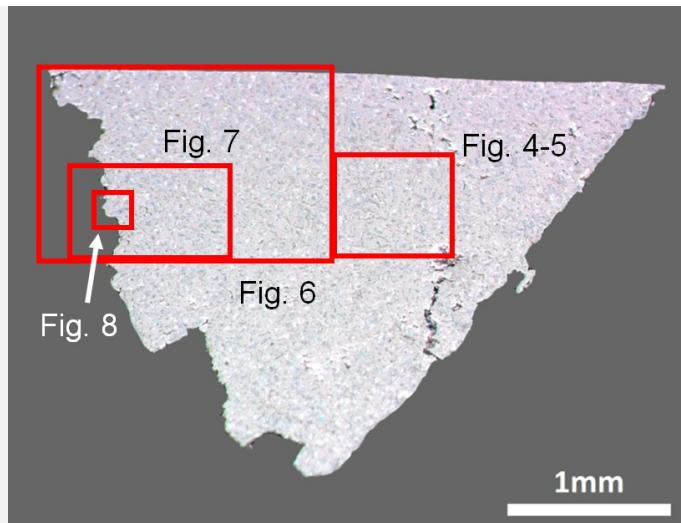


Fig. 3: Micrograph of the cross-section of the sample taken from the front fastening plate showing the location of Figs. 4 to 8,

Credit HE-Arc CR.

Description of sample

The top part has been cut during sampling (Fig. 2). The more regular right side is the plate surface and the irregular side is the broken edge (Fig. 3). Dimensions: L = 4mm ; W = 4mm.

Alloy

Al Cu Sn Zn Si Alloy

Technology

As-cast

Lab number of sample

DUF-4

Sample location

HE-Arc CR, Neuchâtel, Neuchâtel

Responsible institution

Swiss Museum of Transport, Luzern, Lucerne

Date and aim of sampling

September 2007, metallography and alloy composition

Complementary information

None.

▼ Analyses and results

Analyses performed:

Metallography (unetched), Vickers hardness testing, SEM/EDS.

▼ Non invasive analysis

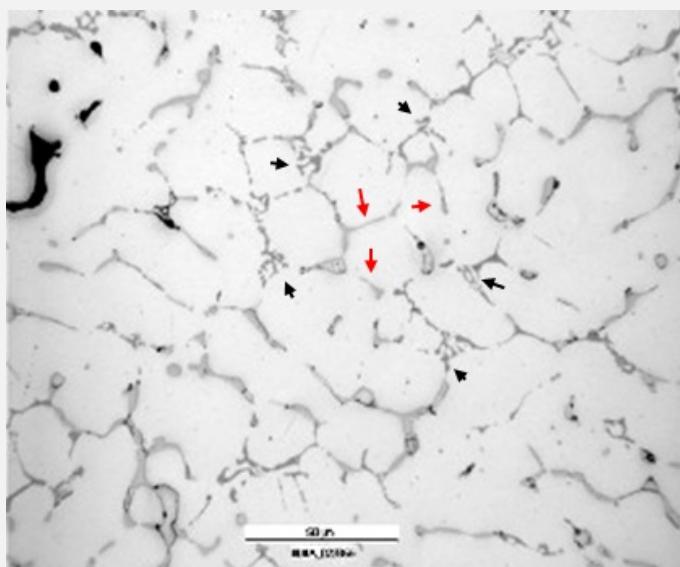
None.

▼ Metal

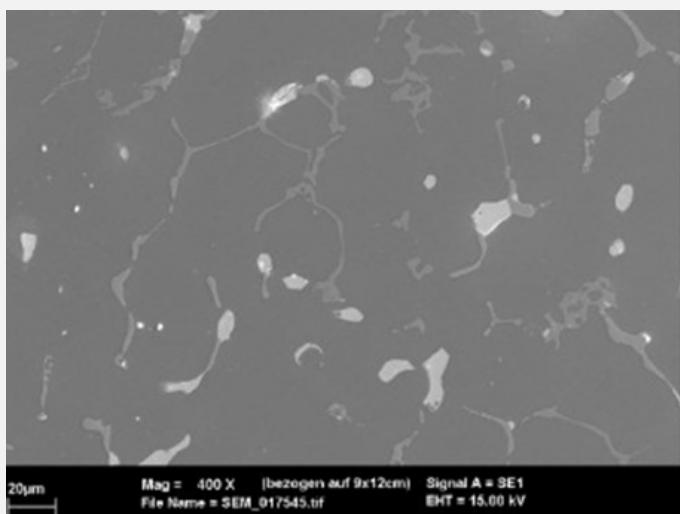
The metal is an aluminium alloy containing Cu, Sn, Zn and Si (Table 1). The unetched metal shows an as-cast structure consisting of the aluminium matrix with Sn (not soluble in Al) inclusions (Figs. 4 and 5), intermetallic compounds such as Al₂Cu (Fig. 4, red arrows) and clusters of Al,Fe,Cu & Si phases (Fig. 4, black arrows). There are porosities in the metal (Figs. 3 and 5). The average hardness of the metal is HV1 80.

