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

Artefact name Aircraft rear fastening plate VHS-497

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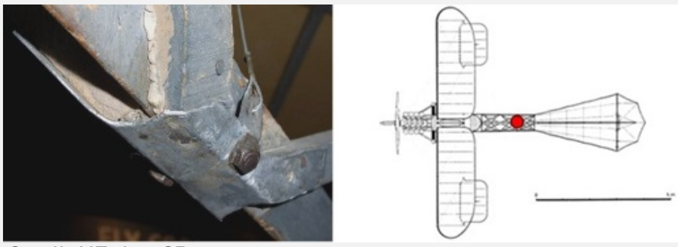
Url /artefacts/1235/

The object



Credit HE-Arc CR.

Fig. 1: Fastening plate from the back 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 rear of the aeroplane (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	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

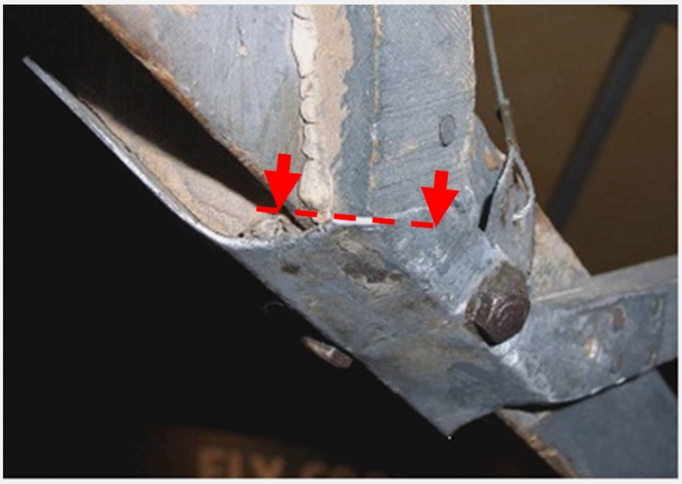
Inv. number VHS-497

Recorded conservation data N/A

Complementary information

None.

Study area(s)



Credit HE-Arc CR.

Fig. 2: Location of sampling area,

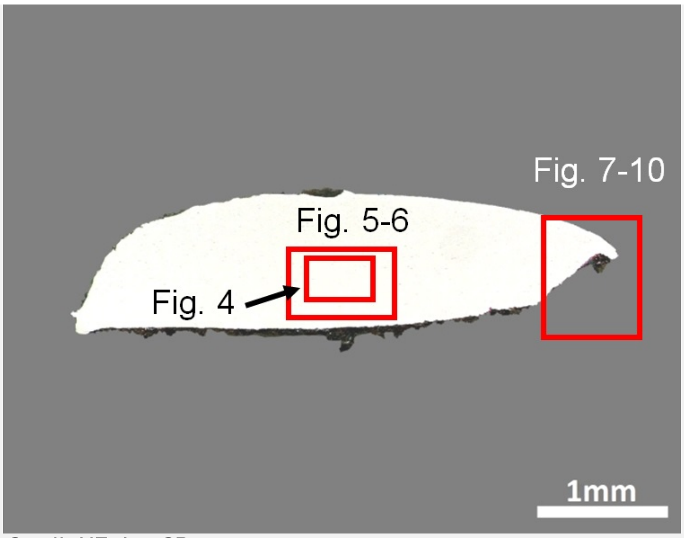
Binocular observation and representation of the corrosion structure

None.

MiCorr stratigraphy(ies) – Bi

Sample(s)

Fig. 3: Micrograph of the cross-section of the sample taken from the back fastening plate showing the location of Figs. 4 to 10,



Credit HE-Arc CR.

Description of sample	Sample cut from the corner of the fastening 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	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 (nital etched), Vickers hardness testing, SEM/EDS.

Non invasive analysis

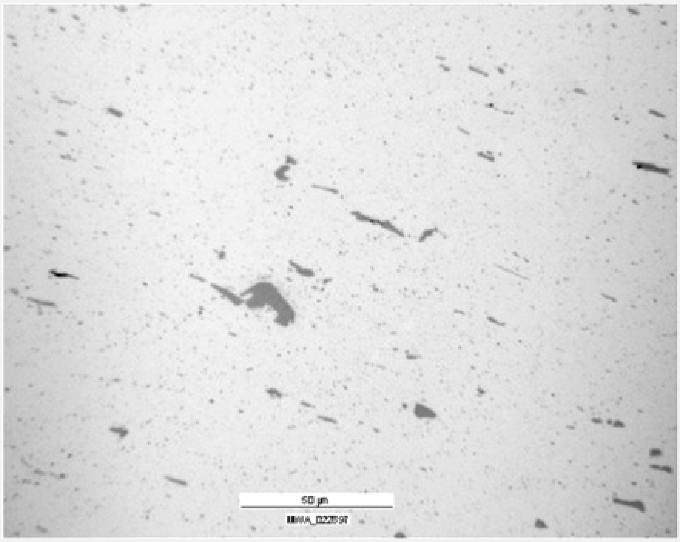
None.

