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GILDING TECHNIQUES IN RELIGIOUS ART BETWEEN EAST AND WEST, 14TH –18TH CENTURIES

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Abstract

The paper proposes a short review on gilding techniques and materials from artifacts of religious heritage between 14th and 18th centuries, mainly gilt wood and gilded panel paintings. The study underlines the main aspects related to the use of certain materials and application techniques in different countries and époques, between Eastern and Western Europe, exemplifying with case studies of real gilded objects from Romanian, Greek, Russian and Portuguese ecclesiastic heritage. The contribution of some analytical techniques, such as optical, scanning electron and atomic force microscopies (OM, SEM, AFM), XRF and EDX spectroscopic analysis to the study of these objects is emphasized as well as the peculiarities of the obtained information.

Keywords: gilding techniques, European religious heritage, analytical techniques

Introduction

As any other artistic techniques during history, the use of "gilding" knew an evolution, both from the material and the technical point of view, in association with the effort of rendering mankind's soul closer to the spiritual world. In this way, the aesthetical value, intrinsic to the artwork, was added with a mystical/religious and symbolic value [1-31].

"Gilding" was privileged in artworks of religious content or in decorations that would illustrate the opulence and luxury of monarchs. As far as the liturgical wooden objects are concerned, gilded sculptures and altarpieces, icons, frame works, furniture, etc., were the main typologies of applications of different "gilding" materials and techniques, since the early times of Middle Ages to the late Baroque, as some of the historical treatises assess [19-23]. In time, these objects were subject to various interventions and in many cases the original gilded layers were lost or replaced with cheaper imitations [4-19, 28-31]. Sometimes, the taste of the époque or the antiquity market imposed spurious interventions as an added value for commercial purposes. A case that we could mention here is the removal of gold leaf from the background of many Orthodox Icons sold in the Western antiquity market [29-31].

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The conservation-restoration activity and conservation science are useful to complete the knowledge of this evolution, but also to lead to a better comprehension of all the factors and mechanisms that assured the survival of the "gilding" coatings over time and their historical background, offering tangible proofs of the composition, meaning/value and processes that stood behind these techniques [28, 32-58].

Micro-structural and technical aspects on gilded layers can be understood through non-invasive and micro-destructive analytical techniques, such as X-ray fluorescence spectrometry, optical and scanning electron microscopy (on surfaces and on cross-sections of samples), surface parameters measurements [10-11, 28, 24-29, 31-37, 50-58]. Some examples on the use of these techniques will illustrate the aspects discussed in the present paper, on case studies from European cultural heritage.

Historical aspects

"Gilding" and other metal surfaces have been used since ancient times, particularly in the art of East and South Asia and the Middle East. Examples of gilding can be traced to 2300 B.C. on ancient Egyptian paintings that show goldsmiths making gold leaf, and the sarcophagi of nobles often had gilding decorating the outside [1, 33]. "Gilding" became popular during the New Kingdom (1570-1070 B.C.) [1] and many objects such as gilded and painted wooden statuettes are now hosted in several museums around the world, such as the Museum of Archaeology and Pre-history of the Institute of Anthropology of the Faculty of Science in Porto, where we can find an interesting Egyptian mask (Figure 1). This mask was made of "cartonnage", which is a specific type of three-dimensional Egyptian mummy technique using layers of linen and gesso which can be painted and, in same cases, partially gilded [2].

Fig. 1. "Egyptian Mask" before conservation work and detail of gilding where limits of the gold leaf application can be seen. Photographed at the Department of Conservation and Restoration from the Institute of Museums and Conservation (IMC) in Lisbon.

In the ancient world certain statues of great prestige were *chryselephantine*, i.e. made of gold-plated wood (for the clothing), or metals like bronze (Figure 2) and ivory (for the flesh). The most famous of these statues was the sculpture of Zeus in Olympia made by Pheidias in the 5th century B.C. This statue was c.14 meters high and was considered one the Seven Wonders of Antiquity. By the time of Constantine, in the early 4th century A.D., it seems that the gold already had been removed from the statue [5].

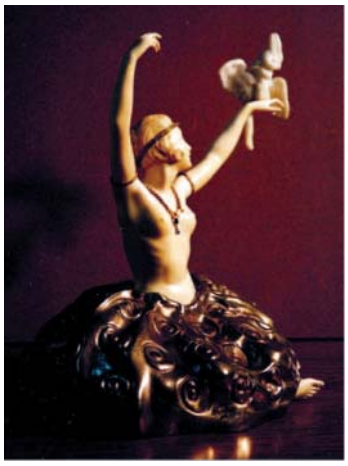

Fig. 2. Chryselephantine sculpture representing a woman and a parrot. All flesh zones are in ivory and all metal zones in bronze. Private collection. Picture gently provided by Henrique Silva – furniture restorer.

