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A Multiple-text Collection by Ẓahīr al-Dīn Mirzā Muḥammad Ibrāhīm

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Cover

Cambridge, Mass., Harvard Art Museums/Arthur M. Sackler Museum, Gift of Philip Hofer, MS 1984.463. fol. 61r: This folio shows in the middle at the right the riddle text in large letters in *thulūth* calligraphy. Between the five lines of this riddle is a part of an Arabic philosophical work in *naskhī* comprising three lines in each piece. In red, numbers and words are placed mostly below individual words of the riddle referring to letter magic. Around this centre piece, two brief Persian texts in *nasta‘līq*, an Arabic table, and a triangular diagram between lines of an Arabic explanation can be found. Both Arabic pieces are written in *naskhī*. The Persian text above the table introduces the lunar mansions, which the table enumerates. The Persian text in the left margin, entitled „A gem on theoretical philosophy about true speech“, deals with themes from *kalām*. The triangular diagram with its surrounding Arabic text treats the cosmological division of the universe in Muslim terms, beginning with God’s throne and descending through the Ptolemaic planetary sphere to the four Aristotelian spheres of the sublunar world to the underworld.

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Article

Art Historical and Technical Examination of the Cover of a *Jung* (Multiple-text Manuscript) from the Harvard Art Museums

Katherine Eremin, Mary McWilliams, and Georgina Rayner | Cambridge, Mass.

1. Introduction

This essay presents an art historical and technical examination of the cover of the *jung* manuscript, Harvard Art Museums, Arthur M. Sackler Museum, 1984.463. The cover was likely made in Isfahan in 1685–86 CE, just prior to production of the manuscript in 1686–87 CE.¹ A range of analytical techniques were employed to determine the construction sequence and the materials used. The technical aspects of the *jung* cover are compared with those of other Iranian lacquer covers.

2. Cover

The exterior surface of the cover is lacquered, whilst the interior consists of leather panels punctuated by gilded filigree in leather and paper, over surfaces painted blue, red, or green. The cover consists of three parts – front, back, and flap, the outside of which are shown in Figures 1a–b with the interior shown in Figures 2a–b. As noted in the essay by Knipe and Beaty in this volume, these components of the cover are presently positioned incorrectly on the text block, so that what is now the back cover is the front proper, and vice versa. In this essay, the terms ‘front cover’ and ‘back cover’ refer to the current rather than the original configuration. The front and back panels are somewhat compromised by darkened lacquer, craquelure, areas of loss, and inexpert over-painting. In contrast, the flap shows less abrasion and brighter colors. As detailed in the technical analysis, it is our working hypothesis that the three sections were produced in the same time period with similar materials and techniques. The flap received less light exposure over the centuries and is the only area that preserves the original color of the lacquer. In the following sections, a brief art historical examination of the inscriptions and pictorial elements of the decorative

program on the exterior of the cover is given, together with the results from technical examination.

2.1 Inscriptions

Determining if the flap is contemporary with the front and back panels is critical to understanding the cover. The flap features two small cartouches with minute texts written in gold that give the place and date of manufacture as Isfahan, 1097 H/1685–86 CE, Figure 3a, and bear the name Shafī‘ al-Tabrīzī, Figure 3b, who is also named as the scribe of the manuscript.² Given that Persian lacquer is an inherently ambiguous medium, assessing the authenticity of the signature and date was a major preoccupation of our examination. When there are multiple paint, lacquer, and metallic layers, as in this cover, it can be difficult to discern later interventions. As utilitarian objects, Islamic lacquer objects often have repairs and repainting. To consolidate the surface visually and physically, many objects have received new coatings of lacquer, under which inscriptions have sometimes been altered or added. Furthermore, the industry has a strong tradition of looking inward, creating works of art in historicizing styles linked to past masters.³ With these caveats, we examined the book cover’s flap under magnification in visible, infrared (IR), and ultraviolet (UV) radiation, which revealed that the craquelure disrupted the gold letters. This suggests that the date and signature are not a later addition.

² The signature reads: ‘By the attempt of the worthless particle Muḥammad Shafī‘ al-Tabrīzī / Finished in the ruling city of Isfahan in the year 1097.’ For a brief discussion of Shafī‘ al-Tabrīzī, see the essay by Pourjavady and Rahimi-Riseh in this volume.

³ For example, a pen box signed by the Qajar artist Zayn al-‘Ābidīn [al-Imāmī] and dated 1270 H/1853–54 CE that meticulously follows the style of the eighteenth-century master ‘Alī Ashraf (Cambridge, Mass., Harvard Art Museums, Object Number 2018.7).

¹ For the digitized manuscript see the databank of the Harvard Art Museums, Arthur M. Sackler Museum <<https://hvrd.art/o/215600>>.



