God is in the detail. Gold, silver and polychromy

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Abstract

The visible polychromy of a wooden sculpture representing St. John the Evangelist, from *Museu Nacional de Arte Antiga*, Lisbon (Portugal) presents several techniques that complement each other on the creation of a sumptuous *estofado*. This case-study allowed the survey on gilding, silvering and polychromy practices, and observations on their execution are briefly reported and documented with results from a multi-analytical approach. Examination included digital photomicrography and the observation of micro-samples cross-sections, while material identification resorted to several analytical methods that included scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM-EDS) and X-ray diffraction (XRD).

Keywords

Polychromy, gilding, silvering, *estofado, pastiglia, sgraffito*, punchwork.

Deus está nos detalhes. Ouro, prata e policromia

Resumo

A policromia visível de uma escultura em madeira representando S. João Evangelista, do Museu Nacional de Arte Antiga, Lisboa (Portugal) apresenta várias técnicas que se complementam na criação de um sumptuoso estofado. Este caso de estudo permitiu o exame de processos de douramento, prateamento e policromia, sendo as observações da sua execução reportadas e documentadas com os resultados de uma abordagem multi-analítica. O exame incluiu fotomicrografia digital e observação de cortes transversais de amostras de policromia, recorrendo a identificação material a vários métodos analíticos, incluindo microscopia eletrónica de varrimento associada a espectroscopia raios-X por dispersão de energia (SEM-EDS) e difração de raios-X (XRD).

Palavras-chave

Policromia, douramento, prateamento, estofado, *pastiglia*, esgrafitado, puncionado.

Dios está en los detalles. Oro, plata y policromía

Resumen

La policromía visible de una escultura de madera representando a San Juan Evangelista, de Museu Nacional de Arte Antiga, Lisbona (Portugal) presenta varias técnicas que se complementan en la creación de un *estofado* suntuoso. Este estudio de caso permitió el examen de procesos de dorado, plateado y policromía, y las observaciones a su ejecución son reportadas y documentadas con resultados del enfoque multi-analítico. El examen incluyó fotomicrografía digital y observación de secciones transversales de muestras de policromía, la identificación material recurriendo a diversos métodos analíticos, incluyendo microscopía electrónica de barrido con espectroscopia de rayos X (SEM-EDS) y difracción de rayos X (XRD).

Palabras clave

Policromía, dorado, plateado, estofado, pastillage*,* esgrafiado, burilado.

Introduction

Following the poster presentation at GILT-EnArt 2015 on the case-study of the re-polychromy of a wooden sculpture comprising several techniques, this article provides more data and further discussion.

The creation of polychrome sculpture was a corporative and collaborative activity that resulted from joint efforts of several artists and took advantage of each one's particular skill to create meaningful religious works of art (Bassett and Alvarez 2013). The carved shapes of the sculpture were further enhanced by the painter-gilder's work through the choice of materials and colours. Depending upon the artist's expertise, an enhancement on the realism and splendour of the sculpture could be achieved, while imparting an entirely new set of iconographic connotations that deepened the image's significance (Falcão and Afonso 1997:114).

Although most artistic and historic studies value the sculptor´s work, often overlooking other artists' contributions, significant efforts have been recently implemented to reattribute the rightful importance to the painter-gilder's role, allowing for a holistic approach to the work of art (Gómez Espinosa et al. 2004).

The object under study is a small polychromed wooden sculpture (47 x 20,5 x 10 cm) that represents *St. John the Evangelist* (figures 1 and 2), and it constitutes a good example on how exquisite polychromy technical skills contribute to the image's artistic value. This sculpture from *Museu Nacional de Arte Antiga* (MNAA), Lisbon (Portugal), of unknown authorship, is dated from the late 17th century, and has been studied in Portugal, at *Laboratório José de Figueiredo* (LJF-DGPC), Lisbon, with the analytic support of *Laboratório HERCULES, Évora*.

