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THE GILDING TECHNIQUE ON LEAD OBJECTS OF THE ROYAL PALACE IN CASERTA (ITALY) STUDIED BY pXRF

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ABSTRACT

Several lead objects were found gilded at the Royal Palace in Caserta (1752, Italy) and the gilding technique of nine of them was analysed. Historical research shows that lead was used because of its easy workability, wide availability, and low cost, and was also gilded like wood or stucco. XRF analysis made it possible to determine the elemental composition of the layering created for gilding, highlighting its characteristics and differences. Standard samples with similar features were made for the characterization of the stratigraphy of interest through the XRF technique. The novelty found in this study is that lead was also gilded using the gouache technique, that is a layering with *gesso*, Armenian bolus and gold leaf. The restoration interventions carried out in the past were highlighted. The results found are very useful for museum conservators and restorers as well as for research.

KEYWORDS: Gilding on lead, Gouache gilding, Lead artworks, Royal Palace in Caserta, XRF technique.

1. INTRODUCTION

In the field of cultural heritage, conservators and museum restorers require specific analysis to deepen their knowledge of artifacts. Determining the materials used and the techniques employed can help define the main methods of intervention and conservation to be implemented on a work of art (Liritzis et al., 2020; Mantler and Schreiner, 2000). The reasons for investigation are also often related to dating in a precise historical and artistic context and verification of authenticity.

The study of gilding, used to embellish objects, is also of great interest. In fact, the gilding of stucco, metal and wood has been established since ancient times as a precious and refined surface finishing technique, also by virtue of the ductility and malleability of this material and its good resistance to attack by alcohols and ordinary acids (Marconi, 2001).

The gilding technique is of Mediterranean and Oriental origin and developed in the Byzantine and early Christian periods, remaining unchanged until the 17th century, lavishly invading architectural ornaments and decorations (Marconi, 2001).

Gold can be used pure or in gold-based alloy using silver, copper or both metals (Darque – Ceretti et al., 2011) and on substrates of different nature. In most cases wooden objects are covered with a pure gold finish or sometimes with metal coined to reproduce a false gold. The gilding technique most used to embellish these objects is the gouache gilding. It is carried out by laying the pure 24 carat gold leaf on a layer of clay composed of Armenian bolus, which facilitates its adhesion and sealing. Before the layer of bolus, a layer of preparation is applied composed mainly of gesso and animal glue (rabbit and fish generally). Once the laying of the gold leaves is completed, everything ends with the burnishing (polishing) phase which is done through the agate stone to make the gold even brighter. The bolus can be of various colours, also according to the final effect to be obtained, but the most used is the red one. Sometimes silver replaces gold, and a natural yellow varnish (shellac) is then applied over it to simulate gold, but of course at a lower cost (mecha gilding).

Another gilding technique widely used is the mission or mordant gilding. It is like gouache gilding with the difference that the bolus layer is replaced by a "mission", which is an oil-resin or water-based adhesive that allows the overlying gold leaf to adhere and therefore will not be burnished.

The earliest historical information of gilding metal objects using *gesso* concerns the gilding of bronze, used in ancient Egypt (McArthur et al., 2015), and of copper during rescue work in the northern cemetery of ancient Demetrias at Volo (Asderaki and Rehren, 2008). The technique consisted of first applying a layer of plaster or a layer of fine-grained plaster-like material to cover the metal core.

The purpose and particularity of this study is the analysis of gilding performed on objects with lead structure. It is, to the best of our knowledge, unusual and not highlighted in the literature for other works of art.

Many researchers have devoted decades to the study of gilding using XRF, particularly trying to estimate the layer of gold that covered the works of art (Cesareo et al., 2013; Cesareo et al., 2020; Guerra M. F, 2008; Pessanha et al., 2019b; Ridolfi R., 2008). However, the presence of Pb is due to the use of lead white as a mordant, for example in the Manueline charters letters of Murça (Pessanha et al., 2014), in the frescos in the Chapel of the Scrovegni by Giotto (Cesareo, 2003; Cesareo et al., 2008), in the church icons form the Baptism museum of Jordan (Al Khasawneh and Elserogy, 2019), in the Indo-Portuguese panel paintings (Pessanha et al., 2019a) and also in the analysis of an 18th century Brazilian Imperial carriage (Nardes et al., 2019), but not as an object entirely made of lead, as in our case.

The XRF technique is used to analyse nine selected gilded lead objects present in the royal apartments and in the storeroom of the museum of the Royal Palace, including two winged lions that serve as the feet of Francesco II's bed in the so-called Murat Apartment and floral decorations located on mirrors in the boudoir of Queen Maria Carolina and in the museum's storeroom. These objects are studied for the first time using pXRF with the aim of determining the gilding technique used. They represent a novelty as they have a lead structure and are completely gilded. In fact, lead is not among the main metals chosen as a support material for gilding (McArthur et al., 2015; Asderaki and Rehren, 2008) and wood is preferred among the non-metals (Afifi et al., 2020; Blonski and Appoloni, 2014).

