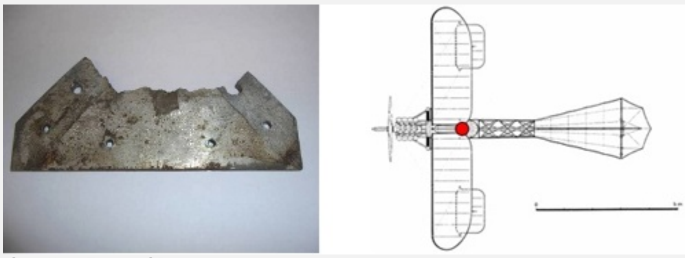
# AIRCRAFT FRONT FASTENING PLATE VHS-497 (2) - AL CU SN ZN SI ALLOY - MODERN TIMES

**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/510/

## 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

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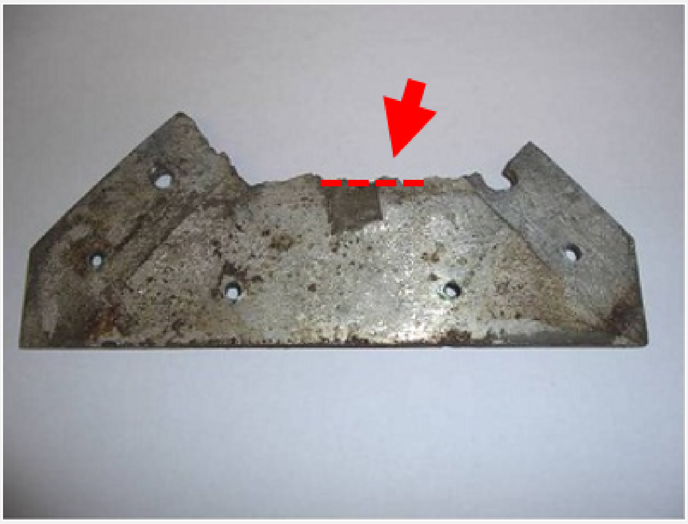
|---|---|
| **Description of the artefact** | Metal fastening plate for the wooden construction of the front of the aeroplane, broken by use (Fig. 1). |
| **Type of artefact** | Aeroplane part |
| **Origin** | Dufaux IV aeroplane |
| **Recovering date** | Biplane built by Henri and Armand Dufaux in 1909/10 |
| **Chronology category** | Modern Times |
| **chronology tpq** | 1909 A.D. |
| **chronology taq** | 1910 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** | Not known |

### Complementary information

Nothing to report.

## Study area(s)



Credit HE-Arc CR.

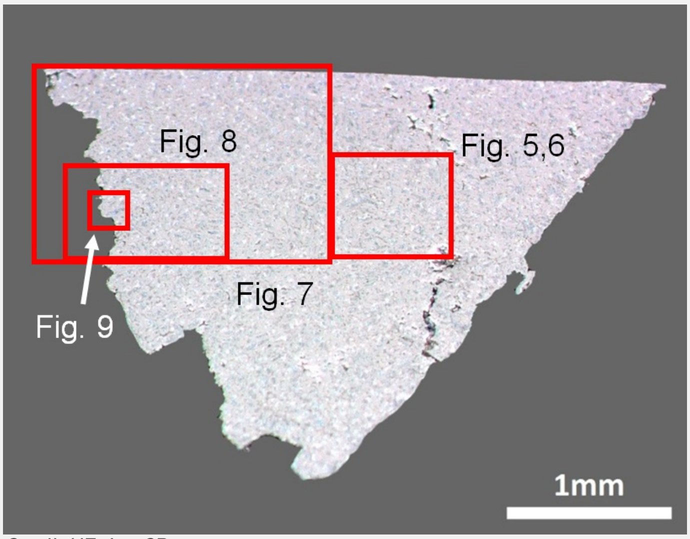
Fig. 2: Location of sampling area,

## Binocular observation and representation of the corrosion structure

Stratigraphic representation: none.

## MiCorr stratigraphy(ies) – Bi

## Sample(s)




Credit HE-Arc CR.

Fig. 3: Micrograph of the cross-section of the sample taken from the front fastening plate showing the location of Figs. 5 to 9,

**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** Empa (Marianne Senn)

**Responsible institution** Swiss Museum of Transport, Luzern, Lucerne

**Date and aim of sampling** September 2007, metallography and alloy composition

### Complementary information

Nothing to report.

