Fakes in African art: study of a reliquary figure *(Mbulu-Ngulu)* from Gabon

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The aim of the present work is the chemical and microstructural characterisation of a reliquary figure, stylistically consistent with the art of the Kota population, which lived in the eastern part of Gabon (Africa). The artefact was subjected to preliminary observation by stereomicroscopy, and then Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) analyses are carried out on a fragment and on surface compounds. Lastly, AMS radiocarbon dating of the wooden support allowed further information about the production period to be obtained. The results show that the artefact was produced by a Cu-Zn alloy and contains non-metallic impurities made up of S and Se. The greenish and whitish surface compounds, which are mainly collected near the nails and in proximity to the overlaid sheets, are probably only partly related to natural corrosive processes. Finally, radiocarbon dating established that the wooden support certainly dates after 1950.

Keywords: Copper and alloys – Material characterisation – Metallography – Electron microscopy – Metallurgy

INTRODUCTION

The proliferation of fakes in African arts has grown enormously in recent years, with a particular explosion since the 1950s, due to an increase in demand by collectors, which created new fields of activities for African foundries. In fact, in the 1980s the quantity of antiquities on sale increased further and today many replicas of tourist souvenirs and fanciful copies of traditional forms enrich the art market.
The official definition of authenticity for African artefacts consists of two inseparable conditions: any object created for a traditional purpose and by a traditional artist may be considered authentic [1].
It is rather difficult to determine if an African artefact is original or a copy because literature is characterised by incomplete information about the African arts and the production of artefacts by artists [2]. The studies of African artefacts are somewhat incomplete since there is no correlation between the style used in these works, the materials used to produce them and the geological context of the extraction zone.
Archaeometric analyses are essential to determine the state of conservation of the objects as well as to evaluate the production period in order to establish the authenticity of the artefacts.
The aim of the present work is the characterisation of a sculpture, stylistically consistent with the art of the Kota population, which lived in the eastern part of Gabon (Africa). This community is known for the realisation of metallic reliquary figures, which were set on wooden supports and called *Mbulu-Ngulu* or *Bwéte*. It should be noted that the first samples of these sculptures arrived in France and Germany during the last quarter of the 19th century. Reliquary artefacts should, however, be more ancient given that the local copper mines had already been exploited to obtain metal for the coating of artefacts [3].
Unfortunately, the majority of researchers have relied solely on stylistic analyses of the ornaments, which decorate the surface of the objects. More extensive investigations on the chemical composition of the alloy of the artefacts, in conjunction with a systematic characterisation of original African metallic objects would allow the evaluation of the provenance and the dating of Kota funeral art [4].
The present paper focuses on the investigation of the symbolic representation of a human abstract figure whose head is bigger than the rest of the body. These abstract figures were used to protect and demarcate the bones of family ancestors, which were preserved in containers made of bark.
The artefact consists of a carved piece of wood (42 cm in height, 23 cm wide and 2 cm thick) covered on one side with metal sheets, which were fixed onto the support with

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Fig. 1 – Macroscopic images of the sculpture: front (a), back (b) and side view(c).

Fig. 1 – Immagini fotografiche del manufatto: parte anteriore (a), parte posteriore (b) e visione laterale (c).

small metallic nails. These metal sheets are very thin in order to fix almost perfectly to the carved wood. The following morphological elements of the sculpture are detectable in Fig 1a-c:

- The oval face has stylised eyes and nose but the mouth is not depicted. Two metallic plates are nailed onto the surface to represent a cross. In agreement with E.W. Herbert [5] this element has been found starting from the end of the 15^{th} century as a result of the Congolese population's conversion to Catholicism;
- Two lateral parts at ear-level which are often considered the representation of a hat;
- Two cylindrical pendants placed on the base of the lateral parts, which are the abstract representation of traditional male and female hairstyles;
- One half-moon shaped sheet is located above the oval face and harmoniously integrated with the lateral parts;
- One rhomboid element that symbolises the body and the legs, placed on a rectangular wooden base;
- Another rhomboid element, on the back of the sculpture, stretched along the vertical axis and with a protruding "vein".