The sculpture's visible (re)polychromy in the drapery areas, which presents an elaborate *estofado,* is the main focus of this case-study. *Estofo* and *Estofado* are the Portuguese terms that mean, respectively, fabric or clothes and their representation through polychromy (Bluteau 1728:III-325; Ferreira-Alves 2004:18). Several techniques can be combined in the creation of these often elaborate and lavish fabrics, such as: *sgrafitto*, punching (Nunes 1615:69), glazing and brush-tip painting (Gómez Espinosa et al. 2004:44; Serck-Dewaide et al 2004). In the sculpture under study many of these techniques were used to create St. John´s garments, which will be further detailed in an attempt to trace back the steps on their creation.

Figures 1 and 2 - *São João Evangelista*, front and back side. Polychrome wood sculpture (47 x 20,5 x 10 cm), MNAA, esc. 597. Images acquired by Luis Piorro, LJF-DGPC.

Analytical methodology

The study of the polychromy started with close observation and photographic records. Surface details providing technical information were registered through Digital Photomicrography (DP) using a handheld digital microscope Dino-lite Pro AM413T, which allowed detail measurements.

Selected areas of the polychromy were micro sampled and the samples were mounted on clear epoxy resin (EpoFix Struers) and polished to provide observable cross sections. Optical microscopy (OM) observations were obtained by the dark-field microscope Leica DM2500 coupled with the digital camera Leica DFC290 HD that provided the corresponding photographic documentation.

Scanning Electron Microscopy (SEM) images were made by using the Hitachi 3700N scanning electron microscope coupled to the Bruker X Flash 5010 SDD X-ray energy dispersive spectrometer (EDS), used for point analysis and elemental mapping, with the resolution of 129 eV for Kα of Mn, and QUANTAX micro analysis system. The analyses were made at 20 kV under variable pressure (40Pa).

The characterization of crystalline phases was made by using a micro-diffractometer D8 Discover of Bruker AXS with area detection system (GADDS), equipped with Cu-kα anode, göbel mirror, HiStar detector and 1 mm diameter collimator. The angular range considered varies between 8º and 70º and the acquisition time was 1800 s with a step of 0.02º. The tension and the current intensity applied to the tube were 40 kV and 40 mA, respectively. Phase identification was made through EVA software (version 2) of Bruker AXS using the files of the international database PDF-ICDD.

Beneath the surface

The sculpture of *St. John the Evangelist* was carved in wood identified as oak wood (*Quercus sp.*), through morphological characterization (Esteves 2014). During the polychromy study it was noticeable that the visible polychromy covered a previous one, partially visible on the lacunae areas, which was later confirmed by examining micro-samples cross-sections (figures 3 and 4). Although the study focuses on the latter polychromy – the visible one – a few observations can be made on these underlying layers.

Surveying the samples where this first polychromy is visible, it is possible to determine that the multilayered structure is consistent with water-gilding, where ground layers of gesso and red bole are set as base for the gold leaf.

EDS elemental mapping allowed for the identification of the gesso layers by the presence of S and Ca, and the bole layer, by the detection of Al, Si and Fe matching an aluminosilicate clay rich in iron oxides. The EDS point analysis on the gold leaf allowed the identification of a ternary Au-Cu-Ag alloy with a gold content ranging from c. 22,5 kt to 23 kt.

It was also observed that the burnished leaf was covered with coloured layers, which could indicate the use of the *sgraffito* technique. Samples from the tunic present a blue colour (possibly an azurite based pigment given the high concentration of Cu) (figure 3) and samples from the mantle have a red layer over the gold leaf (figure 4).

