

# CURVED PIN OR TANG FK 2670.20 – TIN BRONZE – LATE BRONZE AGE – SWITZERLAND

Artefact name

Curved pin or tang FK 2670.20

Authors

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

Url

/artefacts/683/



Fig. 1: Curved pin or tang (after Fischer 1997, plate 43),

Credit HE-Arc CR.

# $\,\,$ $\,$ Description and visual observation

Description of the artefact	Curved pin or tang (Fig. 1). Several samples were taken. Only one is presented here (Fig. 2). The metal is covered with black corrosion products attributed to a burning process mixed with green corrosion products. Dimensions: L = 114mm; $\emptyset$ = 4.6mm; WT = 16.7g.									
Type of artefact	Not defined	ot defined								
Origin	Steinmöri, Neftenbach / Dor	teinmöri, Neftenbach / Dorf Neftenbach, Zurich, Switzerland								
Recovering date	Excavation in 1991?, grave 1	Excavation in 1991?, grave 18								
Chronology category	Late Bronze Age									
chronology tpq	1400	B.C. 🗸								
chronology taq	1300	B.C. 🗸								
Chronology comment	14th Century BC, Bronze Age	e D								
Burial conditions / environment	Soil									
Artefact location	Kantonsarchäologie, Dübendorf, Zurich									
Owner	Kantonsarchäologie, Düben	antonsarchäologie, Dübendorf, Zurich								
Inv. number	FK 2670.20									

## **Complementary information**

# Nothing to report.

℅ Study area(s)



Credit HE-Arc CR.

st Binocular observation and representation of the corrosion structure

Stratigraphic representation: none.

℅ MiCorr stratigraphy(ies) – B

# ℅ Sample(s)



Credit HE-Arc CR.

Fig. 2: Location of sampling area,

Fig. 3: Micrograph of the cross-section of the sample taken from the curved pin or tang showing the location of Figs. 5 to 9,

Description of sample	The sample (Fig. 3) is a section from the pin (or tang). The metal is covered by a thick corrosion crust (blue layer adhering to the metal, topped by a green layer mixed with black corrosion products - Museum report (1992)). Dimensions: L = 1.8mm; W = 1.2mm.
Alloy	Tin Bronze
Technology	Secondary recrystallization (produced by burning)

MiCorr | Curved pin or tang FK 2670.20 - Tin Bronze - Late Bronze Age - Switzerland This work is licensed under <u>CC BY-NC-ND 4.0</u> (c) (s) (s) (c)

Lab number of samp	ole	MAHS	92-5-4-00	02											
Sample location		Musée	es d'art e	t d'histe	oire, Ge	nève	, Gen	ieva							
Responsible instituti	on	Musée	es d'art e	t d'histo	oire, Ge	nève	, Gen	ieva							
Date and aim of sam	pling	1992,	examina	tion of	metallo	grap	hy e>	kamina	ition						
Complementary info	ormation														
Nothing to report.															
	ılts														
<i>Analyses performed</i> Metallography (etch	Analyses performed: Metallography (etched with ferric chloride reagent), Vickers hardness testing, EPMA/WDS, SEM/EDS.														
× Non invasive anal	lysis					1	1					1			
∀ Metal															
The remaining metal is a tin bronze (Table 1) with copper sulphide inclusions that contain some Fe (Figs. 5 and 6, Table 2). After etching, the tin bronze shows polygonal grains with few twins (Fig. 6). The grain size varies between 70 and 180µm indicating grain growth due to an extended or excessively hot annealing process. The copper sulphide inclusions appear in blue. The average hardness of the metal is HV1 70.															
	Elements	Cu Si	n Pb	As	Sb	Fe	Zn	Ag	Au	Со	Bi	Ni	S		
	mass% 8	9.94 8.1	1 0.63	0.41	0.29	0.24	0.1	3 0.1	0.1	0.04	0.01	<	n. d.		
Table 1: Chemical co	mposition of t	he metal.	. Method	ofanal	ysis: EP	MA/\	NDS,	Lab D	epartı	ment of	Mater	ials,	Unive	rsity of Oxford.	
			Eleme	nts		s	Fe	Cu 1	<b>Fotal</b>						
			Dark-b	lue inc	lusion	21	2.8	77	102						
Table 2: Chemical composition (mass %) of the dark-blue inclusions on Fig. 4. Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.															
Fig. 5: Micrograph of the metal sample from Fig. 3 (detail), unetched, bright field. In pink the metal, in light-blue the copper sulphide inclusions and in dark- blue corrosion products,															



Credit HE-Arc CR.



Credit HE-Arc CR.

Microstructure	Large polygonal grains with few twins
First metal element	Cu
Other metal elements	Fe, Co, Zn, As, Ag, Sn, Sb, Pb

#### **Complementary information**

Nothing to report.