Fig. 1a: Back cover of the *jung* with the attached flap on the outside.



Fig. 1b: Front cover of the *jung*, showing areas of loss and restoration. The restored areas are darker and duller in texture than the original lacquer.



Fig. 2a: Inside of the back cover of the *jung*.



Fig. 2b: Inside of the front cover with attached flap open.



Fig. 3a: Date in gold script on the lacquer border of the flap.



Fig. 3b: Signature of Shafīʿ al-Tabrīzī in gold script on the lacquer border of the flap.

Rectangular inscription panels containing a Persian poem frame the three parts of the cover. The poem begins on the front proper, continues onto the back proper, and terminates on the flaps. From beginning to end, the poem appears to be written by the same hand. The last couplet contains the penname Najīb, likely Najīb-i Kāshānī (Nūr al-Dīn Muḥammad Sharīf Kāshānī

[1063–1123 H/1652–1711 CE]).⁴ A *mathnavī* of 16 couplets, the poem belongs to a tradition of inscriptions that praise the work of art they adorn and celebrate its patrons and future users. It opens with pious phrases blessing and praising the king, identified as Shāh Sulaymān (r. 1077–1105 H/1666–1694 CE), who is referenced several times in the text block. Also praised, but not named, is the royal treasurer, (*mustawfi*

⁴ We are grateful to Farshid Emami for this suggestion and for translating the poem while a graduate student intern at the Harvard Art Museums in 2015.

al-mamālik), who is credited with compiling the texts. He is Ṣāḥīb al-Dīn Mīrzā Muḥammad Ibrāhīm (d. after 1099 H/1688 CE), so often mentioned in the papers of this volume. The poem describes the book's contents as a guide to esoteric knowledge and praises its beauty with conventional calligraphy and garden metaphors. These continue onto the flap, where the book is compared to a garden filled with colorful flowers.

2.2 Pictorial Decoration

More than the manuscript which it now encloses, the lacquer cover is indeed richly filled with a variety of flowers. The front and back panels employ the same composition and motifs. The field is organized as a grid with twenty-four cells that each hold a plant. Allowing for repetition, there are eighteen different plant motifs. Some are stylized or composite, but most are rendered in a naturalistic style. Those that may reliably be identified include crown imperial (shown in Figure 4a), carnation, crocus (shown in Figure 4b), coreopsis, rose (shown in Figure 4c), iris, violet, prunus, weeping willow, and cypress.

Several of the individual motifs – both naturalistic and stylized – find close parallels in an important album of late Safavid drawings made in Isfahan, now in the British Museum.⁵ The album features more than fifty flower drawings, several bearing signatures or seal marks of the artist Shāfi 'Abbāsī (d. 1080s H/1670s CE), also known as Muḥammad Shafī 'Iṣfahānī. Although the album's few dates span 1638–74 CE, and thus predate the Harvard lacquer cover, the strong visual rapport between these works of art suggests they were produced in the same artistic milieu, that is, late Safavid Isfahan. By the seventeenth century, a naturalistic floral style was practiced internationally, and comparisons with seventeenth-century examples from South Asia particularly warrant further research. Nevertheless, critical years for the development of the naturalistic style in Iran fall during the reign of Shāh Sulaymān, and the numerous correspondences that can be found between Harvard's lacquer cover and late Safavid painting and decorative arts confirms the validity of the inscription on the flap.⁶

⁵ MS London, British Museum, 1988,0423,0.1.1–56. For particularly close comparisons with the Harvard cover, see folios 1988,0423,0.1.20 and 1988,0423,0.1.52.

⁶ For example, a brocaded taffeta with floral motifs (Washington, D.C., The Textile Museum, 3.138); a gold-ground textile with irises (Washington, D.C., The Textile Museum, 3.118); a painting *Judith with the Head of Holofernes* by Muḥammad Zamān, c.1675 (London, The Nasser D. Khalili

The floral motifs on the flap recognizably echo those used on the front and back panels, but they appear to be painted by a different, less skilled hand. In the treatment of irises, for example, the flowers on the flap are rendered in a more summary fashion: the silhouette of petals is simplified, and the blossoms always overlap in front of the leaves. On the flap, the colors do not always fill the gold outlines of the flowers and some color extends outside the gold outline. The colors in the flowers on the covers correspond much more closely to the gold outlines. These differences are clear from comparison of the irises depicted on the back cover (Figs 5a–b) with those shown on the flap (Figs 5c–d). In addition, both the visible light and infrared images reveal that the pigment used on the flap was applied much more thickly and the green pigment on the flap is much more opaque in IR than that on the back cover (see Fig. 5a–b for the cover and Fig. 5c–d for the flap). Similar differences are observed between other pairs of flowers, for example the red coreopsis on the back cover and a related red flower on the flap (shown in Figures 6a–b for the cover and Figures 6c–d for the flap). In addition, the tiny cloudbands on the flap usually uncoil to the right (as can be observed in Figure 5c and Figure 6c), whereas on the front and back covers, the cloud tails usually stream to the left (as seen in Figure 5a and Figure 6a). Given the close similarity in the treatment of the borders to the flap and front and back covers, these differences in the depiction of the flowers may reflect the work of different artists within the same workshop.