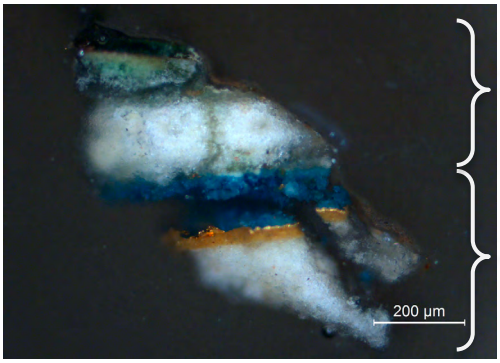

Figure 3 – Sample cross section from the tunic area where it is possible to observe the overlapped polychromies with metal leaves, and a blue layer on the pre-existing polychromy. Reflected light OM, 100x. Image acquired by Tiago Dias.

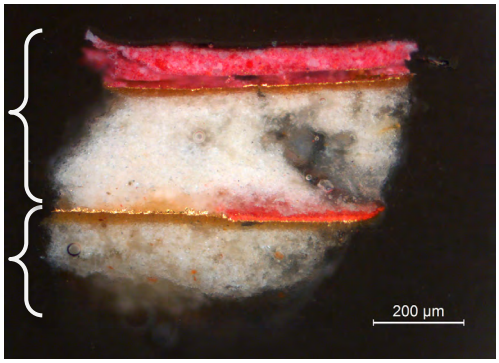

Figure 4 – Sample cross section from the mantle with a red layer on the pre-existing polychromy. Reflected light OM, 100x. Image acquired by Tiago Dias.

A sculpture´s second skin

On the second and currently visible polychromy, different materials and techniques were applied on the drapery to create an intricate *estofado*. Raised gesso motifs (*pastiglia*) were made to add further volume and decorate the tunic and mantle, and the surfaces were gilded and silvered. The mantle was gilded with gold leaf and painted, and elaborate *sgraffito* patterns were scraped, while the tunic received a green glaze that partially covered the silvered surfaces. A yellow coloured glaze was also used over gilded areas, complementing the delicate punchwork compositions. Finely detailed brush tip painting of floral motifs and other finishing touches brightened up the whole polychrome decoration.

Following what is believed to be the execution sequence in which the techniques were carried out, the most noteworthy observations made on each one are described next.

Preparatory layers

The ground is arranged in a multilayered structure, according to the traditional water-gilding practice. The white ground layer is composed of calcium sulphate dihydrate (gypsum), identified by X-ray diffraction (figure 5). In this case no underlying layer of anhydrite (*gesso grosso*) was detected, although it is commonly referred to be used as the first ground layer and then followed by gypsum. This gypsum should be of synthetic nature (*gesso fino*), a higher quality of gesso produced by re-hydration of anhydrite, presenting small even particles of lamellar shape (Cardoso 2013:173).

For a new polychromy to be made over a pre-existing one, there was no need to create a thick ground layer, which can explain the single use of gypsum. Nevertheless, the resource to this finer gesso may reflect the great care on the preparation of this polychromy. Although the gypsum might have been applied in several consecutive layers, it is not possible to distinguish between each of them, since the need to apply these preparatory layers while

warm could cause them to fuse together. The measured samples show that the layer thickness varies from 71 *μm to* 261 *μm.*

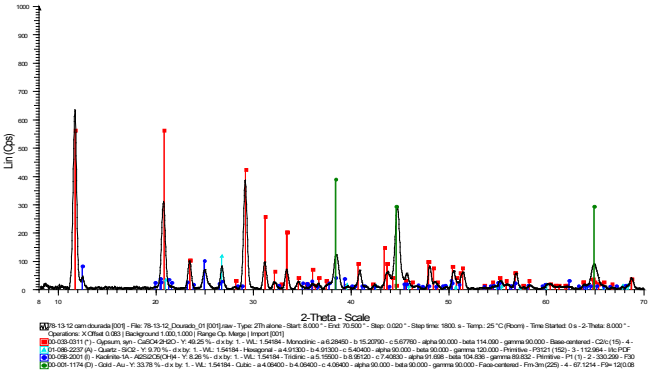

Figure 5 – XRD diffractogram identifying gypsum. XRD analysis by M. José Oliveira, LJF-DGPC.