Pliny the Elder (23-79 A.D.) writes in Chapter 18 of Book 33 of his *Natural History* that only after the destruction of Carthage, under the censorship of Lucius Mummius, did the Romans began to master the technique of "gilding", namely by decorating the ceilings of their temples and palaces. Apparently, the Capitol was the first building where this process was used. Pliny adds that this luxury practice advanced so rapidly that in a short period of time even private and poor people gilded the walls, vaults, and other parts of their dwellings. Owing to the comparative thickness of the gold leaf used in ancient gilding, whose techniques Pliny describes in Chapter 20 of the same Book, their traces remain remarkably brilliant and solid [6].

Throughout the Middle Ages, gold was regularly recycled, "*traded, looted, melted-down, crafted into jewellery and other prestige items, looted and melted-down again*" [7]. This scarcity of gold did not stimulate a broad use of "gilding" in churches and palaces. However, "gilding" was extensively used in the illumination of religious manuscripts as well as a decorative surface covering metallic *vasa sacra* or the front and sides of wooden altars [8].

This tradition of decoration in religious artifacts will be continued in the Renaissance and Mannerism periods in gilded vessels and in altarpieces (retables) whose parts (as architectural furnishing elements or statues) are covered with gold or imitation of gold leaves (made of varnished/glazed silver or gold alloys leaves) [9-19, 39-48].

In the Baroque époque the massive use of decorated gold leaves coating is expressed through rich, sumptuous wooden sculptures and decorative elements/friezes, placed in the front of altars or inside chapels in churches and cathedrals, as a sign of spiritual and terrestrial enrichment and embellishment [10-18, 55-58]. A true expression of opulence is the "*talha dourada*" that became a symbol of the gilded craftwork done in churches for embellishing the altars and the interiors in Portugal [10-18]. An interesting case, still to be investigated, is the complex wooden decoration of the altar found in the Church of Val Figueira in the Diocesis of Santarém (Portugal) dated from 18th century, now under restoration interventions (Figure 3).

Besides Portugal, Spain also has many artifacts from Renascentist and Baroque period that speak of the taste for golden decorations and in particular of sculptures in which complex polychromy containing gildings were created [11, 43-46]. One of the most astonished and rich expression of this taste are the polychrome and gilded techniques applied in carved wooden sculptures and altarpiece decorations. In early 16th century the gilding structure of some sculptures altarpieces with polychrome decoration was made of: white ground (chalk and animal glue), imprimatura, filling mass, bole (clay, or mixture of ground earth, with animal glue), metallic leafs set over animal glue as adhesive, and finally a mat colour in an aqueous medium, a tempera, or an oily or resinous lake, laid over carefully burnished gold or silver leaf, with a piece of agate.

Fig. 3. "Talha dourada" altarpiece, Church of Val de Figueira, Santarém, 18th century: entire image and detail of the altar.

In most of the cases, the complex polychrome was made of opaque paints completely covered the shiny colour of the burnished gilded areas, the patterns of geometrical, vegetal or zoomorphic motifs being brought to light from the layers beneath with the help of a sharp point resulting in a high quality and aesthetically good looking work. It was this difference between the mate-gloss colors that made the Portuguese sculpture very famous during Baroque époque (Figure 4) [45].

Fig. 4. Detail of Saint Peter, 17th century sculpture, from Church of S. Francisco de Paula (Lisbon), and closer detail of burnished gilded and tempera polychrome area, where open drawings were made. Photographed at the Department of Conservation of IMC, Lisbon.

Applied relief decoration was also used for rendering the appearance of a textured cloth of gold drapery faster and more economically than creating texture on the paint surface directly with gesso in relief. Pre-formed relief patterns were made by pressing tin leaf into a mold and then filling from behind to support the relief pattern. The sheets were adhered to the painting using an oil-based paint, then mordant gilded and finally painted with a colored brocade pattern [1, 11, 43-46].

