MICORR

Interreg France - Suisse

ARMATURE FROM A CLOCK MOVEMENT MIH IV-212 - ZN AL SN CU ALLOY - MODERN TIMES

Artefact name	Armature from a clock movement MIH IV-212
Authors	Marianne. Senn (EMPA, Dübendorf, Zurich, Switzerland) & Christian. Degrigny (HE-Arc CR, Neuchâtel, Neuchâtel, Switzerland)
Url	/artefacts/388/

The object

Credit HE-Arc CR.

Fig. 1: Wooden wall clock, zinc alloy armature from the clock movement (after Seematter 2009),

Description and visual observation

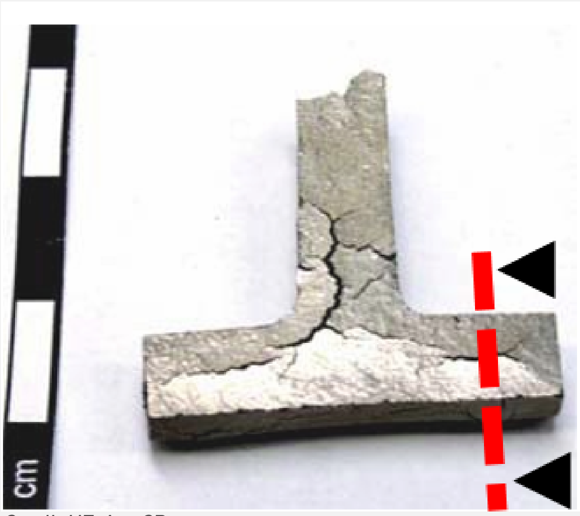
Description of the artefact	Armature from the clock movement of a wooden wall clock with electric movement (fig. 1).
Type of artefact	Horological object
Origin	Wooden wall clock
Recovering date	1902-1904
Chronology category	Modern Times
chronology tpq	1902 A.D.
chronology taq	1904 A.D.
Chronology comment	1902 _ 1904
Burial conditions / environment	Indoor atmosphere
Artefact location	International museum of horology (IMH), La Chaux-de-Fonds, Neuchâtel
Owner	International museum of horology (IMH), La Chaux-de-Fonds, Neuchâtel
Inv. number	MIH IV-212

Recorded conservation data Not conserved

Complementary information

Nothing to report.

Study area(s)



Credit HE-Arc CR.

Fig. 2: Location of sampling area,

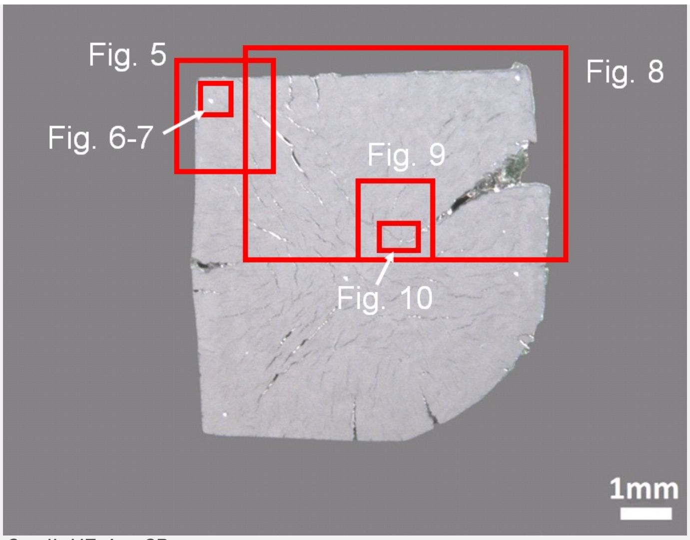
Binocular observation and representation of the corrosion structure

Stratigraphic representation: none.

MiCorr stratigraphy(ies) – Bi

Sample(s)

Fig. 3: Micrograph of the cross-section showing the location of Figs. 5 to 10,



Credit HE-Arc CR.