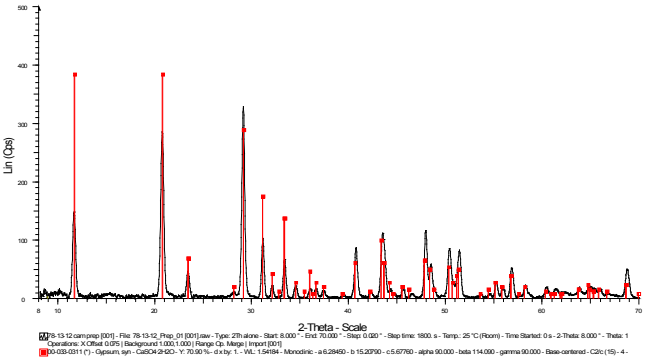

Figure 6 – XRD diffractogram identifying gypsum, kaolinite and quartz. XRD analysis by M. José Oliveira, LJF-DGPC.

Although all the bole layers seem to have a similar base composition of aluminosilicate clay, confirmed by the XRD analysis through the identification of kaolinite and quartz (figure 6), they differ according to the metallic leaf they are to support. While the bole in gilded areas has a warmer orange colour, with the detection of Fe suggesting a high concentration of iron oxides (figure 7), the white bole underlying the silver leaf shows a reduced amount of Fe on elemental mapping (figure 8). The average thickness for the orange bole layer is c. 20 *μm, while for the white one is c. 24 μm.*

The intentionality of using different coloured boles, for different kinds of metal leaf, reveals great attention to the final outcome, since the silvered areas would become lighter by the use of a white substrate instead of a reddish one.

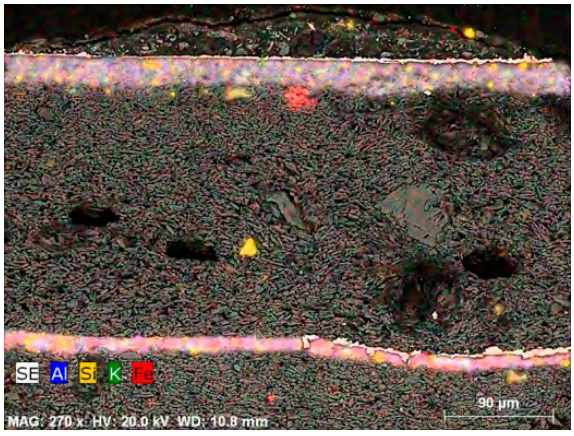

Figure 7 – 2D elemental mapping (Al, Si, K, Fe) by EDS analysis of burnished gilding over a red bole sample. Fe distribution indicates the concentration of iron oxides. SEM-EDS analysis by Luis Dias, HERCULES.

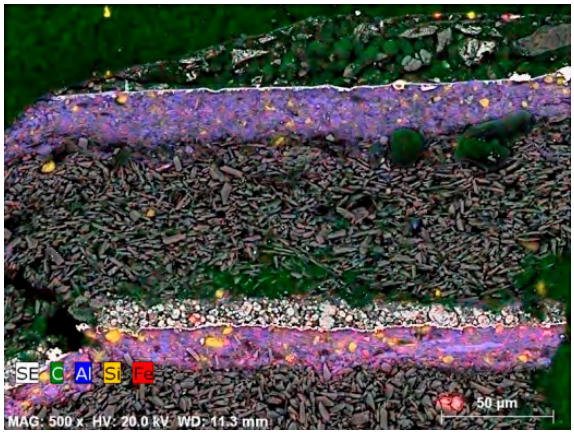

Figure 8 – 2D elemental mapping (C, Al, Si, Fe) by EDS analysis of burnished silvering over a white bole sample. The low Fe distribution on the top bole layer reveals low concentration of iron oxides. SEM-EDS analysis by Luis Dias, HERCULES.