The Byzantine and post-Byzantine art preserves many objects (icons, mosaics, metal crucifixes) in which gold or imitation of it were used to express the immaterial divine world and the holiness of the represented Christian saints [25-27, 29-31, 50-51]. Early European paintings and post-Byzantine icons have in common gold backgrounds, as simple decorative surfaces or embellished with ornamental motives obtained through different techniques and tools (Figure 5). In many cases, the golden background was removed or retouched during time in order to correspond to the antiquity market and different époques tastes (as in the case of Russian icon representing Mother of God breastfeeding, where the original gilding was removed together with the over-painting, Figure 5c).

Fig. 5. Byzantine, Cretan and Russian icons with "gilded" decoration in the background:
a – Annunciation, 17th century, Greek school; b – St. Arch. Michael, 17th century, Cretan school;
c – Mother of God Breastfeeding, Russian School, 16th century.

Technical and micro-structural aspects

From a strictly technical point of view, "**gilding**" is the process of covering an item with a thin layer of gold [1, 3-4]. The application of other types of metal leaf may also be referred to as "gilding", though gold and silver are the most common. Imitation of gold leaf reduces the cost of the gilding process and nowadays it is often used for decoration.

The main effort of ancient gilders was focused on the development of coating methods for obtaining **gold** (Au) or **silver** (Ag) layers as thin as possible in order to save these precious metals, as well to decorate the surface of artifacts with a resistant and embellishing noble metal cover [1, 35-37, 47-48].

The process of "gilding" can be employed on **various supports**, such as: wood, metal, ivory, leather, paper, glass, porcelain, stone and fabrics [1, 3-4].

Since gold is so malleable, even when cold [35], it was a natural choice to be used to cover other materials, such as parchment in manuscript illumination and wood in sculpted furniture or altarpieces, icons, mural paintings etc. Gold, or its substitute, may be applied as a leaf to a surface previously prepared using a treatment with size, mercury, acid, or heat. The applied leaf is burnished or left matte. Electroplating has largely superseded mechanical and chemical gilding of metals, but traditional gilding of delicate objects is still widely used today.

There are two basic methods of gilding: *mechanical* and *chemical* [1, 3-4, 28, 32-33, 48-49].

Mechanical gilding, the only type used in the ancient times, begins with gold leaf, which is made by hammering gold into paper-thin sheets between layers of parchment. The

gold leaf used in the ancient era was typically thicker than today's gold leaf and has consequently survived the centuries quite well.

Water gilding, which uses a layer of gesso and a layer of bole to make the gold leaf adhere, is traditionally used for wood surfaces [4]. The gold leaf must be brushed on with a gilder's tip before burnishing in this type of gilding. A fourth type of mechanical gilding, *oil gilding*, uses an adhesive oil (or resin) primer to gild the walls of a building or other support. No burnishing is necessary in this process.

There are a few different forms of **chemical** gilding as well, all of which use gold in a chemical compound at some point in the process. Cold gilding, used on a silver surface, consists of dipping a linen cloth into a liquid solution of gold in "aqua regia", burning the cloth, and rubbing the ashes onto the silver [3].

The most ancient gilded surfaces were made of pure or highly pure gold, beaten out to form a leaf or as a powder mixed with an organic binder. Later, during the medieval era, other metals are introduced in pure form (such as silver leaf) or as alloys of gold and silver with less precious metals (copper, tin and zinc). Using gold, silver and copper, the goldsmith was able to produce a large variety of alloys with different colors (from green to red, pink, white etc.) and mechanical and chemical properties (strength, hardness, ductility, melting points) [1, 3]. The addition of silver and copper to the gold was also motivated by the necessity to increase the resistance of the gold foils and usually the quantity of gold was not inferior to 50% of the total weight. The alloy gold-copper was widely used for darker applications, while the gold-silver alloy is clearer and have a major property to reflect the light. The ternary alloys made of gold, silver and copper are less ductile and the quality of the foils decreases.

Recent studies on gilded sculptures and altarpieces from Baroque époque showed how the quality and chemical composition of the leaf, analyzed through X-ray fluorescence spectrometry and other microanalytical techniques, is indicative of the erudite character of the religious art piece [55-58]. These studies complete other comparative analyses performed on Baroque polychrome artifacts from Portugal, Spain and Belgium [10-11, 43, 45-46]. For example, an extensive and comparative SEM-EDX study performed on several Portuguese polychrome statues (reliquaries from Alcobaça, Açores, Coimbra, Aveiro, Tibães) of 16^{th} century showed the use of a highly gold-content alloys (87% Au) and of an alloy of Au-Ag-Cu and one of only Au-Cu [11].