Description of sample	This sample is the complete cross-section from an element of the armature (Fig. 2). The metal has huge cracks radiating from the centre to the outside which have deformed the armature (Fig. 3). The metal is covered with a Ni coating.
Alloy	Zn Al Sn Cu Alloy
Technology	As-cast
Lab number of sample	MIH-VI-212
Sample location	HE-Arc CR, Neuchâtel, Neuchâtel
Responsible institution	International museum of horology (IMH), La Chaux-de-Fonds, Neuchâtel
Date and aim of sampling	2009, metal analysis

Complementary information

Nothing to report.

Analyses and results

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

Non invasive analysis

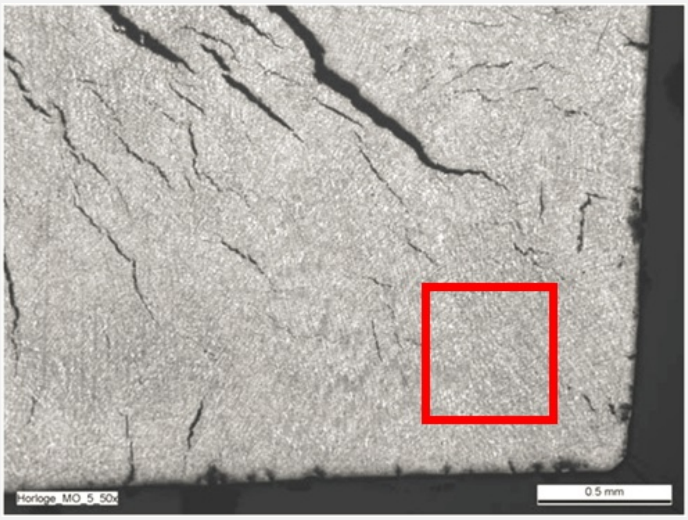
Metal

The metal is a Zn-Al-Sn-Cu alloy (Table 1) with an average hardness of HV1 105. A fine dendritic structure is observed (Fig. 5) which consists of clearly separated Zn, Al-Cu and Sn-rich phases (Figs. 6 and 7). Pb is associated with Sn but also forms tiny nodules.

Elements	Zn	Al	Sn	Cu	Pb	Total

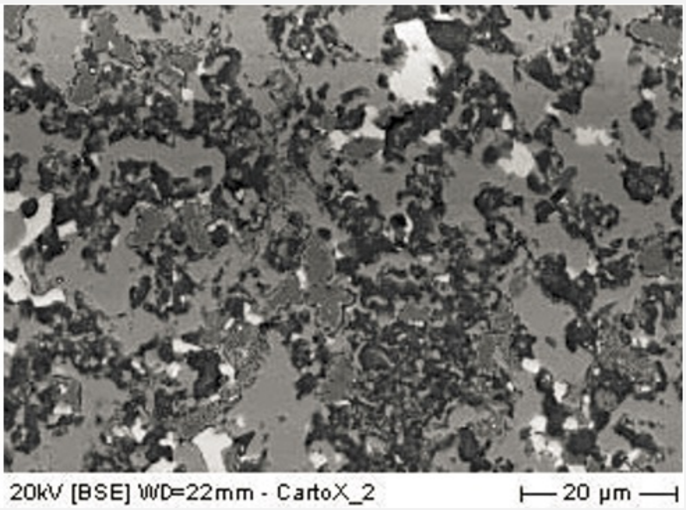
Metal	67	17	11	4	<1	99

Table 1: Chemical composition (mass %) of the metal (oxygen not shown). Method of analysis: SEM/EDS, Lab of Electronic Microscopy and microanalysis, IMA (Néode), HEI Arc.