Raised gesso – *Pastiglia*

Several raised elements were built up with gypsum, with the *pastiglia* technique, and further complemented with punchwork to represent *passementerie* or lace motifs (figure 9). These elements consist mostly of "C" shapes on the mantle and leaf shapes on the tunic. They must have been created freehandedly with several repeated brush applications of the warm gesso preparation until the desired shapes and relief were achieved (Martínez 1997:175; Le Gac 2004:80), or by means of a piping bag (García 2002:244). The mantle's hem also presents some bead shapes that could have been achieved by dripping the gesso. The boles were applied after the execution of these gesso elements (figure 10).

Figure 9 - Details of the raised *pastiglia* motifs on the hem of the mantle. Image acquired by Tiago Dias.

Figure 10 - Composite image of sample cross section of the *pastiglia* work. Reflected light OM, 100x. Image acquired by Tiago Dias.

Gilding

The use of metal leaves followed the traditional water-gilding method for both gold and silver, allowing the surfaces to be burnished to achieve a high sheen (figure 11). The attained smoother surface also enabled and facilitated the execution of the *estofado* techniques, providing a flat surface to paint, scrape and punch with less risk to drag out any metal leaf. So the mantle, the greater part of the gilded surface where these techniques were to be executed, presents burnished gold leaf. The sandals' straps are the only areas left unburnished, likely to achieve a differentiated matte finish (figure 12).

The gold leaf used is a ternary Au-Cu-Ag alloy, as indicated by EDS analysis. With a gold content from 94,25 wt% to 97,41 wt%, it corresponds to a gold leaf ranging from 22,5 kt to 23 kt (figure 13).

Figure 11 – Details of burnished gilding, hem of the mantle. Image acquired by Tiago Dias.

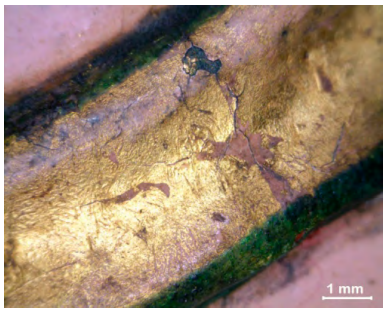

Figure 12 – Detail of unburnished gilding, sandal´s strap. DP c.60x. Image acquired by Tiago Dias.

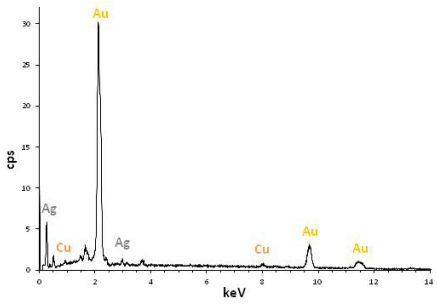

Figure 13 – SEM-EDS spectrum of the gold leaf indicating the ternary alloy Au-Cu-Ag. SEM-EDS analysis by Luis Dias, HERCULES.

Silvering

Although the artists at the time might have known that silver leaf is much less stable than gold, tarnishing quickly if left unprotected, it was still in usage (Gómez Espinosa et al. 2004:43; Serck-Dewaide et al 2004:136). Its high reflection index, about 95% of incident light (Rodríguez 1999:746), would provide extremely shiny white surfaces, being also favoured as a base for transparent to semi-opaque coloured glazes for the creation of metallic colours, especially cooler hues, since its white shine would not interfere on the final look of blues and greens as much as if gold leaf was used.

The tunic was water-silvered following the same processes used on the gilded areas. As previously reported, on the areas where silver leaf was to be laid a white bole was applied, thus reinforcing its final "whiteness". All the silvered areas must have been burnished, although the widespread tarnishing makes it difficult to assess.

