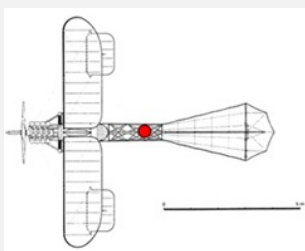


AIRCRAFT REAR FASTENING PLATE VHS-497 - AL ALLOY - MODERN TIMES

| | |
|---------------|--|
| Artefact name | Aircraft rear fastening plate VHS-497 |
| Authors | Marianne. Senn (EMPA, Dübendorf, Zurich, Switzerland) & Christian. Degrigny (HE-Arc CR, Neuchâtel, Neuchâtel, Switzerland) |
| Url | /artefacts/331/ |

✧ The object



Credit HE-Arc CR.



Fig. 1: Photograph of the aeroplane showing the location of the fixation plate (red dot) (www.hepta.aero),

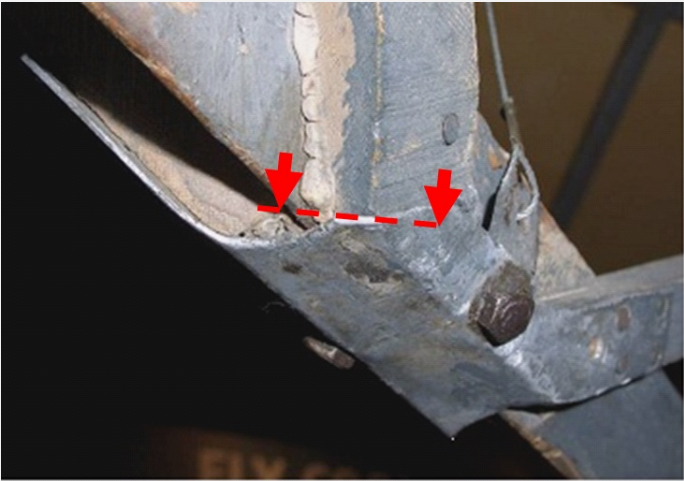
✧ Description and visual observation

| | |
|---------------------------------|---|
| Description of the artefact | Fixation plate for the wooden construction at the back of the aeroplane (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 | 1909 _ 1910 |
| 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 |
| Recorded conservation data | Not known |

Complementary information

Nothing to report.

Study area(s)



Credit HE-Arc CR.

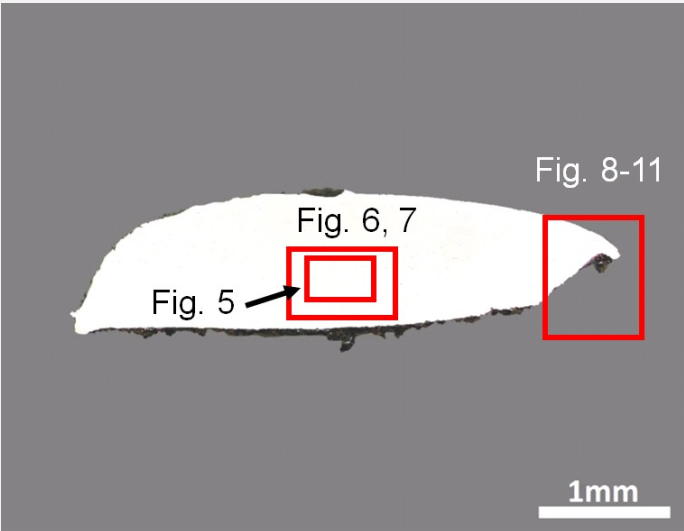
Fig. 2: Location of sampling area,

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 showing the location of Figs. 5 to 11,

Description of sample

Sample cut from the corner of the fixation plate (Fig. 2). Dimensions: L = 4mm ; W = 1.2mm.

| | |
|--------------------------|---|
| Alloy | Al Alloy |
| Technology | Hot rolled and annealed |
| Lab number of sample | DUF-12 |
| 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

| |
|--|
| <i>Analyses performed:</i> Metallography (nital etched), Vickers hardness testing, SEM/EDS. |
|--|