2. MATERIALS AND METHODS

The Royal Palace in Caserta and the museum environments of the objects analysed

The construction of the Royal Palace in Caserta (Italy, Fig. 1) began in 1752 at the behest of King Carlo III of Bourbon (1716-1788) in a program of expansion and adaptation of public buildings in Naples which in 1734 became the first capital of a national monarchy established in Southern Italy. His desire was also linked to the need to remove the administrative and representative seat of the kingdom from the risks of order and security in the city of Naples. The project of the palace, destined to rise on the flat land of the actual city of Caserta and that at the time belonged to the feud of the Princes of Acquaviva, is assigned to

the architect Luigi Vanvitelli. At the date of Vanvitelli's death (1773), the works were still unfinished, so a new generation of architects stepped in, first of all, his son Carlo Vanvitelli (Progetto, 2014).

Figure 1. Map of Italy showing the location of the city of Caserta where the Royal Palace is.

The palace has been declared a World Heritage Site by UNESCO since 1997. It covers an area of about 47000 m² and is 36 m high. Inside there are 1200 rooms, 56 stairwells and 1046 fireplaces and, on the back, there is a wonderful park full of gardens, fountains and buildings that stretches for 3 km in length over 120 ha (Reggia di Caserta, LAVORI Palazzo Reale, 2021).

From the museum point of view, the Royal Palace in Caserta is rich in collections of works and furnishings. Despite significant dispersions, the Royal Palace received multiple and progressive enrichments during the Bourbon period, the Neapolitan Murattian season, the Bourbon restoration and finally the flow of historical events related to the post-unification of Italy (Progetto, 2014).

Walking around the royal apartments, one finds many decorative elements and real objects (chandeliers or clocks of the consoles) made of gilded metal (bronze, brass, copper, etc.).

The objects in gilded lead covered by this paper are found among the most important rooms of the Royal Palace, some of which are in the museum's visitable itinerary, namely the Royal Apartments that were designed by Luigi Vanvitelli for the king and crown prince.

In order there is the *Hall of Bodyguards (*one of the five antechambers that precede the *Throne Room*) which housed the soldiers chosen by the noble families to watch over the king's safety. Here, the furniture is composed of gilded consoles of Neapolitan manufacture from the second half of the eighteenth century (Fig. 2), on which are placed the busts of the sovereigns who succeeded the government of the Bourbon kingdom (Progetto, 2014).

Figure 2. Hall of Bodyguards (Reggia di Caserta, 2019) (a) and the gilded console analysed by XRF analysis (b)

Having reached the *Hall of Alexander the Great*, located in the centre of the facade of the Palace, on the left is the *Eighteenth-century Apartment* (*Old Apartment)* which was inhabited by Ferdinando IV of Bourbon and his consort Maria Carolina of Hapsburg, as completed in the decoration and furnishings already in the last years of the eighteenth century (Progetto, 2014).

Here is located the *Her Majesty's Apartment*, Queen Maria Carolina, consisting of four rooms in the rocaille style: the second room is the boudoir known as the *Hall of Mirrors* whose furniture surrounded by walls of yellow satin and floral decorations (Fig. 3).

Figure 3. Hall of Mirrors (Guide Turistiche Frosinone – Altervista, 2021) (a) and gilded floral decorations analysed by XRF analysis (b).

From this room there is access through two doors to the *Toilet for bathroom use* and to the *Toilet for limitated use*. In the first there is a mirror in three sections framed with vegetable rechemera in gilded lead made by the artisan Gennaro Fiore (Fig. 4). It has a circular opening in the terminal part in the upper centre that in the antiquity was called 'eye' (Catalogo generale dei Beni Culturali, Specchiera, 1750 – 1799).

Figure 4. Mirror of Toilet for bathroom use (Catalogo generale dei Beni Culturali, Specchiera, 1750 – 1799) (a) and analysed part of vegetable rechemera (b)

Beyond the *Throne Room*, which closes the rooms of the *Nineteenth-century Apartment* the sovereign's private apartments begin. Here is the bedroom of Francesco II of Bourbon whose current furniture, in Empire style, dates back to the years of the Restoration.

The bed *en bateau* in inlaid wood has the backs decorated with gilded ornaments. On the base of the bed rest four carved and gilded wooden spades and the structure ends with a high fabric canopy (yellow silk and muslin curtain embroidered with lace) with a crown at the top. The four corners are enriched by a refined all-round decoration, four herms, under which there are four winged lions resting on mahogany bases (Catalogo generale dei Beni Culturali, Letto en bateau, post 1808 – ante 1825). In detail, two lions are in gilded wood and two in gilded lead. Only the latter two are the subject of this study using XRF (Fig. 5).

Figure 5. Bedroom of Francesco II of Bourbon (a) and winged lion in gilded lead (b).

Some of the gilded lead objects that were analysed are preserved in the Museum's storage room, located on the fourth floor of the palace. Inside the storeroom there is a conservation laboratory for small maintenance of the collection that allows the relocation of some objects.

These are small and medium-sized fragments of floral decoration that need careful study of recovery and relocation (Fig. 6).

Figure 6. Pictures of fragments: (a) floral decoration; (b) floral decoration of the Toilet for limited use; (c) two gilded flowers.

Reference samples

For an accurate analytical evaluation of the x-ray spectra of the analysed objects, we commissioned an expert restorer of the Royal Palace in Caserta to create ten reference samples, retracing the various phases and reproducing the various preparatory layers of gilding gouache on lead (Fig. 7).