The goal of the present work is the chemical and microstructural characterisation of the sculpture as well as of the products located on its surface. The analyses were carried out by stereomicroscopy, Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) coupled with Energy Dispersion Spectroscopy (EDS). Finally, a wooden fragment of the support was analysed using Accelerator Mass Spectrometry (AMS), which enabled radiocarbon (^{14}C) dating of the artefact.

MATERIALS AND METHODS

The sculpture was observed by stereomicroscopy, equipped with a Moticam 2500 – 5 Mp camera, in order to obtain information on the manufacturing technique and to check the state of conservation. The investigations have revealed the presence of some compounds, which are mainly concentrated near the nails and in proximity to the overlaid sheets.

Thereafter, the evaluation of the alloy and the composition of the different colour surface compounds was carried out using a ZEISS EVO MA 15 Scanning Electron Microscope (SEM), coupled with Energy Dispersion Spectroscopy (EDS).

Moreover, a metal fragment of a few millimetres was taken from an unobtrusive area of the sheet. The sample was mounted in conductive resin, polished and submitted to conventional metallographic observation using LEICA MEF4M Optical Microscopy (OM).

Lastly, a sample of a few grams was collected from the base of the wooden support and subsequently was dated using Accelerator Mass Spectrometry (AMS) at Centro di Datazione e Diagnostica (CEDAD) – University of Salento.

RESULTS AND DISCUSSION

Macroscopic investigations

Preliminary macroscopic investigations have yielded a great deal of information about the manufacturing technique as well as the nature of the products located on the surface.

In agreement with some of the literature and private communications expressed in the last few years [4], the parts of the face that are not overlaid by the two metallic sheets (positioned in a cross) consist of a single plate. These are decorated with *"lamellage"*, a technique characterised by various equidistant streaks, which are placed in a slanting or horizontal pattern. These strips are also depicted on the half-moon sheet and on the rhomboid element that symbolises the body and the legs. In the latter two cases, a multitude of pitting embossed using a punch also decorates the surface of the plate [4].

Fig. 2 shows representative images of the rare compounds using stereomicroscopy, which were mainly collected near the nails and in proximity to the sheets. The colouring of these products is clearly green or whitish.

Fig. 2 – Macroscopic images of the different colour compounds that appear on the surface.

Fig. 2 – Macrografie rappresentative dei composti che si presentano con cromie differenti.

In particular, in Fig. 3a a shrinkage cavity of remarkable dimensions, formed during the alloy solidification, is visible. Fig. 3b also shows the microstructure of the alloy after chemical etching by $FeCl_3/HCl$. The presence of both non-homogeneous grain size and thermal twin bands would suggest that the artefact was obtained by alternate hammering and annealing steps. It should be noted that the variable grain size is probably due to a heterogeneous plastic deformation induced by manual hammering.

Chemical analysis

Fig. 4a shows a SEM image of the alloy together with the corresponding EDS spectrum. SEM-EDS analysis highlights that the artefact was produced by a Cu-Zn alloy, without the addition of alloying elements, i.e. Pb. No impurities (i.e. As, Fe, Sb), which are very common in the ancient alloys, were detected. It should be noted that, comparable amounts of Cu and Zn (Fig. 4b) could also be found in modern brasses such as the commercial "Yellow Brass" which contains 65 wt.% of Cu and 35 wt.% of Zn [7].

Fig. 5a shows a SEM image of rare microscopic inclusions that are visible in the alloy. In particular, SEM-EDS analysis allows the verification of the presence of non-metallic impurities enriched with S and Se. To our knowledge, only one reference reports some South African (Lowveld) metallic artefacts [8], approximately dated from 1000 A.D. to 1980 A.D., which were characterised by many copper-iron sulphide inclusions containing up to 3% Se by weight, residual from incomplete ore reduction.