The application of "gilding" layers in painting and other decorative techniques (sculptures, frames, iconostases, altarpieces) on wooden support has mainly seen the evolution of two procedures: ***water*** and ***oil/mordant gilding***, using leaves of gold or alloys imitating gold or metallic powder mixed with a binder [37-38, 49-58]. In general, mordant gilding has a yellower, more matt surface than water gilding.

Historical and artistic treatises such as ones of Eraclio (10^{th} -11^{th} centuries), the *Mappae Clavicula* (8^{th}-12^{th} centuries), St. Audemar (13^{th} century), Jehan le Begue, Cennino Cennini, Vasari, Manoscritto Bolognese (15^{th} century), Filipe Nunes (17^{th} century), Dionysios of Phourna (18^{th} century) mention "gilding" techniques and explain the procedures for applying gold or imitations of it on various supports [20-24, 38].

Many retables of 12th and 13th centuries present a thin leaf of gold or silver between the ground layer and the paint having probably the function of modifying the porosity of the gesso ground leading to a characteristic "smalt-like" aspect of the paint [38].

In latter époques the preparation for gold leaf is simply done using earth pigments, commonly known as "Armenian bole", over gesso ground. For example, Cennino Cennini describes the ***water gilding*** ("*a guazzo*"), emphasizing the role of colored bole on the appearance and chromatic hue of the gilded backgrounds [9, 22, 38]. The water gilding technique was usually employed when the gold was to be burnished and decorated by punching. Generally the metal leaf was laid onto an adhesive layer of soft iron-containing clay (bole) mixed with glue size [1]. This bole layer imparts a warm color to the thin gold leaf and provides

a smooth, slightly yielding cushion against which to burnish the gold or the add punched or incised decorations.

In the ***gilding with mordant*** ("*a missione*") the bole is substituted by the oily-resinous mordant. Many documentary sources, including the one by Cennino Cennini [22], gives recipes for an ***oil-based mordant*** made of thickened and pre-polymerised linseed oil mixed with a variety of pigments as driers. Sometimes the addition of a little quantity of varnish is mentioned. This type of gilding is usually recommended for small details of decorative carved wood, when small pieces of gold leaf has to adhere to an adhesive or mordant previously applied to the areas to be decorated [52]. Both Vasari and F. Baldinucci underline the fact that this procedure is not applicable for works on which final burnishing should be done [23].

Literature punctually reports other materials used for applying the leaf in mordant gilding techniques, as *propolis* and *garlic* [52-53], that might be derived from the Eastern practice of gilding.

Another type of gilding is the one with ***gold in powder*** mixed with varnish, gum arabic or animal glue ("*oro a conchiglia*" or "*a nicchia*") and applied by brush [28-29].

When the gold was too expensive but its effect was required, another technique called ***"mecca" gilding*** was applied: the gold leaves substituted with silver ones and then varnished for imitating the gold surface's effects [9, 29, 40], Figure 6.

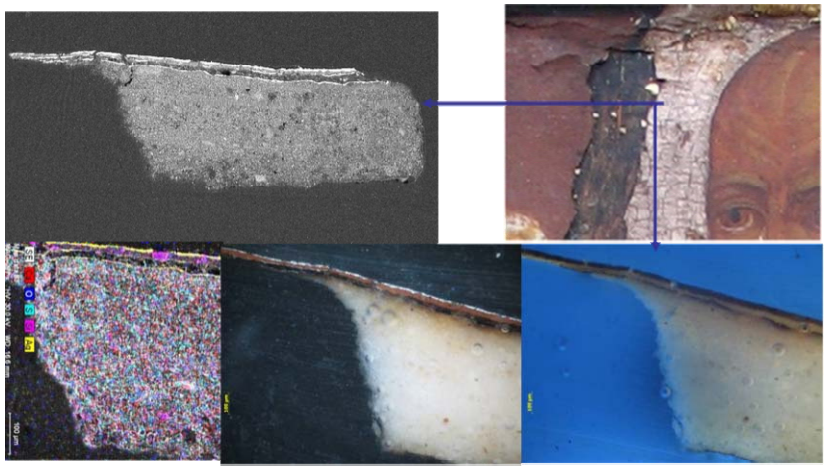

Fig. 6. Images of a detail from the "mecca" gilding on a Russian icon:
a – SEM image of the cross-section; b – EDX elemental mapping on cross-sections;
c – Vis image at OM; d – UV image at OM.