The materials used in the gilding process are Bologna *gesso* dust, rabbit glue, Lefranc red bolus, 24 K gold leaf (Giusto Manetti Battiloro, Firenze), flakes of dewaxed and natural shellacs. Table 1 shows the stratigraphic characteristics of the ten reference samples made for gouache gilding.

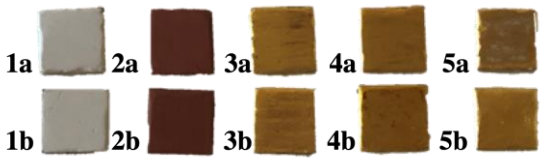

Figure 7. Photos of the lead reference samples with the various layers of gouache gilding (see Table 1).

Table 1. Stratigraphic characteristics of the ten reference samples made for gouache gilding. Roman numbers in parentheses identify the order of the layers applied.

Material/treatment	Reference samples					
	1a - 1b	2a - 2b	3a - 3b	4a	4b	5a - 5b
Lead base	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)
Bologna gesso layer	X (II)	X (II)	X (II)	X (II)	X (II)	X (II)
Armenian bolus layer		X (III)	X (III)	X (III)	X (III)	
Gold leaf			X (IV)	X (IV)	X (IV)	X (III)
Dewaxed shellac treatment				X (V)		
Natural shellac treatment					X (V)	

The preparation layer ("ammannitura") was made with sieved Bologna *gesso* bound with rabbit glue, prepared with water in a ratio of 1:7, left to dissolve overnight and then heated in a bain-marie. The preparatory layer was applied in several coats (3 or 4) with a bristle brush. It was then sanded with fine and

extra-fine sandpaper to remove the roughness of the plaster.

To facilitate adhesion and hold, a couple of coats of Lefranc red bolus slightly diluted with animal glue (rabbit glue diluted with water) were applied with a brush.

The gilding was done by applying a single 24 carat gold leaf using a brush made of marten hair, called palette for gilders, previously greased brush, cut with a gilder's knife in the appropriate mat, and applied over the bolus layer. The bolus was moistened with Vajo's brush. The gold leaf was burnished using agate stone.

On samples 4a and 4b, dewaxed and natural shellacs were applied in flakes with a flat brush, after dissolution in alcohol. The use of shellac as an adhesive and especially as a binder is not common, however, its presence has been found in some gildings in the Royal Palace.

pXRF

Portable x-ray fluorescence technique (pXRF), which provides significant results in the archaeometric study of objects of historical and artistic interest (Hein, 2021; Liritzisand and Zacharias, 2011; Liritzis et al., 2020; Perea et al., 2018), is well suited to these applications because it is non-destructive and non-invasive, capable of determining the chemical elements present in the surface of an object in a very short time. Therefore, surface gold is easily and quickly detected. The application of XRF is widely used in studies of historical gilding techniques (Laskaris et al. 2020; Wu et al., 2018).

There are several examples in the literature including the analysis of polychrome statues and frames of panel painting (Hradil et al., 2017), antiphonary illuminations (Doni et al., 2014), jewels (Karydas, 2007; Scrivano et al., 2017; Sabbarese et al., 2021), polychrome sculptures covered with Zwischgold foils (Wu et al., 2018; Wu et al. 2020), gold leaf (Aldrovandi et al., 2011) and decorated elements of altarpieces (Sandu et al., 2013).

Detailed analysis of XRF spectra also allow estimating the thickness of gold as a coating material on metallic objects (Brocchieri et al., 2020b; Brocchieri et al., 2021b; Lopes et al., 2016; Pessanha et al., 2014; Sabbarese et al., 2021). Other such studies are conducted on silver-plated objects (Brocchieri et al., 2018; Brocchieri et al., 2021a) and on different metals (Martinuzzi et al., 2021).

Here, the pXRF measurements were carried out on nine untreated objects present in the royal apartment and in the storeroom of Royal Palace in Caserta using a hand-held system XRF (XSORT XHH03 Spectro). The objects were analysed at different measurement points to assess the differences potentially introduced by the method and/or by the selection of the measurement area. Portions of the flat surfaces of the objects were carefully chosen based on easy positioning of the instrument by hand or by using a tripod, which was built specifically to support the instrument. The measuring window of the instrument was placed delicately on the surface of the artifact.

The spectrometer is equipped with a Rh-target X-ray tube. It operates at 50 kV with a current of 125 μA. The used Si drift detector has a 10 mm^2 active area and approximately 160 eV energy resolution at the K_α line of Mn (5.9 keV). No collimator was used. The measurement area has an estimated diameter of approximately 10 mm.

In the present work the method 'Light element' was used, it has proved in the past to be suitable for metal studies (Brocchieri et al., 2018; Brocchieri et al., 2020a; Brocchieri et al., 2020b; Brocchieri et al., 2020c; Brocchieri et al., 2021b; Sabbarese et al., 2021). The selected duration of the measurements, carried out in air, was 20 s for each sample, measuring in two energy intervals (10 s using 50 kV tube voltage and 10 s with 15 kV). The system was either fixed on a stand so that the sample could be positioned from above or was hand-held, depending on the size of the fragments being analysed; in the case of objects in the storeroom, the measurements were made inside the docking station. Acquisition and analysis of the XRF spectra are carried out using the XRF Analyzer CE and XRF Analyzed PRO software.