The larger part of the tunic was covered with a green glaze, while only the *pastiglia* elements on the collar and hem and the small punched flower compositions were left unglazed, creating what must have been a suggestive colour contrast (figure 14).

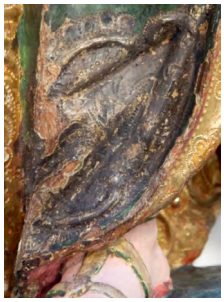

Figure 14 – Burnished silvering on raised gesso motifs, hem of the tunic. Image acquired by Tiago Dias.

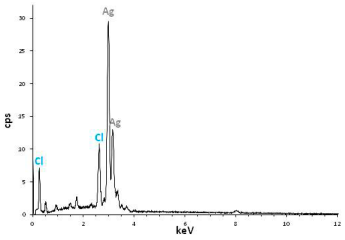

Figure 15 – SEM-EDS spectrum of the silver leaf, the presence of chlorine indicates the formation of silver degradation products. SEM-EDS analysis by Luis Dias, HERCULES.

Figure 16 – Detail of burnished silvering under green glaze, the leaf tears show the white bole. DP c.60x. Image acquired by Tiago Dias.

Figure 17 – Tarnished silvering on raised gesso motifs, tunic´s collar, with visible wear caused by abrasion, which reveals the preparatory layers. Image acquired by Tiago Dias.

The high reactivity of silver with atmospheric compounds, especially those containing sulphur and chlorine, can lead to its irreversible degradation (Homem 2013). In this case EDS point analysis detected the presence of Cl on the 24 kt silver leaf (figure 15). The unglazed areas now appear completely dark and dull, and even the glazed portions of silver leaf seem to have tarnished, given the dark stains that surround the cracking of the glaze (figure 16). This degradation permanently changed the painter-gilder's intent. And inadequate cleaning that removed the tarnished silver seems to have been carried out on several of these areas, partially exposing the white bole and gypsum preparatory layers (figure 17).

Sgraffito

The *sgraffito* technique was used only on the mantle, over the gold leaf. In order to produce the motifs the burnished gilding was painted, leaving the mantle's hem unpainted. The matte appearance of colours might point to the use of the tempera technique, most often used for *sgraffito* (Nunes 1615:69; Serck-Dewaide et al 2004:148). A red colour was applied on the outer surface, where the presence of Hg in EDS analysis indicates the use of vermillion (mercury sulphide, HgS); and a pink layer was applied on the inner side where the presence of Pb alongside Hg points to a mixture of vermillion and lead white (basic lead carbonate, $2PbCO_3 \cdot Pb\ (OH)_2$).

While on the outer side of the mantle, a floral motif was designed (figure 18), on the inner side a fish-scale pattern was chosen (figure 19).

Figure 18 – Decorative *sgraffito* motif on the outer side of the mantle, back. Image acquired by Tiago Dias.

Figure 19 – Fish-scale pattern on the inner side of the mantle, back. Image acquired by Tiago Dias.

All these motifs seem to have been designed freehandedly, and must have been firstly outlined with a fine sharp stylus of c. 0,1 mm, likely made out of wood or other soft material not to damage the metal leaf (Martínez 1997:182; Serck-Dewaide et al 2004:144), although references also refer to the use of silver stylus to scrape off the paint on the required areas (Nunes 1615:69) (figures 20 and 21).

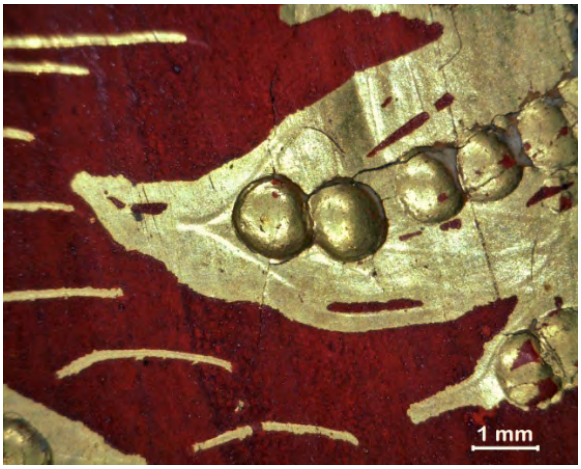

Figure 20 – Detail of *sgraffito* with visible indentation of the outline of the motif. DP c.60x. Image acquired by Tiago Dias.