The use of ***"stagno dorato"*** (tin gilt or gilded tin) is mentioned by an article published in the Technical Bulletin of National Gallery: gold leaf was applied over a thicker tin leaf then cut into shapes and applied on the panel for the golden rays emanating from the white dove [33, 54]. The use of composed foil (made of Au and Sn) was explained taking into consideration the thickness of the tin leaf (generally 15-20 microns) that allowed an easier handling than the gold leaf (2-4 microns). The composite material was cut in the required shape and then applied over the wall using an oily adhesive ("missione"). This allowed the final procedure of burnishing and engraving.

In the ancient technique of Eastern icon painting the application of gold (or imitation of it) was done according several procedures: "*assist*" (use of shell gold or application of a size, laying on the gold, and brushing off the excess), "*gemelli*" ("twins" o "zwischgold", that is overlapped thin gold and silver leaves on bole or beating silver and gold leaf together – Figure 7) and "*purpurin*" (gilding with an alloy: Cu-Sn or Cu-Zn for imitating gold, used in the form of powder) techniques [24, 29-30].

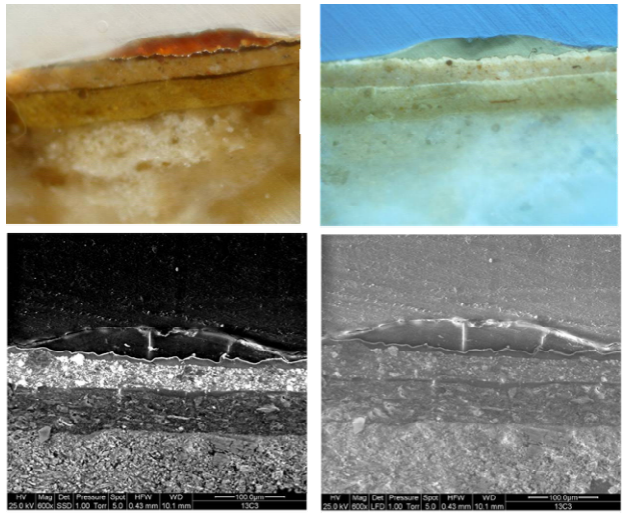

Fig. 7. "Gemelli" technique in the Russian icon, from Fig. 2:
images of the cross-section at OM, Vis-UV and at SEM (SE and BSE images).

For the gilded background of icons in the medieval era a highly pure gold, containing small quantities of Cu or Ag was used; since the 16th century the "gemelli" gilding and at the beginning of the second half of 18th century the "*graffito*" technique (especially in the Moscow school) were mainly applied [29]. During the 18th and 19th centuries the "ammanitura" technique of preparation for receiving the gold or silver leaf [27], of Byzantine origin, was hand engraved (punch marked) or with a sharp tool called "bulino" (burin - a kind of scalpel), Figure 8.

Fig. 8. Mother of God "Oranta", Romanian icon, 18-19th centuries:
"assist" on gilded "a mecca" (silver and Sandarac varnish)
background and red lakes, decoration by "bulino" technique.

The highlights were mainly done with two techniques: "assist" was identified in Byzantine and Greek icons, Venice and Tuscan gilded backgrounds until 15th-16th centuries, Russian icons until 17th century Romanian icons, at the beginning with 17th century the "*crisografia*" (writing with gold powder and a binder) knew a large diffusion in Icon painting [27-31, 37].

The historical period in which gilding imitations ("mecca" technique and leaves made of alloys, such as: Sn-Ag or Sn-Cu) were spread in Italy and other Western countries is corresponding partially to the one in which Russia faced the phenomenon of icons painted in "ancient technique" [30-31]. On the other hand, the taste of that époque was to re-evaluate the medieval style, although the Neo-gothic one already puts its imprint in whole Europe. Not only the icons were "involved" in this fashion of "old, dated" fakes but also polychrome sculptures and other religious objects expressing Christian faith. These "dated" falsified objects are often very well done and quite convincing when analyzed by experts and art historians that are asked to assess their pretended "authentic" value. If the evaluation errors can be understand and accepted in these cases (usually the experts start their study from image's characteristics and continue with the modifications of the iconographic style during centuries) the same is not true for restorers, that are asked to identify their technique, materials, époque of creation before any restoration intervention. This should be done especially to avoid the removal of "patina" varnishes, considered as intrinsic part of the icon painted in "ancient technique" [30-31].