## Analyses and results

***Analyses performed:***
Metallography (unetched), Vickers hardness testing, SEM/EDS.

## Non invasive analysis

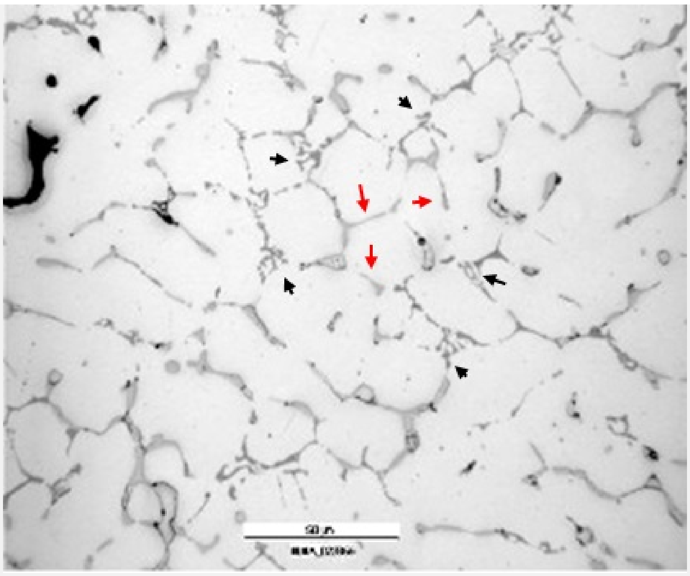
## Metal

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. 5 and 6), intermetallic compounds such as $Al_2Cu$ (Fig. 5, red arrows) and clusters of Al,Fe,Cu & Si phases (Fig. 5, black arrows). There are porosities in the metal (Figs. 3 and 5). The average hardness of the metal is HV1 80.

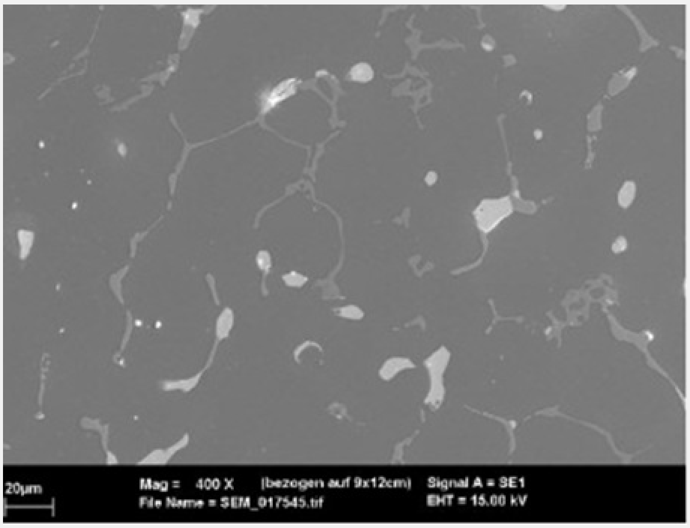
| Elements | Al | Cu | Sn | Zn | Si | Fe | O | Fe | Total |
|---|---|---|---|---|---|---|---|---|---|
| Metal (average) | 89 | 4.6 | 3 | 1.6 | 1 | < | 0.8 | < | 100 |
| Intermetallic compounds | 45 | 55 | < | < | < | < | < | < | 100 |
| Al,Fe,Si,Cu phase clusters | 58 | 11 | < | < | 7.5 | 29 | 3.4 |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

Fig. 5: 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,



*Credit HE-Arc CR.*




*Credit HE-Arc CR.*

Fig. 6: 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,

| | |
|---|---|
| **Microstructure** | Dendritic structure with inclusions |
| **First metal element** | Al |
| **Other metal elements** | Si, Cu, Zn, Sn |

## Complementary information

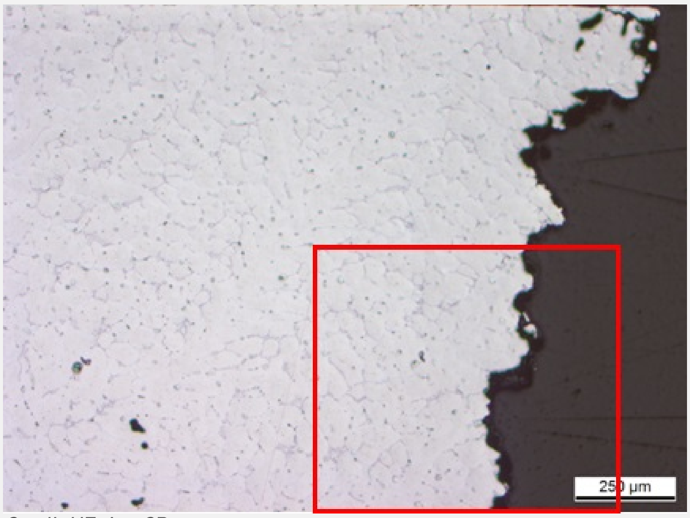
Nothing to report.

## Corrosion layers

No corrosion layer can be seen on the metal surface (Figs. 3 and 7). Under polarized light small white and brown particles are visible on the broken edge (D1, Fig. 8). Their analysis reveals the presence of silica particles surrounded by dirt (Table 2 and Fig. 9). The metal surface is covered by a thin oxygen bearing skin (CP1, Fig. 9).