3. RESULTS AND DISCUSSION

The first qualitative chemical analyses carried out on various gilded lead objects in the royal apartments showed that the gouache technique was used to gild lead with the same procedure applied on wooden or other supports. The uniqueness and originality of the result is due to the lack of other metal works describing gilded metal objects in this way, let alone in lead. This is not known in the scientific literature, but very common in the Royal Palace of Caserta. The lead objects were probably made due to the great availability of the raw material and the easy workability. The gouache gilding technique was probably used because the gilders were very expert and therefore easily reproduced it even if the support was different from the wooden one.

The lead objects analysed are reproduced in copies in the rooms of the museum where they were found. They were probably produced in series using the indirect lost-wax casting method. It consists of creating a plaster mould of an existing model (such as the winged lions Fig. 5). The wax is swished inside the mould to ensure an even coating (about 3 mm), resulting in a hollow sample made of very delicate wax. A

structure of pins, vents and drainage channels is inserted to keep the mould stable while the wax melts. Plaster is used to fill the sample and coat the outside, creating the final mould. The mould is placed in the oven, the wax melts and pours the molten metal into the mould. Once the metal has cooled, the plaster mold is broken. The sprues are cut and the pins removed, and the sculpture is polished (with nettitura work) (Giubbini, 1973). This method had the advantage of being able to produce much larger castings and make more copies of the same object. The detailed description by Vasari (Vasari, 1550) of all the steps of the indirect method suggests that it is an ancient procedure (Hunt, 1980) that has been widely used since the 16th century.

Research carried out in the archives and inventories of the Royal Palace in Caserta (ASCR, 1780) revealed that the royal gilder and assistant of all the work was Antonio Pittarella, together with Felice Giliberti and Bartolomeo di Natale.

Reference samples analysed by XRF

To qualitatively assess and highlight the different gildings using XRF analysis, reference samples were created for comparison with objects in the Royal Palace in Caserta (see Reference samples in Materials and Methods). The individual materials used for gouache gilding were analysed (Table 2), followed by the materials used in the gilding process.

Table 2. Elements detected by XRF analysis of the materials used for gilding. For each material, they are listed in descending order of the concentration value.

Material	Elements	Trace elements
Bologna gesso	Ca, S	Sr, Fe, Ti, K
Rabbit glue	//	Cl, Ca, S, Fe
Lefranc red bolus	Fe, Si, Al, Ti	Ca
23 and 3/4 K gold leaf	Au	Cu, Fe
Natural shellac	//	Ca, K, Fe

Fig. 8 displays the XRF spectra of reference samples 1a and 2a. For greater clarity, the part of the spectra is shown (from 0 to 9 keV) where the peaks of the characteristic elements of the preparatory layer (Bologna *gesso*) and the Armenian bolus layer are present.

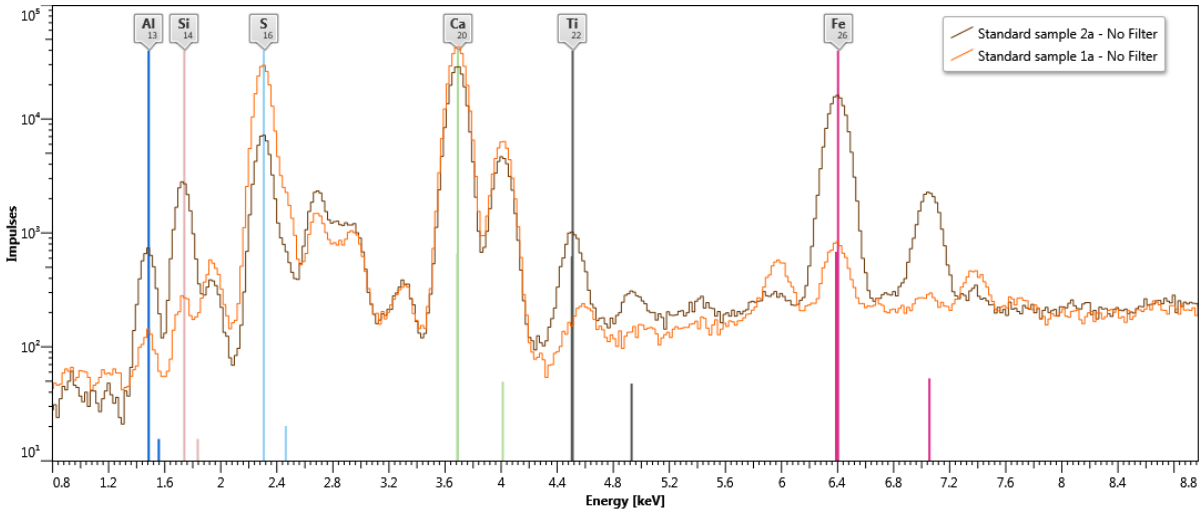

Figure 8. Part of the XRF spectra (from 0 to 9 keV) of samples 1a (orange) and 2a (brown) in which the peaks of the characteristic elements of the gesso preparatory layer and the Armenian bolus are present and highlighted.

The x-ray fluorescence spectrum of 1a acquired shows a discrete presence of S and Ca (characteristic of the *gesso*), while that of 2a shows the presence of Al, Si, Ti and Fe (characteristic of the bolus) in addition to those relative to the "ammanitura" layer.