Figure 21 – Detail of the overlapping scrape marks over the vegetal motif. DP c.60x. Image acquired by Tiago Dias.

Punchwork

Punched adornments were made over silvering and gilding and both the scraped and raised gesso motifs were complemented with punchwork decoration, enhancing the three-dimensional effect of the polychromy through the interplay of light and shadow (Nunes 1615:69; Martínez 1997:179, 182; Serck-Dewaide et al 2004:144). A close survey of the punch marks allowed to determine the use of simple hemispherical tipped punches with

varied sizes (0.6, 0.8, 1, 1.2 and 1.4 mm *Ø)* (figure 22). The more complex patterns are created by punch mark juxtaposition to create different shapes, and by slightly dragging the punch instead of placing it perpendicular to the surface, thus creating oval shapes instead of circular ones (figure 23).

Figure 22 – Detail of different sized punch marks. DP c.60x. Image acquired by Tiago Dias.

Figure 23 – Punch marks on gold with juxtaposition to create a kidney shape. DP c.60x. Image acquired by Tiago Dias.

Glazing

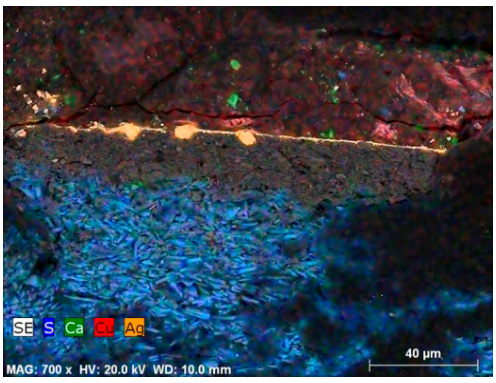

Figure 24 - 2D elemental mapping by EDS analysis revealing Cu distribution on the glaze. SEM-EDS analysis by Luis Dias, HERCULES.

Two different kinds of glazes could be found over the sculpture, likely to serve different purposes. Over the silvering, on the tunic, a translucent green coloured glaze was applied (figure 16). The double refraction of light on the coloured glaze and metallic surface results in a high gloss, shimmering appearance that tries to simulate a glossy fabric like silk satin (Richter 2013a:33; Gómez Espinosa et al. 2004:49; Serck-Dewaide et al 2004:147).

The presence of Cu revealed by EDS elemental mapping indicates that a copper-based pigment was used (figure 24). Although no conclusive identification could yet be made, the

pigment likely used was verdigris, referenced to be commonly employed in the making of copper green glazes for metallic surfaces (Richter 2013b:69). The absence of observable copper particles on the glaze layer also points to this hypothesis, since verdigris is known to dissolve in several mediums such as resins, oils and proteins (Eastaugh et al 2008:289). The medium employed was not yet identified.

Figure 25 – Detail of a yellow glaze brush stroke, hem of the mantle. DP c.60x. Image acquired by Tiago Dias.

Figure 26 - Detail of a floral composition on the, hem of the mantle. Image acquired by Tiago Dias.

Another kind of glaze can be found on the mantle following the motifs on the hem (figure 25). Used much more sparingly, it is brush tip painted over the gilding to highlight some of the shapes of raised gesso and punched compositions, contouring the punched flowers, for example. Its nature is yet to be determined.