⌵ Non invasive analysis

⌵ Metal

The metal is a relatively pure aluminium alloy with numerous inclusions (Table 1). From the chemical composition of the inclusions they can be interpreted as alpha-AlFeSi intermetallic compounds. In bright field we observe elongated inclusions indicating that the metal was rolled (Fig. 5). The alloy composition is similar to an unalloyed primary aluminium (Al content between 99 and 99.8 mass%). The O content reflects the immediate oxidation of the metal and is not part of the alloy. After etching the organisation of inclusions in rows is more easily seen (Fig. 6). The SEM image shows large grains formed after annealing (Fig. 7). The average hardness of the metal is HV1 40.

| Elements | Al | Si | Fe | O | Total |
|---------------------|----|-----|----|-----|-------|
| Metal (average) | 95 | 0.8 | < | 0.7 | 97 |
| Inclusion (average) | 60 | 8.6 | 31 | 1.5 | 100 |

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

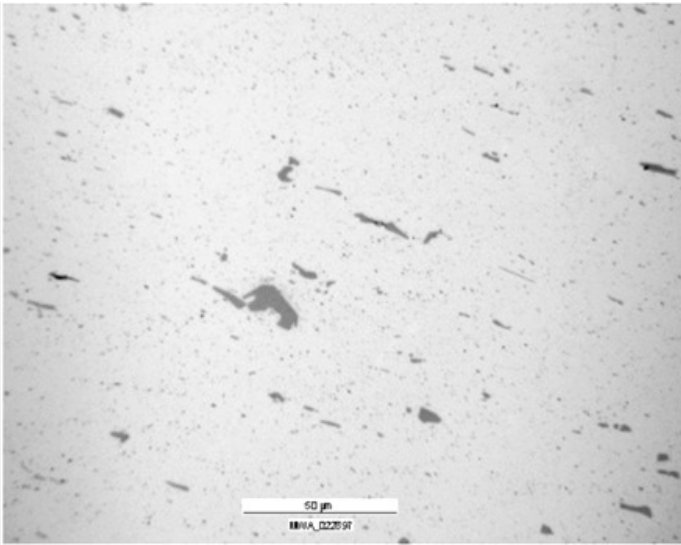


Fig. 5: Micrograph of the metal sample from Fig. 3 (detail), unetched, bright field. The metal matrix is in white, the elongated inclusions in grey.

Credit HE-Arc CR

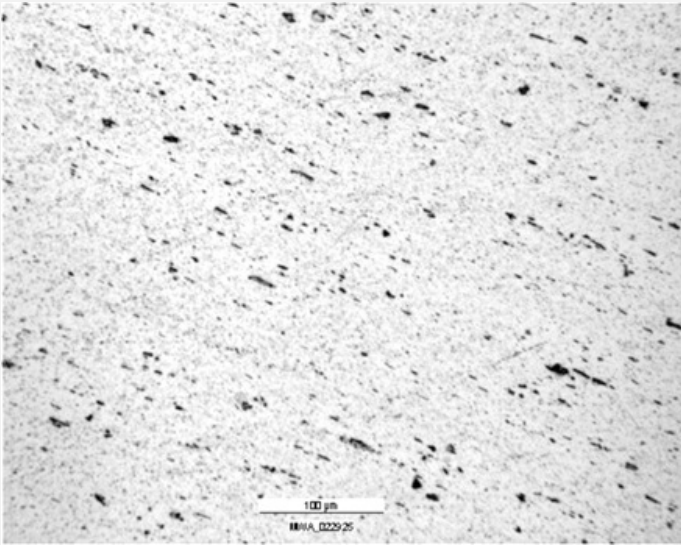


Fig. 6: Micrograph of the metal sample from Fig. 3 (detail), etched, bright field. The metal matrix is in white, the elongated inclusions in dark-grey and black,

Credit HE-Arc CR.