Over the centuries, the Kota reliquary figures went into stylistic decline and they were characterised by more abstract and grotesque meanings. Moreover, the demand for these artefacts from Western collectors has grown enormously in recent years, causing the proliferation of sculptures without any "funerary" meaning for the purpo-

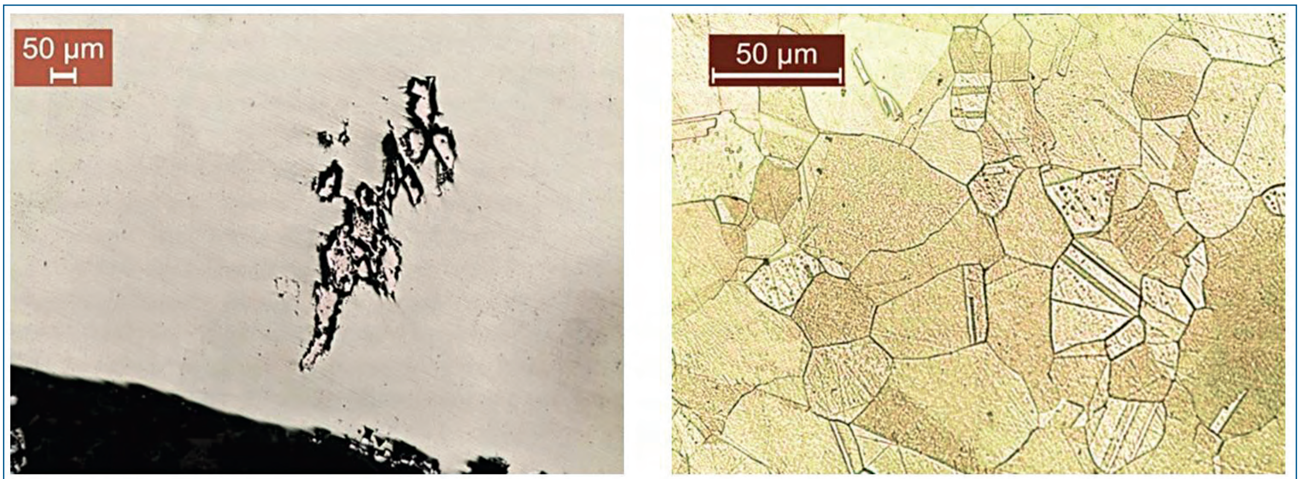


Fig. 3 – Optical images of: (a) a detail of a shrinkage cavity on the polished surface; (b) the microstructure of grains with the presence of thermal twin bands on the chemically etched surface.

Fig. 3 - Micrografie OM del manufatto: cavità da ritiro (a), in assenza di attacco metallografico; microstruttura a grani e geminati (b); in presenza di attacco con reattivo a base di cloruro ferrico.

Radiocarbon measurement

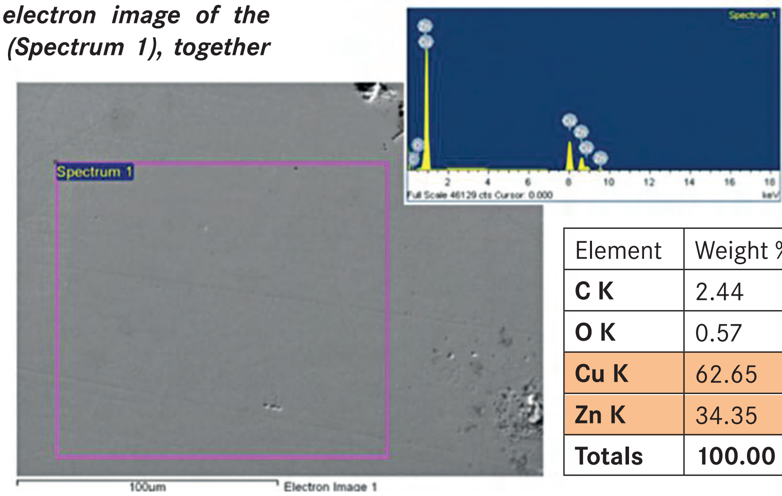
The AMS radiocarbon dating established that the wooden support is certainly dated after 1950. It is well known that the production of these sculptures ended around the 1930s because of the great number of Catholic missions, which imposed a new social organisation based on Western households [4]. Finally, it should be pointed out that the integrity as well as the total absence of signs due to a wooden support substitution is clearly evident.