Brush tip painting

The polychromy is finished with fine details brush tip painted. In the fish-scale pattern on the inside of the mantle, the painting uses a deep darker pink colour to simulate shadows and a lighter pink colour for highlights, adding a sense of three-dimensionality to the pattern (figures 19 and 29).

On the mantle further embellishment was done on the hem with floral designs of purple flowers with green foliage fitted between the *pastiglia* motifs (figures 27 and 28). It was possible to observe some preparatory drawing for these flowers and leaves made by incision with a stylus over the gold leaf (figure 28). The overlapping of the brush strokes over scrapped and punched gilding areas also allows to conclude that this was the last process on the making of this polychromy (figure 29).

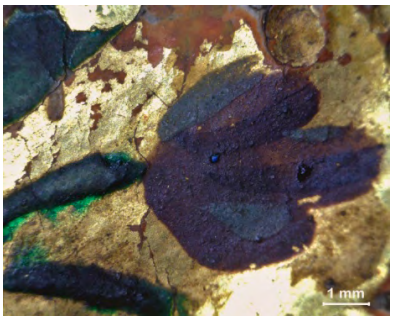

Figure 27 – Detail of a brush tip painted flower. DP c.60x. Image acquired by Tiago Dias.

Figure 28 – Detail of a flower where preparatory incisions and brush strokes can be seen. DP c.60x. Image acquired by Tiago Dias.

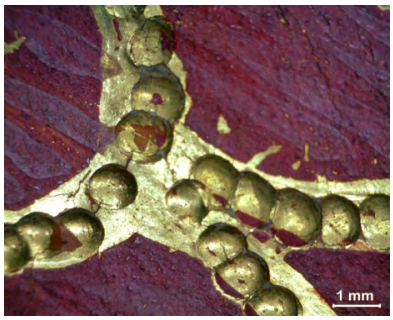

Figure 29 - Detail where highlight brush strokes cover scrapped and punched gilt areas. DP c.60x. Image acquired by Tiago Dias.

Final remarks

This case-study allows to knowledge some of the processes involved in the creation of a complex polychromy program that is an *estofado.* The different materials and techniques used to create the garments of *St. John the Evangelist* are a paradigmatic example of Portuguese seventeenth to eighteenth century polychromy.

Few remarks can be made on the pre-existing polychromy. It follows the water-gilding technique regarding the preparatory layers build-up (gesso and bole) for the gold leaf to be laid. Once the metal leaf was burnished, the tunic was painted blue and the mantle was painted red. The presence of paint layers over gilding might indicate the use of techniques such as *sgrafitto* (since the most common reason to paint over a gilded area was to make decorative motifs or patterns, either painted or scraped). However, no definite assumption can be made without a surface examination to determine the used techniques, prevented by the re-polychromy that now covers the entire surface.

The visible (re)polychromy, that was the main focus of this case-study, lends itself to close observation and documentation, revealing a repository of techniques available to the painter-gilder for the creation of an *estofado* polychromy. The attention given to detail can be observed since the preparatory layers, revealing a particular care with regard to the choice of materials, such as gypsum (*gesso fino*) employed as only component of the ground, and a deliberate choice of bole according to the type of metal leaf to be applied on each area. The use of different metal leafs to represent different textiles is also noteworthy. The gold leaf is laid as base for a brocade representation, and the silver leaf provides the sheen to the green glaze to emulate a lustrous satin-like fabric.

Intentionality and planning are also found on the sequenced creation of the decorative motifs; whether regarding the *pastiglia* motifs, the construction of which started at the preparatory layer stage and was complemented through punchwork and brush tip painting,

or regarding the preparatory "drawing" with stylus of the motifs to be further scraped off (*sgrafitto*) or bush-tip painted.

Although the materials and techniques identified are not uncommon to Portuguese polychromy of the period, the study of the *estofado* of this *St. John de Evangelist's* sculpture allows to document several of the different skills used to mutually complement each other, creating a metalanguage that simultaneously embellishes and enriches the sculptor's work.

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