Fig. 9 shows the XRF spectra of samples 3b and 5a where the characteristic elements of the preparatory layers, the gilding and the lead structure are highlighted.

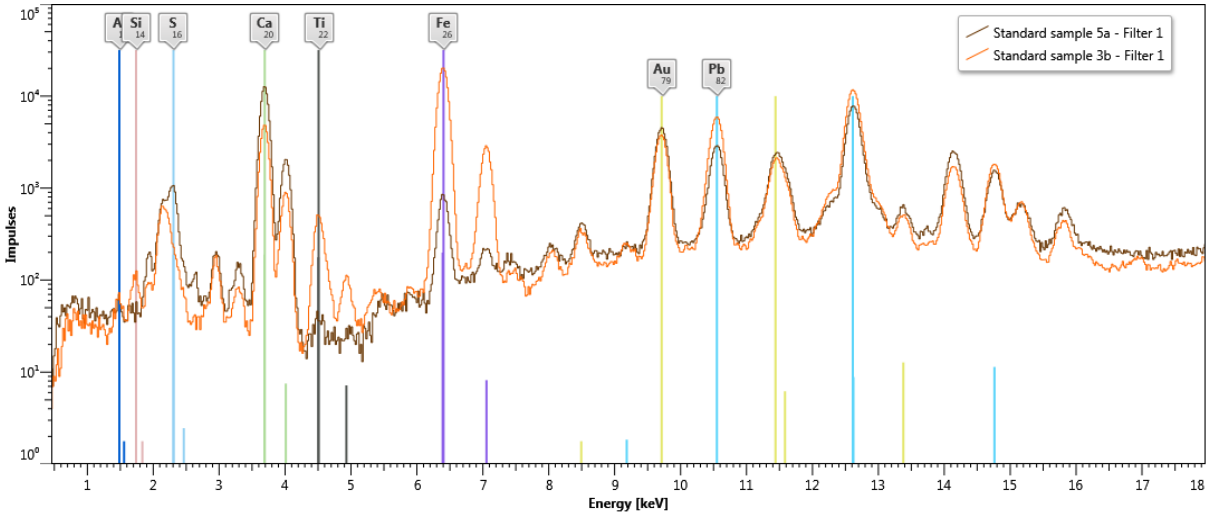

Figure 9. XRF spectra (from 0 to 18 keV) of samples 3b (orange) and 5a (brown) where the peaks of the characteristic elements of the preparatory layers, the gilding and the lead structure are shown.

Sample 3b has a structure typical of gouache gilding while sample 5a has only the preparatory layer of gesso before gilding. The first spectrum (5a) acquired shows a discrete presence of S and Ca while the other shows the presence of Al, Si, Ti and Fe. In both spectra, the lead peaks are related to the base material of the samples.

Objects analysed by XRF

The XRF analysis on the artwork were compared with those on the reference samples.

In the bedroom of Francesco II of Bourbon, which is part of the *Nineteenth - century Apartment*, during an FSC restoration project the bed was dismantled, the wooden parts and cotton mattresses disinfected, the canopy curtain restored, and the gold parts cleaned and chromatically integrated. The feet of Francesco II's bed are made up of four winged lions, two made of gilded wood and two of gilded lead, masterfully executed and still well preserved. Several measurement points were chosen on the winged lions. The technique of gouache gilding on lead has been found again. Only some of them are shown and only those made of lead. Fig. 10 shows XRF measurement points 3 and 5 made on one of the two winged lions. The XRF spectra detected at these measurement points are compared in Fig. 11.

Figure 10. Measuring points XRF 3 and 5 on winged lions.

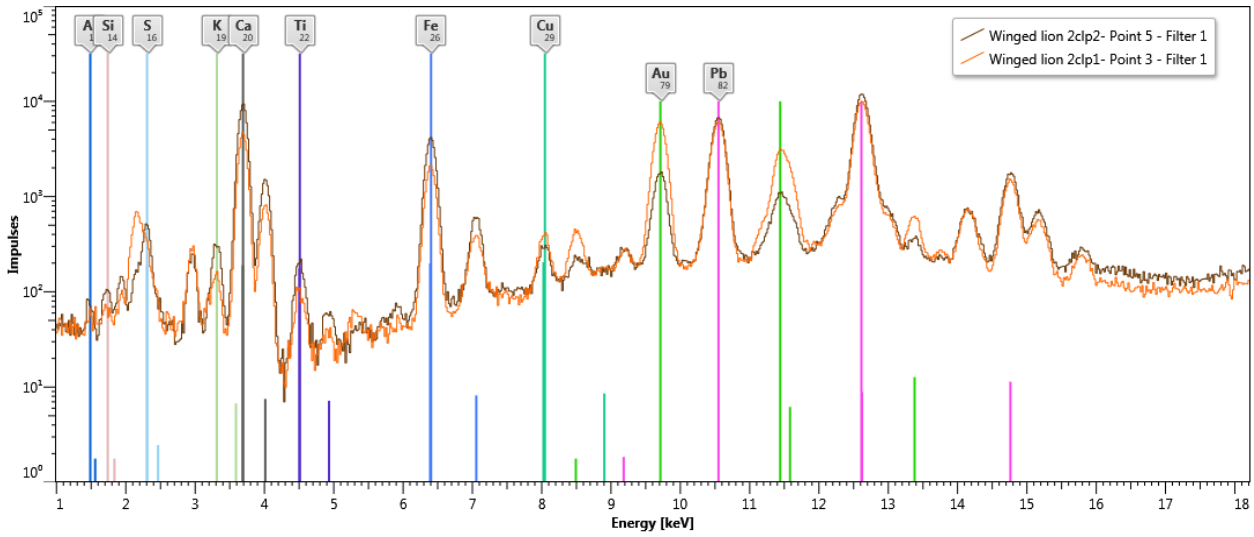

Figure 11. Comparison of XRF spectra obtained in the 3 (orange) and 5 (brown) points.