Microstructural analysis

After metallographic preparation, the microstructure of the metal fragment taken from the sheet was highlighted.

Fig. 4 – SEM backscattered electron image of the alloy indicated by pink square (Spectrum 1), together with the corresponding EDS spectrum; (b) average composition of the area in Fig. 4a (measured by EDS). The contents of Cu and Zn are highlighted in Fig. 4b

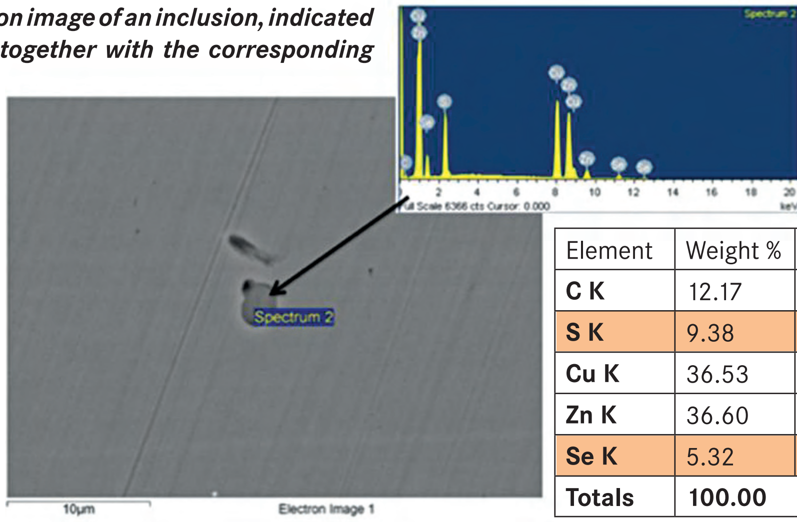
Fig. 4 – (a) immagine al SEM della matrice metallica con indicazione (Spectrum 1) della zona analizzata e corrispondente spettro EDS; (b) dati semi-quantitativi relativi allo spettro in Fig. 4a. In Tabella vengono evidenziati i contenuti di Cu e Zn.



Element	Weight %	Atomic %
C K	2.44	11.59
O K	0.57	2.03
Cu K	62.65	56.35
Zn K	34.35	30.03
Totals	**100.00**	

Fig. 5 – SEM backscattered electron image of an inclusion, indicated by a black arrow (Spectrum 2), together with the corresponding EDS spectrum; (b) average composition of the analysed point in Fig. 5a (measured by EDS). The contents of S and Se are highlighted in Fig. 5b.

Fig. 5 – (a) immagine al SEM di una delle inclusioni visibili all'interno della matrice metallica con indicazione (Spectrum 2) della zona analizzata e corrispondente spettro EDS; (b) dati semi-quantitativi relativi allo spettro in Fig. 5a. In Tabella vengono evidenziati i contenuti di S e Se.