Elements	Al	Cu	Sn	Zn	Si	Fe	O	Fe	Total
Metal (average)	89	4.6	3	1.6	1	<	0.8	<	100
Intermetallic compounds	45	55	<	<	<	<	<	<	100
Al,Fe,Si,Cu phase clusters	58	11	<	<	7.5	29	3.4	29	109
Sn inclusions	<	<	100	<	<	<	<	<	100

Table 1: Chemical composition (mass %) of the metal and inclusions (from Fig. 5). Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.



Credit HE-Arc CR.



Credit HE-Arc CR.

Microstructure

Dendritic structure with inclusions

Fig. 4: Micrograph of the metal sample from Fig. 3 (detail), unetched, bright field. The cast structure is revealed by light grey intermetallic compounds (Al₂Cu, red arrows), dark-grey Al,Fe,Si & Cu phase clusters (black arrows) and Sn inclusions (nodules). On the top left some pores can be seen,

Fig. 5: SEM image of the metal sample from Fig. 3 (detail), SE-mode, unetched. We observe in dark-grey the metal matrix, in medium-grey the intermetallic compound Al₂Cu as well as Al,Fe,Si & Cu phase clusters and in light-grey the Sn inclusions,

First metal element

Al

Other metal elements

Si, Cu, Zn, Sn

Complementary information

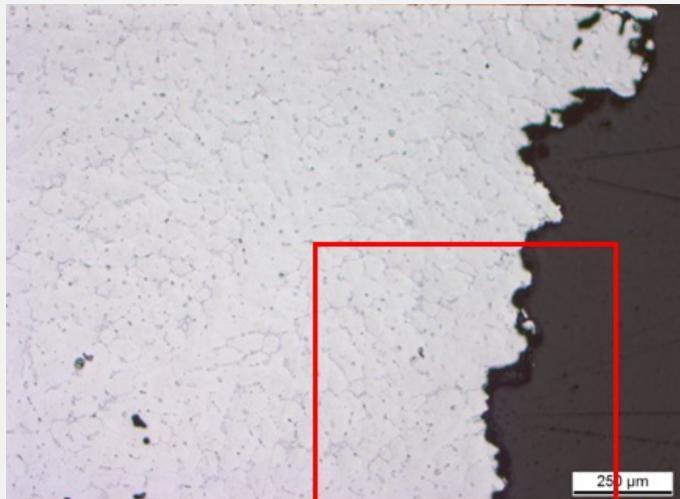
None.

Corrosion layers

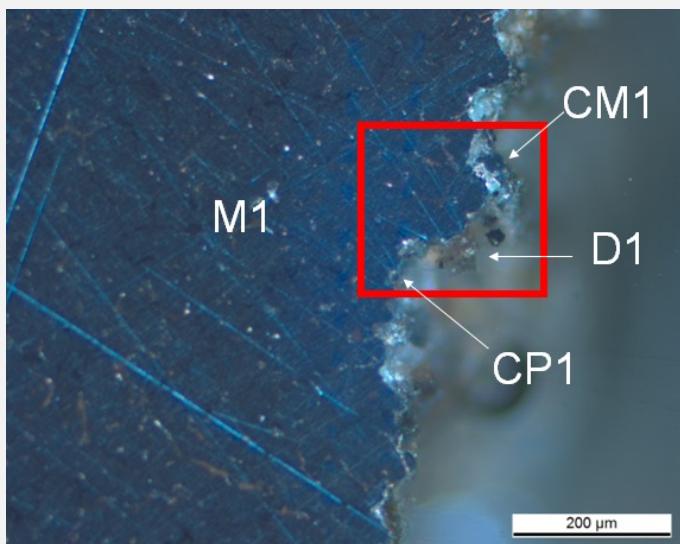
No corrosion layer can be seen on the metal surface (Figs. 3 and 6). Under polarized light small white and brown particles are visible on the broken edge (D1, Fig. 7). Their analysis reveals the presence of silica particles surrounded by dirt (Table 2 and Fig. 8). The metal surface is covered by a thin oxygen bearing skin (CP1, Fig. 8).