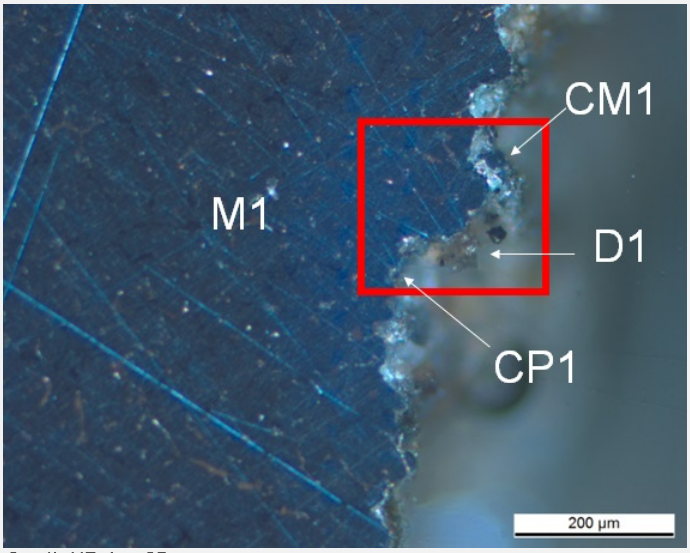
| Elements | O | Al | Si | Cu | Total |
|---|---|---|---|---|---|
| Adherent particle (average of 3 similar analyses) | 55 | 0.6 | 50 | 1.1 | 106 |

Table 2: Chemical composition (mass %) of the adhering particles to the metal surface (from Fig. 7). Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.




Credit HE-Arc CR.

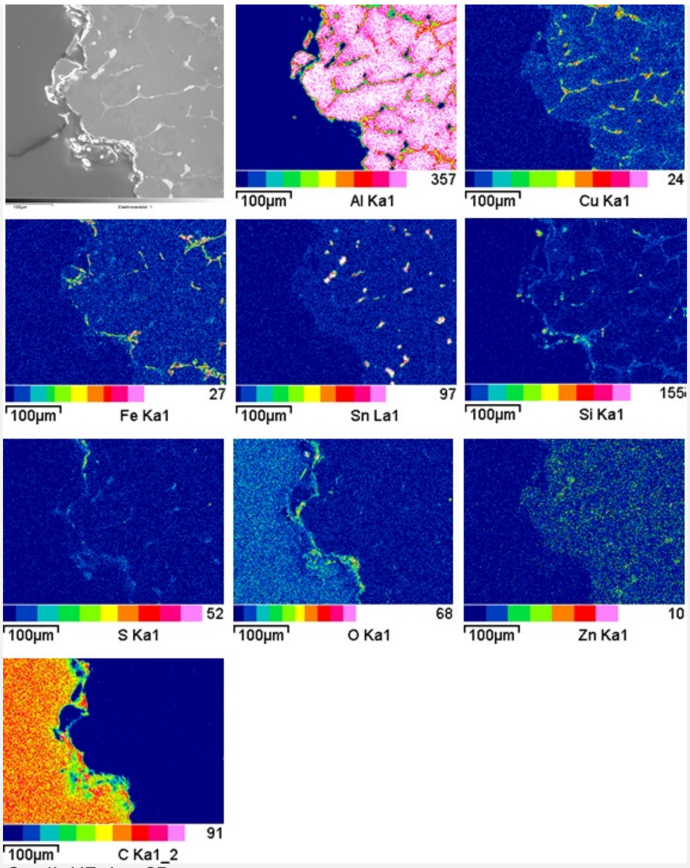
Fig. 7: Micrograph showing the metal - “corrosion products” interface from Fig. 3 (reversed picture, detail), unetched, bright field. We observe in white the metal matrix, in dark-grey Al,Fe, Si & Cu phase and light-grey Al2Cu intermetallic compounds. The micrograph of Fig. 8 is marked by a rectangle,




Credit HE-Arc CR.

Fig. 8: Micrograph from Fig. 7 (detail) and corresponding to the stratigraphy of Fig. 4, unetched, polarised light. We observe in grey the metal matrix and blue-brown the adherent material. The area selected for elemental chemical distribution (Fig. 9) is marked by a rectangle,

Fig. 9: SEM image, BSE-mode, and elemental chemical distribution of the selected area from Fig. 8 (reversed picture, detail). Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa,



*Credit HE-Arc CR.*

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|---|---|
| **Corrosion form** | Passive |
| **Corrosion type** | None |

## Complementary information

Nothing to report.

## MiCorr stratigraphy(ies) – CS

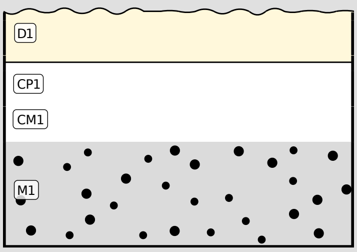


Fig. 4: Stratigraphic representation of the sample taken from the front fastening plate in cross-section using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation. This representation can be compared to Fig. 8, Credit HE-Arc CR.

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

Corrected stratigraphic representation: none.

## Conclusion

Although not common at the beginning of the 20th, this Al-Cu-Sn-Zn-Si cast alloy was used on the Dufaux IV plane. 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**<br>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.<br>**References sample**<br>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. |
| *References on analytic methods and interpretation* |
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