The spectrum acquired (Fig. 11) shows a discrete presence of Ca, Ti, Fe, Au, Pb and Sn. The gilding is confirmed by the presence of the characteristic lines of gold. Lead with traces of copper and tin are due to the structure of the lion. The presence of calcium (Ca) and sulphur (S) are attributable to the preparation of the gilding. The *gesso* used for this type of technique is in fact calcium sulphate. Iron and titanium are present in the bolus layer (Albertin et al., 2020; Sandu et al., 2013). All these elements and the comparison with a reference sample suggest that the gilding technique used is gouache gilding.

Two other spectra were compared at two different parts of the lion, one showing a darker coloration than the other (Fig. 12).

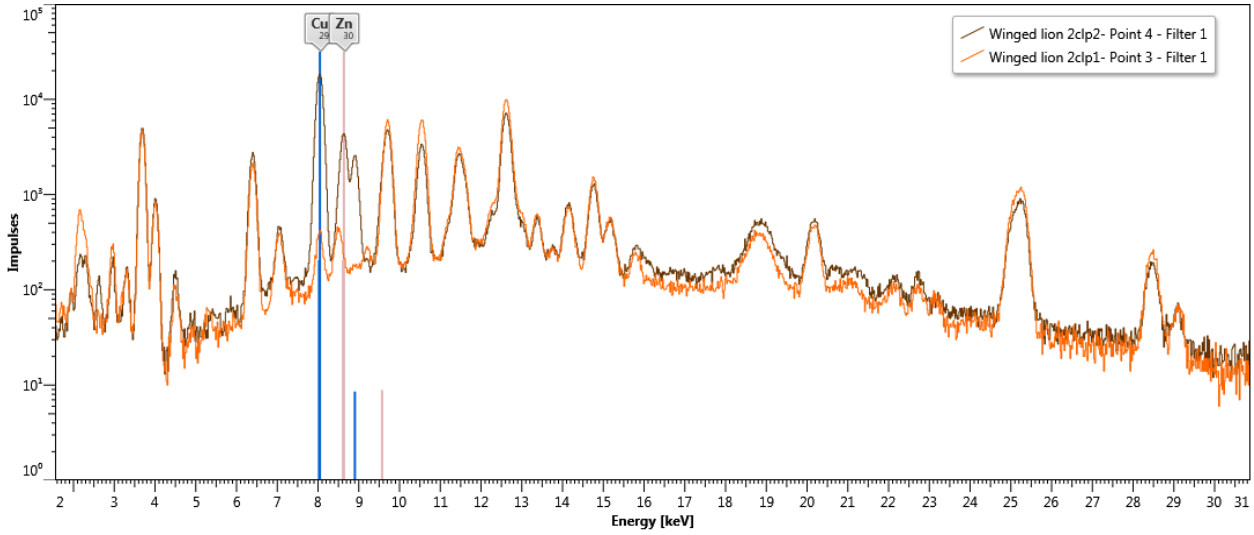

Figure 12. Comparison of XRF spectra obtained at two spots having two different shades of gold, one darker (brown) and one lighter (orange).

Gold is present in both spectra but there are differences; in the dark spot spectrum there are also copper and zinc (Fig. 12, brown spectrum). The copper and zinc can be attributed to the *porporina*. Bushings or *porporina* are generally brass-based alloys that are reduced to powder and coloured by metallochromic (Lalli and Innocenti, 2016). Depending on the colour shade, their composition can vary considerably. Due to subsequent restorations, *porporina* was applied to mimic gold leaf. In fact, it is common practice in restoration to use *porporina* to emulate the chromatic effects of gold leaf, but the effect worsens over time due to the presence of copper, which oxidises.

In the *Hall of Mirrors*, in the Apartment of Her Majesty Queen Maria Carolina, the floral decorations (Fig. 3b) are analysed by XRF technique. XRF measurements were performed at various points and the spectra were compared with a standard reference

sample. These are decorations in gilded lead with gouache gilding, perfectly reproduced and well preserved.

The floral decorations on the Queen's bathroom mirrors were also analysed (Fig. 4b). They result as floral decorations made of lead with gouache gilding, as in the spectrum are present the characteristic peaks of the preparatory layers of this type of gilding: Bologna *gesso*, Armenian bolus, and gold leaf. The only difference is the presence of chromium and zinc on the surface of the objects (Fig. 13). It is probably zinc chromate added in a restoration to give more brilliance to the gilding.