#### ✓ Corrosion layers

The corrosion crust has an average thickness of 500µm but can in areas be much thicker (Fig. 3). It is divided in two layers. The inner layer is itself divided in two sub-layers: a thin light-grey sub-layer at the interface with the remaining metal surface (CP4, in bright field) which appears red-orange in polarised light (Fig. 7) topped by a medium-grey sub-layer (in bright field) that contains remnant metal (CP3). It turns dark-blue in polarised light (Fig. 7). The outer corrosion layer can also be divided into two sub-layers: a porous sub-layer (CP2) followed by a dark-grey sub-layer in which crystals are outlined by cracks (CP1, in bright field). Under polarized light, the latter turns blue-green while on top it appears olive and brown (Fig. 7). Chemically the corrosion crust is Sn enriched and Cu-depleted (Table 3, Figs. 8 and 9). The maximum of the Sn enrichment occurs on the outer olive and brown sub-layer (CP2). The corrosion layer also contains P, Si, C and O. Inclusions containing Fe or Ag can be found in the corrosion crust (Figs. 8 and 9).

Elements	0	Cu	Sn	Si		Fe	Pb		Cl	Total
CP1, outer corrosion layer	27	17	57	1.1	1.9	0.9	1.0	<	<	105

Fig. 6: Micrograph of the metal sample from Fig. 3 (same as Fig. 5), etched, bright field. In pink the metal with few twins, in black the resin and the corrosion products, in light-blue the copper sulphide inclusions,

CP3, inner corrosion layer	39	27	26	1.1	2.5	<	<	<	<	97
Remnant metal in CP3	<	88	8.3	<	<	<	<	<	<	97

Table 3: Chemical composition (mass %) of the corrosion crust from Fig. 7. Method of analysis: SEM/EDS, Laboratory of Analytical Chemistry, Empa.



Fig. 7: Micrograph of the metal sample from Fig. 3 (detail) and corresponding to the stratigraphy of Fig. 4, unetched, polarised light. At the metal - corrosion products interface the colour of the corrosion layer is dark-blue, changing to green-blue in the outer part. The top surface of the corrosion crust is olive to brown,

Credit HE-Arc CR.



Fig. 8: SEM image, BSE-mode, and elemental chemical distribution of the selected area from Fig. 3 (due to repolishing before SEM/EDX investigation, the SEM image is slightly different from the area indicated in Fig. 3). The rectangle in the SEM image marks the detail mapping of Fig 9. Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa,

2008-3-	Т100µт	Ta Cu Ka1	Сорински страна 100µт	O Ka1	27
39 100µm Sn La1	100µт	20 P Ka1	100µт	Si Ka1	16
100µm C Ka1_2 Credit Empa.	100µm	19 Fe Ka1		Ag La1	43
Corrosion form Corrosion type		Uniform - Type II (Ro	intergranı bbiola)	ılar	
Complementary informat	tion				

Nothing to report.

## ℅ MiCorr stratigraphy(ies) – CS



Fig. 4: Stratigraphic representation of the sample taken from the curved pin or tang 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.

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

Corrected stratigraphic representation: none.

## imes Conclusion

The tin bronze was exposed to an extended or excessively hot annealing process. This, combined with the extreme thickness of the corrosion crust and the dark surface, confirms that the object originates from a fire burial context. At the metal - corrosion crust interface some copper oxide (cuprite?) occurs. On top copper carbonates (azurite or malachite?) are mixed with tin oxide (cassiterite/SnO2?). Tin oxide dominates in the brown-black extremely Sn-rich outer layer. The P-enrichment in the whole corrosion

Fig. 9: SEM image, SE-mode, and elemental chemical distribution of the selected area from Fig. 8. Method of examination: SEM/EDS, Laboratory of Analytical Chemistry, Empa, layer may be due to an environment rich in organic material (for example bones). The original surface of the metal has been destroyed, presenting a type 2 corrosion layer after Robbiola et al. 1998.

# imes References

#### References on object and sample

Reference object

1. Fischer, C. (1997) Innovation und Tradition in der Mittel- und Spätbronzezeit. Monographien der Kantonsarchäologie Zürich 28 (Zürich und Egg), 181 and plate 43.

#### Reference sample

2. Fischer, C. (1997) Innovation und Tradition in der Mittel- und Spätbronzezeit. Monographien der Kantonsarchäologie Zürich 28 (Zürich und Egg), 96.

3. Rapport d'examen 92-5-4 (Schweizer, F. and degli Agosti, M.), Laboratoire Musées d'art et d'histoire, Geneva GE (1992).

### References on analytic methods and interpretation

4. Robbiola, L., Blengino, J-M., Fiaud, C. (1998) Morphology and mechanisms of formation of natural patinas on archaeological Cu-Sn alloys, Corrosion Science, 40, 12, 2083-2111.