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. 4). 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. 5). The SEM image shows large grains formed after annealing (Fig. 6). The average hardness of the metal is HV1 40.

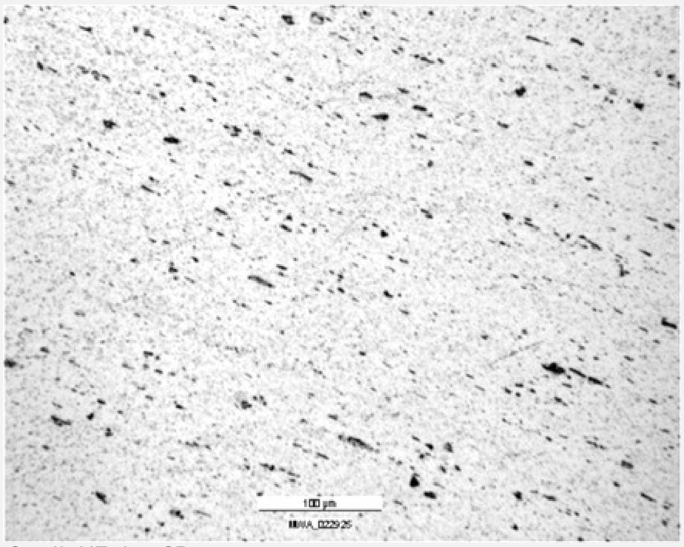
Elements	Al	Si	Fe	O	Total
Metal (average)	95	<1	<	<1	97
Inclusion (average)	60	8	31	1	100

Table 1: Chemical composition (mass %, <: below the detection limit) of the metal and inclusions (from Fig. 4). Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.



Credit HE-Arc CR.

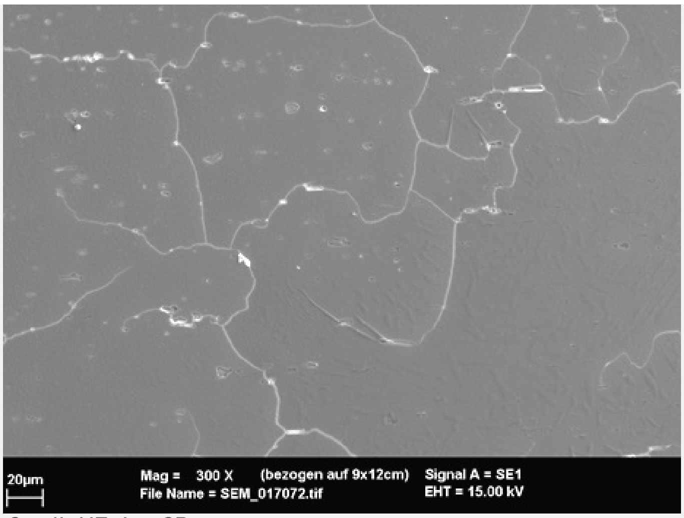
Fig. 4: Micrograph of the metal sample from Fig. 3 (detail), unetched, bright field. The metal matrix is in white, the elongated inclusions in grey,



Credit HE-Arc CR.

Fig. 5: 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,

Fig. 6: 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.

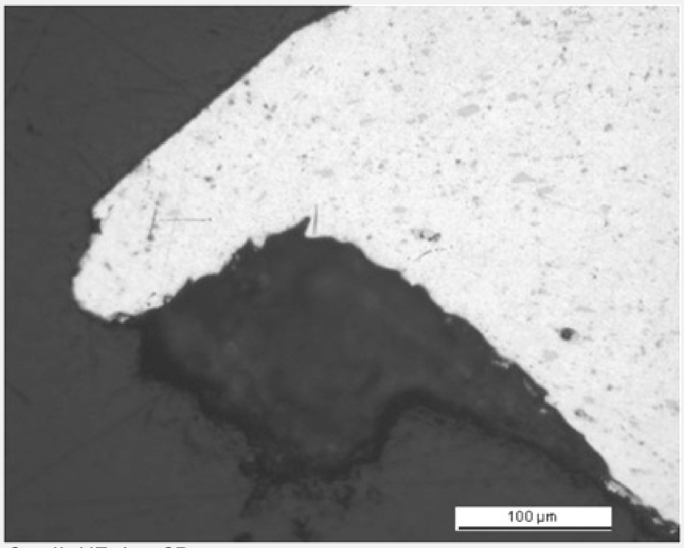
Microstructure	Recrystallized structure with large grains
First metal element	Al
Other metal elements	Si

Complementary information

None.