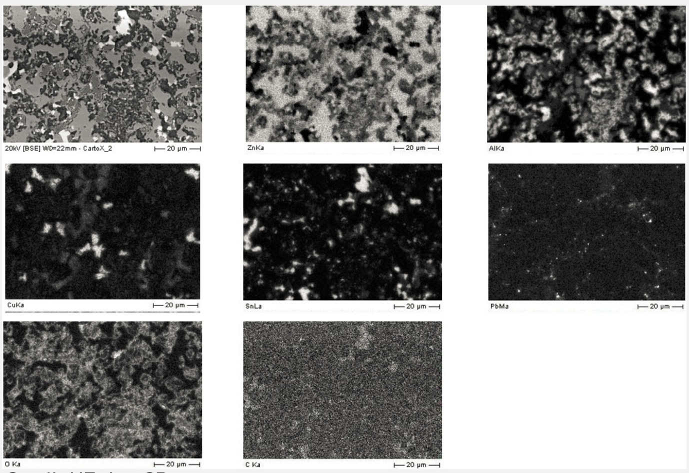
Credit HE-Arc CR.

Fig. 5: Micrograph of the metal sample from Fig. 3 (inverted picture, rotated by 270°, detail), unetched, bright field. A dendritic structure is visible. The micrograph of Fig. 6 is marked by a square,



Credit HE-Arc CR.

Fig. 6: SEM image, BSE-mode, detail from Fig. 5 (detail), unetched, bright field. Three phases appear: in light-grey the Zn-rich phase, in dark-grey the Al and Cu-rich phase and in white the Sn-rich phase,



Credit HE-Arc CR.

Fig. 7: SEM image, BSE-mode, and elemental chemical distribution of the selected area from Fig. 6. Method of examination: SEM/EDS, Lab of Electronic Microscopy and microanalysis, IMA (Néode), HEI Arc,

Microstructure	Fine dendritic structure (no cohesion between the phases)
First metal element	Zn

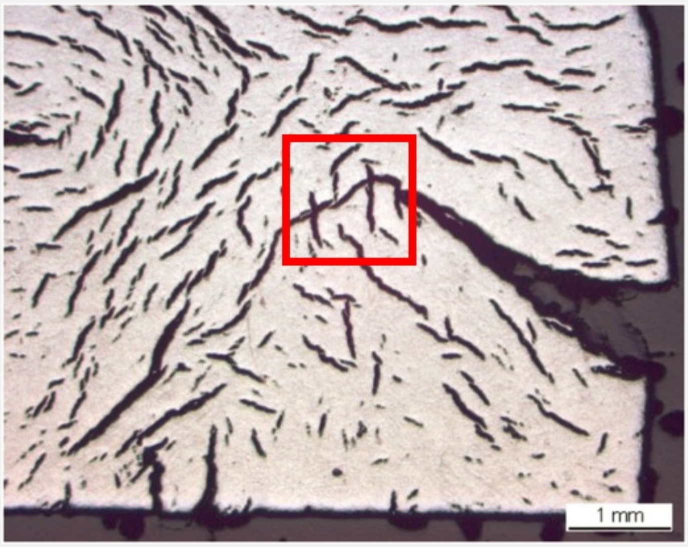
Other metal elements	Al, Cu, Sn

Complementary information

Nothing to report.

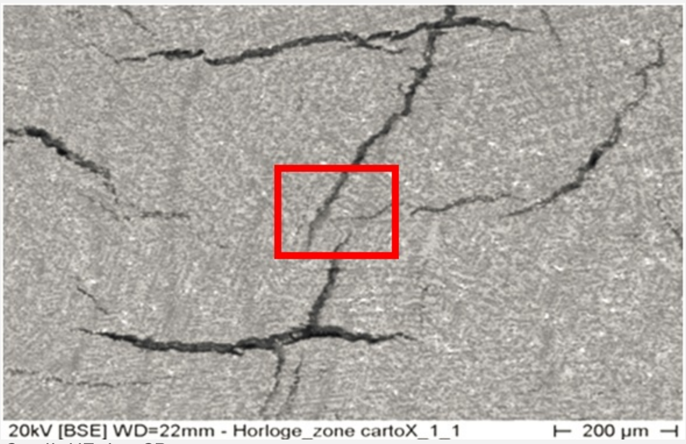
Corrosion layers

The Zn-rich phase is heavily oxidised internally (Fig. 7). The corrosion has developed throughout the entire metal body, generating cracks (Figs. 8 and 9). The cracks are Zn, O and C-rich (Fig. 10) and could be composed of zinc carbonate.