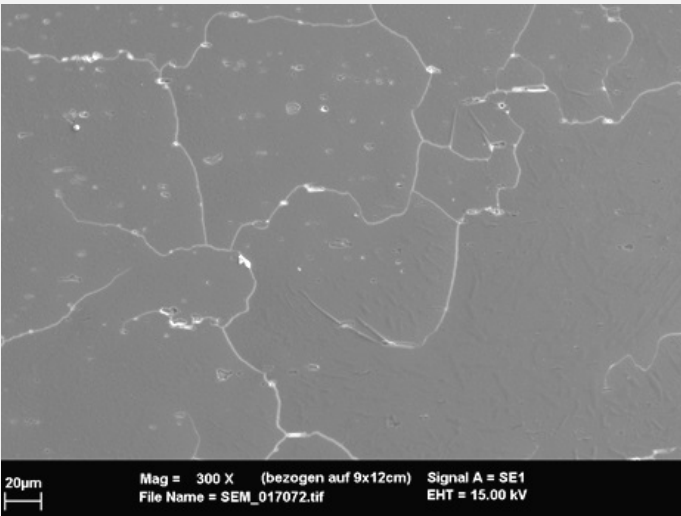


Fig. 7: SEM image of the metal sample from Fig. 3 (detail), SE-mode, etched. We observe the presence of large grains and numerous elongated inclusions,

Credit HE-Arc CR.

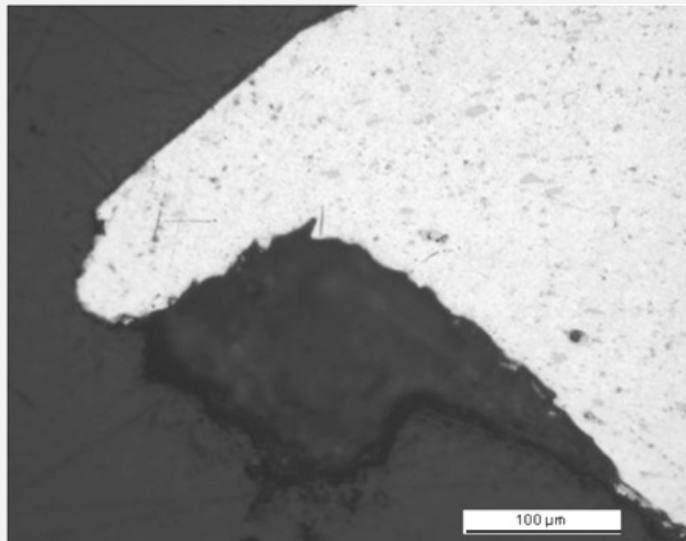
| | |
|----------------------|--|
| Microstructure | Recrystallized structure with large grains |
| First metal element | Al |
| Other metal elements | Si |

Complementary information

Nothing to report.

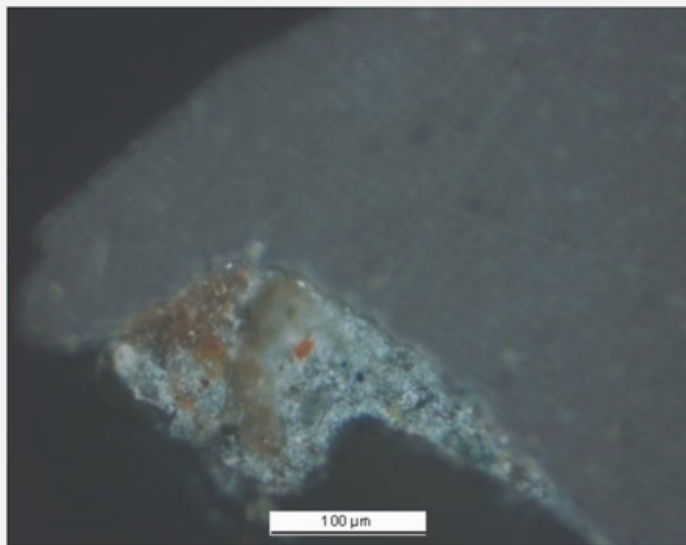
✧ Corrosion layers

The metal is covered by a very thin corrosion layer (CP1). In addition to this, locally thicker “corrosion products” or adherent material can be observed (D1, appearing as dark-grey area in Fig. 8). Under polarized light, they appear blue-brown (Fig. 9). Analysis by SEM-EDS indicates that the metal is, as expected, covered by a very thin Al and O-rich layer whereas the particles in the adherent material contain C, O, Si, Ca, Fe, Zn, S and even Ti (Figs. 10 and 11). The location of the adherent material and the presence of both Zn and Ti suggest that it is a residue of a paint coating.