Corrosion layers

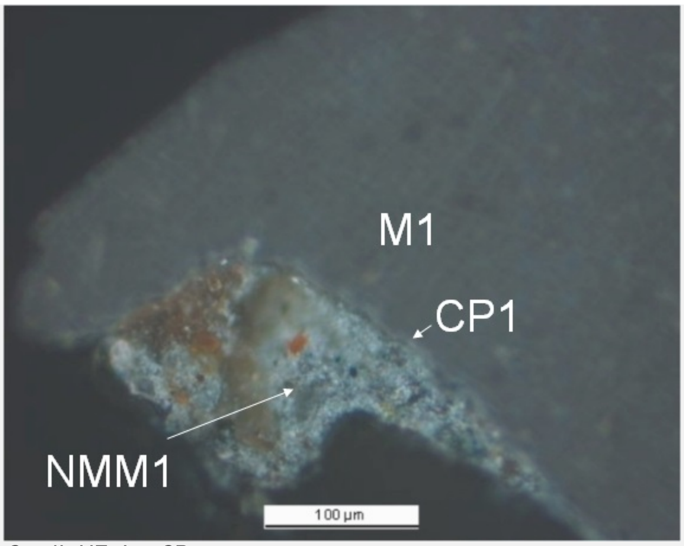
The metal is covered by a very thin corrosion layer (CP1). In addition to this, locally thicker adhering materials can be observed (NMM1, appearing as dark-grey area in Fig. 7). Under polarized light, they appear blue-brown (Fig. 8). Analysis by SEM-EDS indicates that the metal is, as expected, covered 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. 9 and 10). 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.

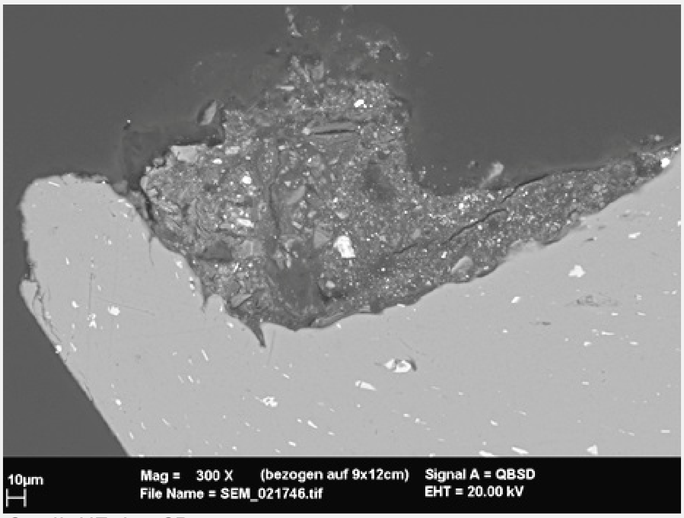
Fig. 7: Micrograph showing the metal - adhering material interface from Fig. 3 (reversed picture, detail), unetched, bright field. We observe in white the metal matrix and dark-grey the adhering material,

Fig. 8: Micrograph (same as Fig. 7) and corresponding to the stratigraphy of Fig. 11, unetched, polarised light. We observe



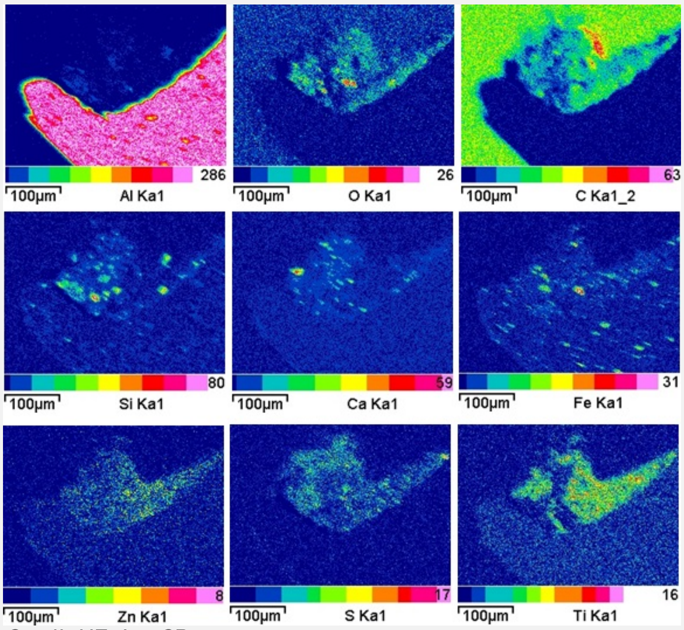
Credit HE-Arc CR.

in grey the metal matrix and blue-brown the adhering material,



Credit HE-Arc CR.

Fig. 9: SEM image (same as Fig. 7, inverted picture, detail), BSE-mode, unetched,



Credit HE-Arc CR.

Fig. 10: Elemental chemical distribution of the selected area from Fig. 9. Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa,

Corrosion form	Passive
Corrosion type	Unknown

Complementary information

None.

MiCorr stratigraphy(ies) – CS

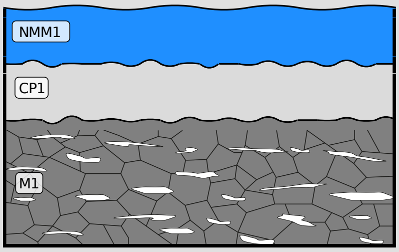


Fig. 11: Stratigraphic representation of the sample taken from the back fastening plate in cross-section (dark field) using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation. This representation can be compared to Fig. 8, Credit HE-Arc CR.

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

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 (alpha-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 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.