The "gilding" techniques used in Portugal in the Baroque era, that caused a great development of "*talha dourada*", in which the relationship between colors and sacred feeling is very deep and develops in a religious context, being associated to the light and iconography of Christ, are the so-called: "*o brunido*", "*o mate*" and "*estofado*" ("gravado" and "esgrafitado") [10-18, 21].

The Portuguese Filipe Nunes describes in his treatises the way in which the "gold" and silver can be applied on paper, silk, parchment (for illuminated manuscripts), stone, leather, wood and glass [21]. He also describes the two types of gilded surfaces: "*ouro brunido*" (describing the procedure of burnishing the gold surface) and "*ouro mate*" (that is indicated for stone and wood). The artist describes the application of a tin leaf over the mordant layer, followed by several applications of "*imprimitura*", mordant and finally the gold leaf.

Another author refers to the application of a varnish over the gold leaf in Portugal in Baroque époque: two types are reported – varnish with alcohol and varnish with oil [11]. The terms encountered in different contracts, associated to the gold as final application for protecting the leaf and reducing its shine, are "gomado" or "agomado" that could be translated as the application of a vegetal gum (probably fig milk or gum arabic) [10].

The expression "dourado fosco" seems to explain this intention of attenuating the optical properties of the precious metal surfaces, sometimes using a layer of animal glue (Figure 9).

Fig. 9. Main alterpiece from the baroque Chapel of Our Lady of Victory (Cascais, Portugal) and image of a cross section of a water gilding polychrome area, where we can see a layer of organic material (probably an animal glue) over the gold leaf to attenuate its optical properties. Photographed at the Department of Conservation of IMC, Lisbon.

Other organic materials, such as shellac or wax, can be found sometimes on the surface of altarpiece decorations, such as in the cases of "talha dourada" from the churches of Val de Figueira (Santarém) - Figure 10 and of Almada, (Lisbon), Figures 11-13.

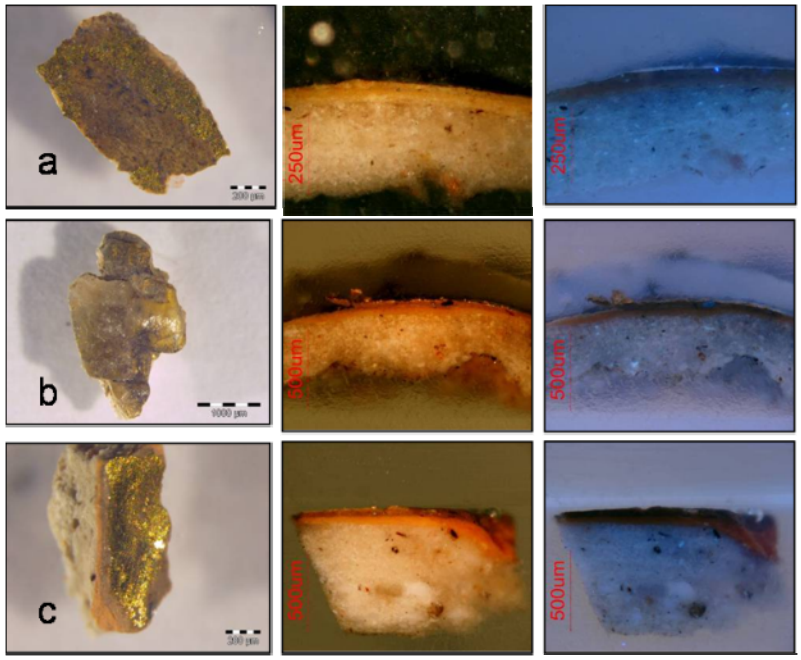

Fig. 10. For the three different samples from the Val Figueira altarpiece, observed in cross-sections, under Vis and UV light, different stratigraphy and use of varnishes are described: fluorescent varnish (a), wax varnish (b) and no varnish (c), over leaf (Au-Cu alloy) applied on one or two ochre layers (probably of bole).