Element	Weight %	Atomic %
C K	12.17	40.42
S K	9.38	11.66
Cu K	36.53	22.92
Zn K	36.60	22.32
Se K	5.32	2.69
Totals	**100.00**	

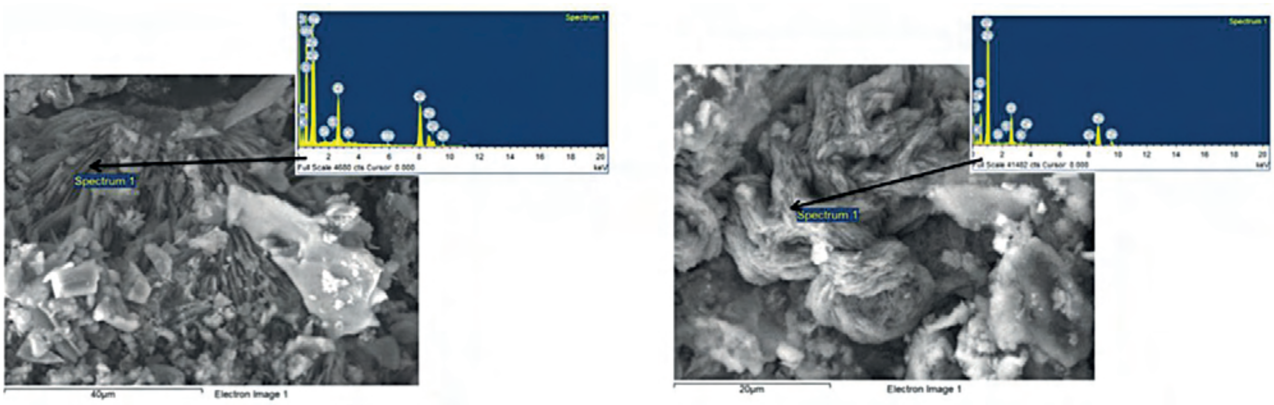


Fig. 7 – Representative SEM image of the morphology of surface whitish compounds, together with corresponding EDS spectrum.

Fig. 7 – Micrografia SEM dei composti di colore biancastro e relativo spettro EDS.

se of enriching the flourishing art market. Starting from the first decade of the 20th century, the practice of recasting damaged copper and brass to recover the precious metal was very common. In particular, E. Andersson [9] highlighted that many *"Mbulu-Ngulu"* were obtained by recasting ancient alloy which was later mounted in more recent wooden supports (second half of the 20th century). In this regard, because of the perfect realisation of the artefact without the addition of alloying elements or common impurities, the rare Se inclusions and the dating of the wooden support (see § *Radiocarbon measurement*), it is possible to further suppose that the sculpture analysed in this paper was realised by the methods described by Andersson in [9].

The SEM image of the greenish surface compounds together with the corresponding EDS spectrum is reported in Fig. 6. Because of the small amount of products on the surface, it was not possible to take samples and to carry out specific analyses like XRD or Raman spectroscopy. First of all, the morphologies in Fig. 6a and 6b are very different. It should be noted that the needle-like or lamellar structure shown in Fig. 6a is frequently observed in copper carbonate compounds. This evidence is supported by SEM-EDS analysis. On the contrary, the same technique would suggest that the compounds of Fig. 6b are probably zinc oxychloride.

Fig. 7 is a representative SEM image of whitish compounds, which are mainly collected in proximity to the overlaid sheets. The EDS spectrum emphasises high concentrations of Cl and Pb. In particular, the latter element is totally absent in the alloy and it is possible that it is not produced by natural corrosive processes.

CONCLUDING REMARKS

The present work has proved the usefulness of an interdisciplinary approach to clarify some general aspects about the manufacturing process and the state of conservation of metal artefacts.

Macroscopic examinations have highlighted a good state of conservation of the sculpture and a manufacturing process consistent with the reliquary Kota art.

Observations by Optical Microscopy (OM) have established that the sculpture was obtained by a casting and was subsequently subjected to alternate hammering and annealing stages.

SEM-EDS analysis has highlighted that the artefact was produced by a Cu-Zn alloy, with an amount of the latter elements comparable to those that could can be found in modern brasses (i.e. "Yellow Brasses"). The absence of alloying elements and the presence of rare Se inclusions bear witness to an advanced manufacturing process and this suggests that the artefact was obtained by a rather recent recast. Finally, the chemical analyses of greenish and whitish surface compounds lead to the assumption that they are only in part related to natural corrosive processes.

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