Elements	O	Al	Si	Cu	Total
Adherent particle (average of 3 similar analyses)	55	0.6	50	1.1	106

Table 2: Chemical composition (mass %) of the adhering particles to the metal surface (from Fig. 8). Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.



Credit HE-Arc CR.



Credit HE-Arc CR.

Fig. 6: Micrograph showing the metal - "corrosion products" interface from Fig. 3 (reversed picture, detail), unetched, bright field. We observe in white the metal matrix, in dark-grey Al, Fe, Si & Cu phase and light-grey Al₂Cu intermetallic compounds. The micrograph of Fig. 7 is marked by a rectangle,

Fig. 7: Micrograph from Fig. 6 (detail) and corresponding to the stratigraphy of Fig. 9, unetched, polarised light. We observe in dark blue the metal matrix and blue-brown the adherent material. The area selected for elemental chemical distribution (Fig. 8) is marked by a rectangle,

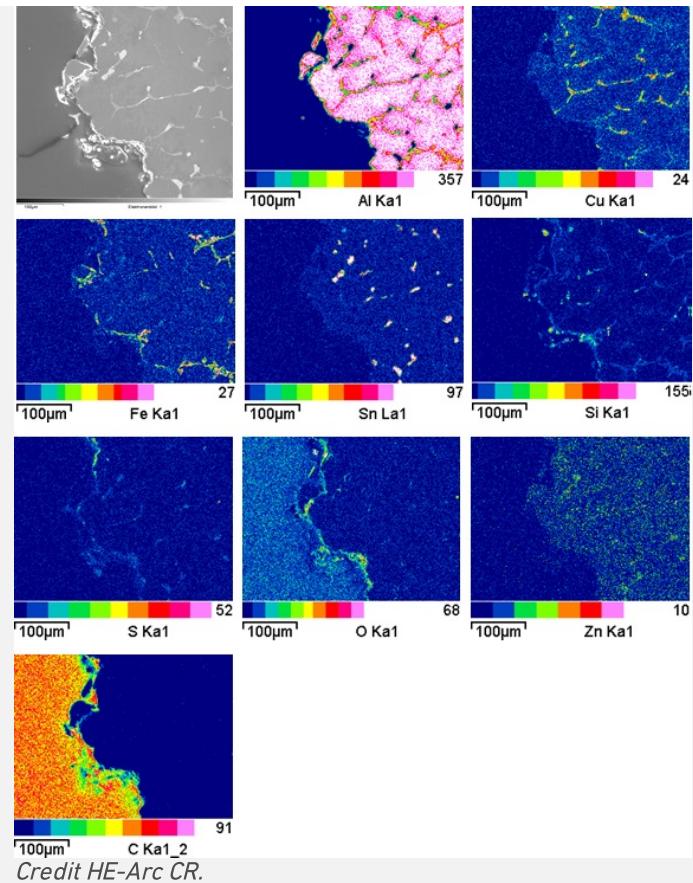


Fig. 8: SEM image, BSE-mode, and elemental chemical distribution of the selected area from Fig. 7 (reversed picture, detail). Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa,

Corrosion form	Passive
Corrosion type	Unknown

Complementary information

None.

▼ MiCorr stratigraphy(ies) – CS

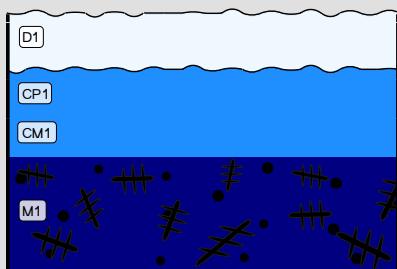


Fig. 9: Stratigraphic representation of the sample taken from the front fastening plate in cross-section (dark field) using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation. This representation can be compared to Fig. 7, Credit HE-Arc CR.

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

None.

▼ Conclusion

This front fastening plate of Dufaux IV plane is made in cast Al-Cu-Sn-Zn-Si, an alloy rather common at the beginning of the 20th century. No corrosion layer has been found on the metal surface except adherent silica-rich particles and the thin oxidised skin typical of Al alloys. The presence of these materials can be explained by the regular maintenance of the metal, probably using silicon carbide abrasive paper.

▼ References

References on object and sample

References object

1. Rumo, L. (2008) Analyse et caractérisation des alliages constitutifs de l'avion Dufaux IV. Mémoire Filière conservation-restauration, Haute Ecole art appliqués, La Chaux-de-Fonds, 101-105.

References sample

2. Rumo, L. (2008) Analyse et caractérisation des alliages constitutifs de l'avion Dufaux IV. Mémoire Filière conservation-restauration, Haute école art appliqués, La Chaux-de-Fonds, 101-105.