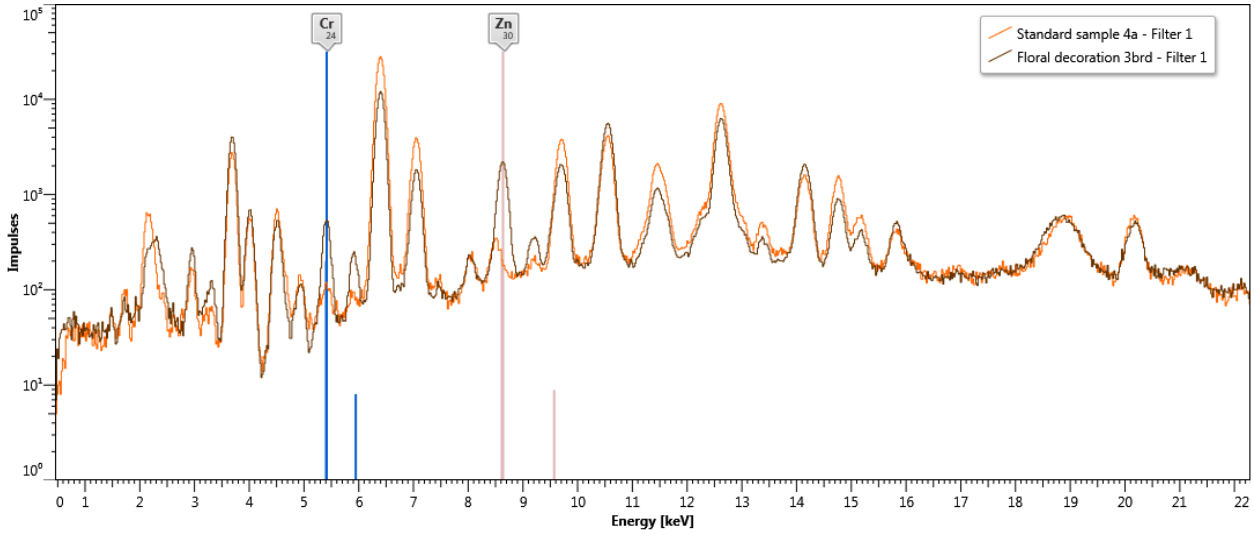

Figure 13. Comparison between the XRF spectrum of a floral decoration (brown) from the Toilet for bathroom use and that of the standard reference sample 4a (orange).

The gilding of a floral decoration was compared to the reference sample with the protective shellac layer (4a). Since the decoration was restored, the sample with the shellac layer simulates this situation the most, as there is a varnish over the object.

XRF analysis on one of the fragments of decoration (Fig. 6a), found in the storeroom of the Royal Palace in Caserta, shown it to be a floral decoration (like that found in the *Toilet for bathroom use*) of lead with gouache gilding repainted with a layer of zinc chromate. In fact, probably it is a piece originating from *Toilet for bathroom use*. The spectra of the object of the *Toilet for bathroom use* and that of the object found in the storeroom are compared in Fig. 14.

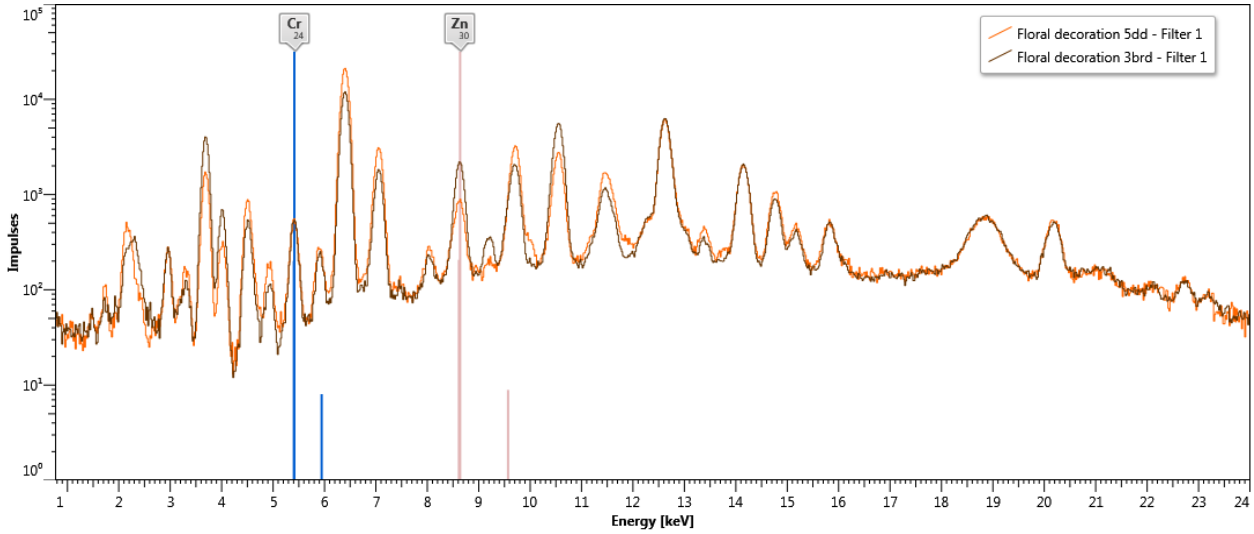

Figure 14. Comparison between the XRF spectrum of the flower decoration part of the Toilet for bathroom use (brown) and that obtained from the similar object found in the storeroom (orange).