Credit HE-Arc CR.

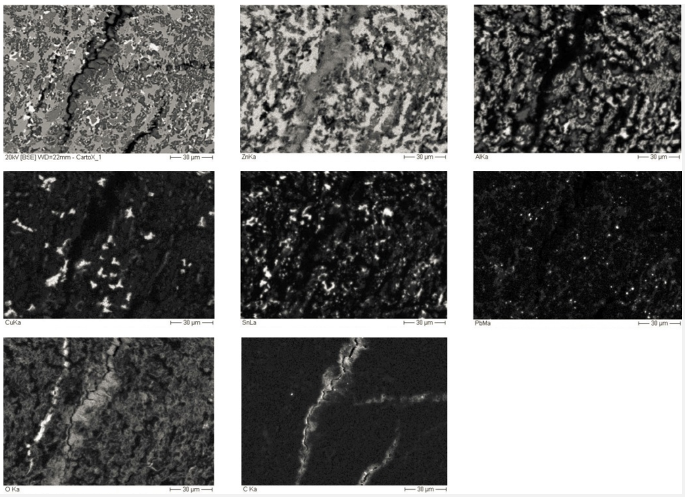
Fig. 8: Micrograph showing the metal - “corrosion products” interface from Fig. 3 (reversed picture, detail), unetched, bright field. We observe in white the metal matrix and dark-grey the adhering material,



Credit HE-Arc CR.

Fig. 9: Micrograph of the metal sample, detail from Fig. 8 (reversed and rotated by 90°), unetched, bright field. A dendritic structure is visible. The micrograph of Fig. 10 is marked by a rectangle,

Fig. 10: SEM image, BSE-mode, and elemental chemical distribution of the selected area from Fig. 9 (detail). Method of examination: SEM/EDX, Lab of Electronic Microscopy and microanalysis, IMA (Néode), HEI Arc,



Credit HE-Arc CR.

Corrosion form	Uniform - transgranular
Corrosion type	zinc pest

Complementary information

Nothing to report.

MiCorr stratigraphy(ies) – CS

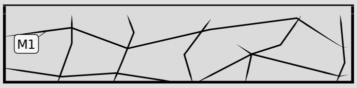


Fig. 4: Stratigraphic representation of the object in cross-section using the MiCorr application. This representation can be compared to Fig. 8, Credit HE-Arc CR.

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

Corrected stratigraphic representation: none.

Conclusion

The armature of the clock mechanism is constituted of a ZnAlSnCu alloy. The absence of cohesion between the different phases has led to the penetration of O during the manufacturing of the alloy. Small original cracks have developed further eventually causing the armature to break. This phenomenon, known since the 1920's, is called zinc pest. It develops mainly on cast objects, starting with localised modifications (blisters and pits, Cramer and Covino 2005).

It appears that the armature was made of an unsuccessful experimental alloy. The IMH has in its collection a similar mechanism with the same armature but made of an another more stable alloy, suggesting then that our armature was some kind of prototype element.

References

References on object and sample
References object
1. Seemater, V. (2009) Conservation-restauration d'une horloge à mouvement électrique, rapport interne HE Arc CR.

References sample

2. Seemater, V. (2009) Conservation-restauration d'une horloge à mouvement électrique, rapport interne HE Arc CR.

References on analytic methods and interpretation

3. Cramer, S.D., Covino Jr., B.S. volume editors. (2005). ASM Handbook**,** 13B, 37.