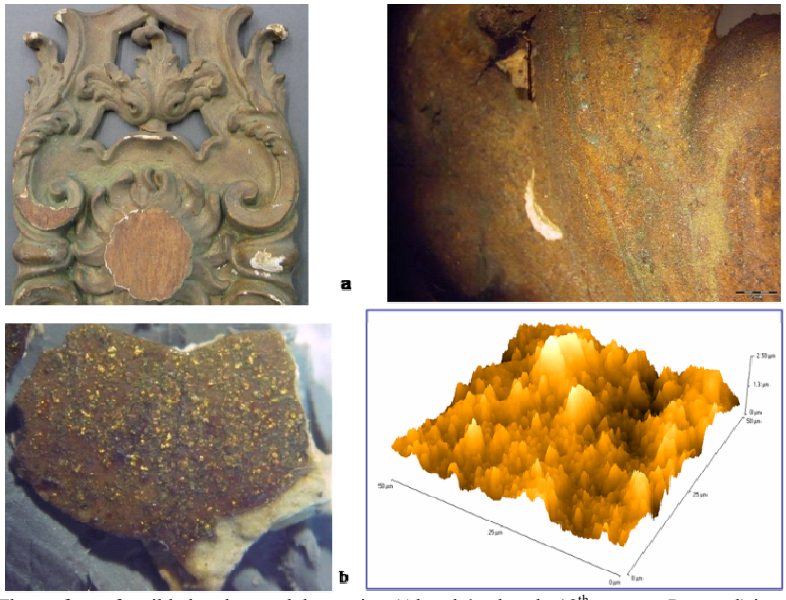

Fig.11. The surface of a gilded and carved decoration (Almada's church, 18th century, Portugal) in which the gold is imitated with silver leaf covered by a thick varnish (shellac-based), with an oxidized aspect (patina):
a) area of the piece and a detail of the surface, photographied under magnifying glass;
b) small sample and the AFM height image of its surface.

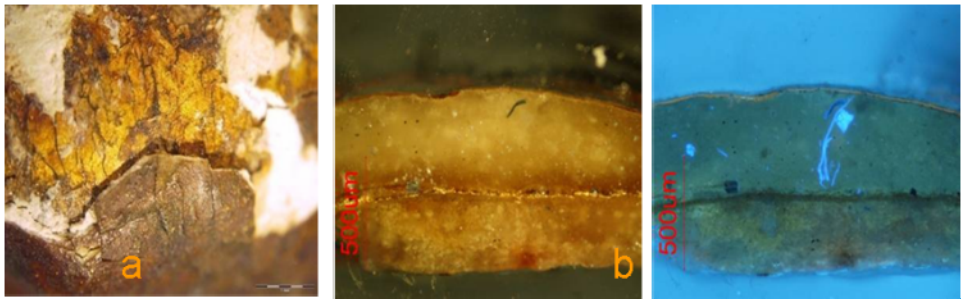

Fig. 12. Images of an area of the above mentioned gilded sculptured element (Almada's church, 18th century, Portugal), in which two layers of "gilding" can be observed: a – macrophotograph of the sampling area; b – cross section observed under Vis and UV light indicating two overlapped gildings.

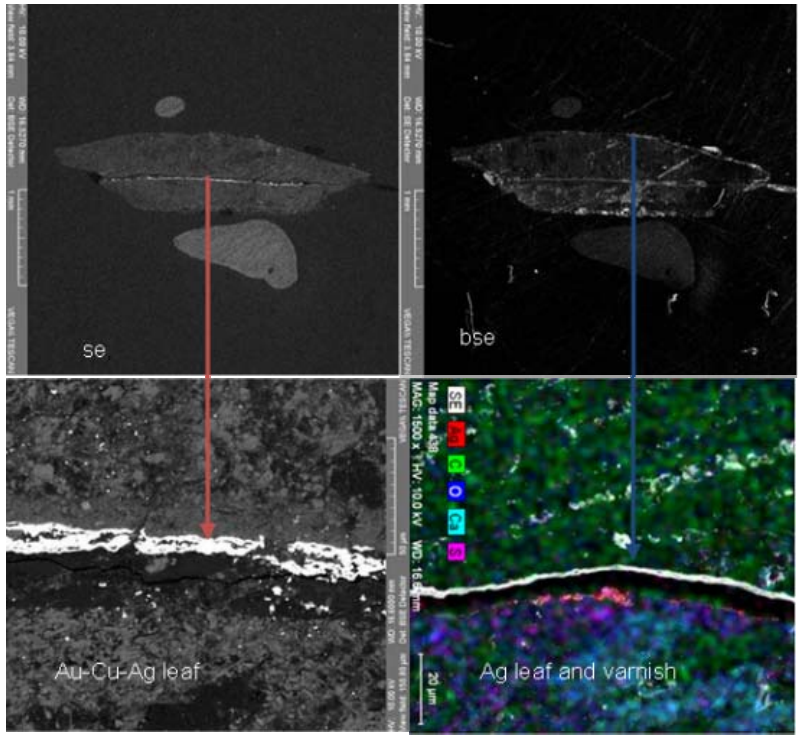

Fig. 13. SEM mapping of the two different overlapped gilding layers, from the sample shown above, in Fig. 12.