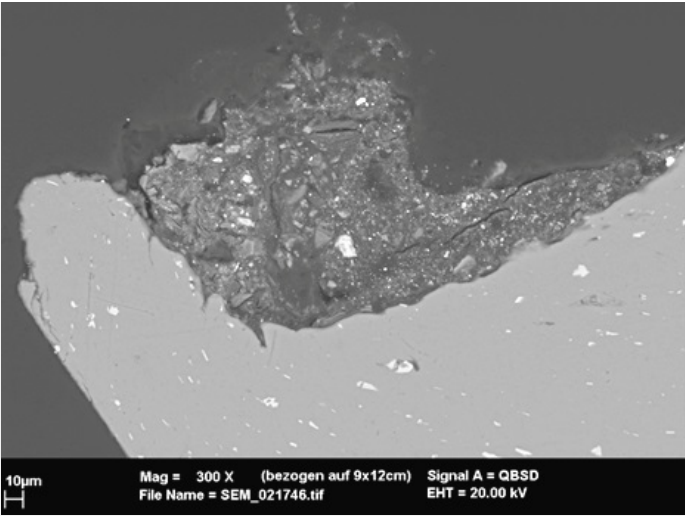
Credit HE-Arc CR.

Fig. 8: Micrograph showing the metal - “corrosion products” interface from Fig. 3 (reversed picture, detail), unetched, bright field. We observe in white the metal matrix and dark-grey the adhering material,

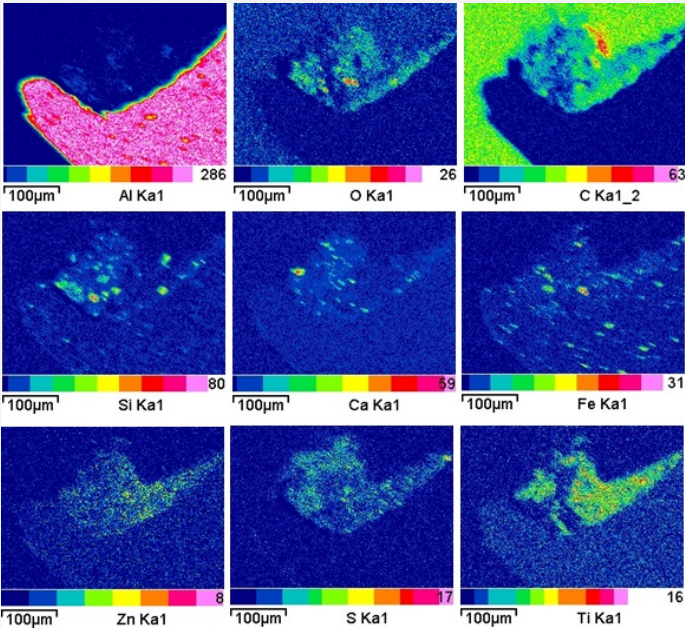


Credit HE-Arc CR.

Fig. 9: Micrograph (same as Fig. 8) and corresponding to the stratigraphy of Fig. 4, unetched, polarised light. We observe in grey the metal matrix and blue-brown the adherent material,



Credit HE-Arc CR.



Credit HE-Arc CR.

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

Complementary information

Nothing to report.

✎ MiCorr stratigraphy(ies) – CS

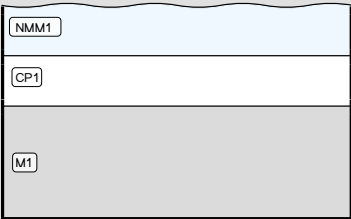


Fig. 10: SEM image (same as Fig. 8, inverted picture, detail), BSE-mode, unetched,

Fig. 11: Elemental chemical distribution of the selected area from Fig. 10. Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa,

Fig. 4: Stratigraphic representation of the object in cross-section using the MiCorr application. This representation can be compared to Fig. 9.

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

Corrected stratigraphic representation: none.

✧ Conclusion

This aluminium alloy has a composition similar to a primary aluminium with an Al content between 99 and 99.8 mass%. The main impurities are Si and Fe. Because of their insolubility in the aluminium they form intermetallic (α -AlFeSi) inclusions. The metal was hot rolled and annealed. It is covered by a very thin corrosion layer (probably aluminium oxide) and in some areas adherent materials are present, most likely the remains of a Zn- and Ti-rich paint system mixed with environmental pollutants.

✧ References

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.

References on analytic methods and interpretation