The piece of decoration was found in the storeroom of the Royal Palace in Caserta (Fig. 6b). It belongs to the Queen's *Restricted Use Toilet*. The sample is different from those previously analysed. It is composed of an alloy of Pb, Sn, Fe and Cu, and has two different types of gilding. On the front there is a gouache gilding, due to the presence of Al, Si, Ca, Ti, Fe and Au, while on the back the gold leaf was applied directly on the metal without a preparatory layer (mission gilding). The gouache gilding is intact compared to the mission gilding. To compare the structure used to make it, a similar but non-golden sample was analysed. The compared XRF spectra show the same elements. They were probably created by the same craftsman.

Another piece of decoration (Fig. 6c) was found in the storeroom of the Royal Palace in Caserta. Several measurements were made on both flowers. The XRF analysis showed the same characteristics both in the composition of the structure (Pb and Sn) and in the gilding Al, Si, S, Ca, Ti, Fe, Cu (probably due to the Au foil), Sr and Au. It corresponds to gouache gilding. It is not known which room they belong to, but most probably the same.

The console of the *Hall of Bodyguards* is a half-round table with festoons of gilded leaves on the central band. According to the technical data, the console is made of gilded wood, but XRF analysis show that some decorations are made of gilded lead while others are gilded wood. The gilding used in both cases is gouache.

Table 3 summarizes the elements detected by the XRF analysis of the nine gilded lead objects. The two lions and the two floral decorations present in the storeroom have the same elements. These elements were tabulated by layer of preparation for gilding, gilding, object structure, trace elements and elements of possible restorations. Anomalous cases were also included: the dark area on the legs of the winged lions, the back of the floral decoration of the storeroom, and the floral decoration in lead and wood of the console in the *Hall of Bodyguards*.

Table 3. Elements detected by the XRF analysis of the objects. They were divided by gilding preparation layer, gilding, object structure, trace elements and elements due to possible restoration. F.D.= Floral Decorations, F.D.D. = Floral Decorations in Deposit.

Objects	*Structure*	*Preparation layer*	*Gilding*	*Trace Elements*	*Restoration*
Two Winged Lions	*Pb, Sn*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	//
Two Winged Lions (dark areas)	*Pb, Sn*	*Al, Si, S, Ca, Ti, Fe*	*Au*	*K, Sr*	*Cu, Zn*
F.D. Hall of Mirror	*Pb*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	//
F.D. of Toilet for bathroom use	*Pb*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	*Cr, Zn*
F.D.D. of Toilet for bathroom use	*Pb*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	*Cr, Zn*
F.D.D. of the Toilet for limitated use	*Fe, Cu, Pb, Sn*	*Al, Si, S, Ca, Ti, Fe*	*Au*	*K, Sr*	//
F.D.D. of the Toilet for limitated use (Back side)	*Fe, Cu, Pb, Sn*	//	*Au*	*K, Ca*	//
Two Piece of F.D.D.	*Pb, Sn*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	//
Console Table of Hall of Bodyguards (lead F. D.)	*Pb*	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	//
Console Table of Hall of Bodyguards (wood F.D.)	//	*Al, Si, S, Ca, Ti, Fe*	*Cu, Au*	*K, Sr*	//

4. CONCLUSIONS

A series of gilded lead objects from the Royal Palace in Caserta (Italy) were analysed by XRF analysis. The novelty found in this study is that the lead was also gilded and that the gilding on the lead was done by gouache, except on one part of an object where the gilding is by mission. There are no other examples in the literature, to our knowledge, but many in the Royal Palace in Caserta.

Historical research of the objects analysed was carried out by consulting the Historical Archive of the Royal Palace in Caserta. Records and documents emerged linking these objects to the work of the famous gilders Antonio Pittarella, Felice Giliberti and Bartolomeo di Natale. The objects were probably made with lead support because of the wide availability, easy workability, and low price of the raw material. The large number of serial reproductions of these objects suggests that the method used to make the lead moulds is the indirect method of lost-wax casting.

The XRF analysis made it possible to determine the elemental composition of the stratification created for

the gilding, highlighting its characteristics and differences.

Standard samples with similar characteristics were made for the characterization of the stratigraphy of interest through the XRF technique. The comparison between samples and standards confirms the presence of the characteristic elements of gouache gilding, that is, a layering with *gesso*, Armenian bolus and gold leaf. Restoration interventions carried out in the past have been highlighted.

The results of the study as well as being interesting for historical-artistic reasons are useful for the conservators and restorers of the museum to update the information about the objects on exhibition and to catalogue the artifacts in the storeroom of the museum. The portable instrument allowed in situ analysis without removing objects from their storage space.

AUTHOR CONTRIBUTIONS

"Conceptualization, A.M. and C.S.; methodology, A.M. and C.S.; software, J.B and E.S.; validation, C.S., A.M., G.O.G. and A.D.; formal analysis, J.B and E.S.; investigation, J.B., E.S. and A.M; resources, A.M., G.O.G., C.S. and A.D; data curation, C.S.; writing—original draft preparation, J.B., E.S. and A.M.; writing—review and editing, C.S.; visualization, J.B and E.S; supervision, C.S., G.O.G and A.D; project administration, G.O.G. and A.D. All authors have read and agreed to the published version of the manuscript."

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