One of the most complex and durable decorative technique spread at the end of Gothic period and beginning of Renaissance in Western and Central Europe was the so called "*estofado*", in which colors are overlapping the gold or silver, imitating the precious textiles – damask and brocades [11]. The "estofado" technique involved the application of paint layers over the gold leaf and its scraping off before the paint was completely dry, revealing the gold beneath according to a certain pattern.

The polychrome decoration containing gilded surfaces ("*dourado*" and "*estofado*") will continue in the 17th century, using burnished or mate surfaces, "*gravado*" or "*esgrafitado*" (punched with a point of a paint brush) [11-12].

A decoration technique used in polychrome sculpture since the 15th century in the Iberian Peninsula is the so called "corlas" (silver brushed with alcohol-based varnish in order to imitate the gold), that will be limited during the 17th century but re-considered in the Baroque and Rococó periods [10-11, 43-45]. An example of this type of application was found in the hair decoration of a wooden sculpture representing Saint Archangel Michael (Museum of Aveiro), obtained by silver leaf set over a fixative layer (oil and protein) and white ground (calcium, white lead and egg protein). The silver leaf was covered by a glaze of alcohol based varnish that gave to the silver layer a golden hue (Figure 14).

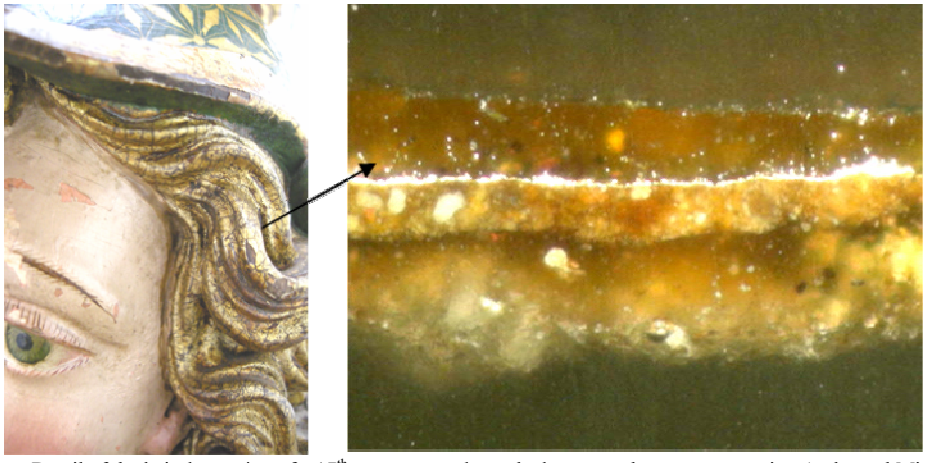

Fig. 14. Detail of the hair decoration of a 17th century wooden polychrome sculpture, representing Archangel Michael, belonging to the Museum of Aveiro (Portugal) and the cross-section illustrating the stratigraphical structure of the polychromy. Photographed at the Department of Conservation of IMC, Lisbon.

Conclusions

The paper does not pretend to be an exhaustive review on gilding techniques and materials in Eastern and Western European artifacts from religious heritage, but to point some general and peculiar aspects related to the evolution of these techniques and to show the necessity to develop further comparative studies on this topic. Although there are differences in materials and ways of application of "gilding" layers, the religious European art on wooden support embellished with this type of polychrome surfaces testify a large use of mechanical "gilding": *water* ("bole" or "bolus" gilding) *and mordant-based* ("mixtion" or "a missione" gilding) techniques. Despite the differences in terminology and the confusion that sometimes arise from the use or translation from another language of a technical definition or material, the analytical approach could be useful to assess the stratigraphical pattern and composition of the polychromy in sculptures or panel paintings, with regional or local peculiarities related sometimes to the cost of materials and to the final aesthetical result: *burnished* (brunido), *matt* and *graffito,* "estofado" or "brocade" "gilded" surfaces. When pure or high quality alloys of gold could not be used, the craftsmen found new solutions to imitate the gold shine, using tin or silver leaf or, in recent times, alloys with Cu, Sn and Zn ("purpurin").

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