The plant motifs on the lacquer cover differ dramatically from the floral ornament found on the pages of the text block. The manuscript's vibrantly colored floral ornament seems to be the work of an illuminator. It is non-naturalistic and adheres to an earlier tradition of scrolling vines with split and serrated leaves, palmettes, peonies, and rosettes. Although in no way conclusive, this stylistic divergence further supports the suggestion that the lacquer cover was not created specifically for the manuscript it now encloses.

2.3 Technical Examination

The cover is formed of pasteboard covered with multiple layers of transparent lacquer through which the flowers painted onto the pasteboard can be seen. The lacquer over the front and back covers is now rather dark and obscures the decorative details, but was likely originally much lighter in color, similar to that of the lacquer on the flap. Tests of the

Collection, MSS1005); and paintings of flowering plants on the walls of the Mausoleum of Shāh 'Abbās II in Qom, c.1666 CE.



Fig. 4a: Flowers depicted on the cover – crown imperial.



Fig. 4b: Flowers depicted on the cover – crocus.



Fig. 4c: Flowers depicted on the cover – rose.



Fig.5: Comparison of irises on the back cover and flap – a) iris on the back cover in visible light, b) iris on the back cover in IR; c) iris on the flap in visible light, d) iris on the flap in IR.



Fig. 6: Comparison of coreopsis type flowers on the back cover and flap – a) coreopsis on the back cover in visible light, b) coreopsis on the back cover in IR, c) coreopsis-type flower on the flap in visible light, d) coreopsis-type flower on the flap in IR.

light sensitivity of the flap and main cover confirmed that the lacquer is light sensitive and darkens with exposure to light. The front and back covers have also suffered significantly more physical damage than the flap, although both the covers and the flap show many losses at the edges. The flap was probably protected from both discoloration and more physical damage by being folded inside the cover.

Following examination, non-destructive x-ray fluorescence (XRF) spectroscopy was undertaken to determine the materials used. The damage to the edges of the cover and flap reveals a complex stratigraphy, which made interpretation of the non-destructive analysis challenging. Following discussions between the curator, conservator and scientist, minute samples were removed from damaged areas for analysis. Most samples were mounted in resin and polished to produce cross-sections for examination with an optical microscope and with a scanning electron microscope with energy dispersive microanalysis (SEM-EDX). These samples greatly improved our understanding of how the cover was constructed and what materials were used.

2.4 Construction

Examination of areas of loss in the center of all three components – the front and back covers and flap – show that the flowers were painted directly onto the pasteboard and then overlain with multiple layers of clear (now discolored) lacquer. Polarized light microscopy of small samples of the fibers from the pasteboard showed that both bast and cotton fibers are present. Analysis of samples of the lacquer suggested a mixture of an oil and resin, consistent with studies showing Persian lacquer to be a complex mixture of resin and drying oils, often tinted with organic dyes or inorganic pigments.⁷ Measurements across losses in the front and back covers and in the flap, and of the thickness of lacquer layers in cross-sections, suggests that the lacquer layers are thicker on the front and back covers than on the flap.⁸ The front and back covers may have received additional consolidating coats of lacquer, which were less necessary for the better protected flap.

The relationship between the painted flowers and the substrate can be seen in Figures 7a–c where lacquer

has been lost over part of a red flower on the front cover. Analysis shows that the red petals lack elements characteristic of inorganic red pigments, such as mercury, lead or arsenic, indicating use of an organic red colorant. The strong fluorescence in UV (seen in Figure 7c) suggests a plant-based organic red such as madder or safflower, both of which occur on the folios within the manuscript.⁹ Examination at high magnification shows that the organic red penetrated the fibers of the pasteboard substrate, as shown in Figures 8a–b. Although no losses occur in red flowers on the flap, XRF analysis shows these also lack distinctive inorganic elements, so were likely also painted with organic pigments. Loss of lacquer in green areas of the flowers on the front and back covers show the presence of very dispersed dark pigment with some absorption of color by the fibers, as shown in Figures 9a–b. Analysis of green areas of flowers on the front and back covers and the flap show the use of copper-based pigments. However, the specific compound cannot be identified through the lacquer, and the green pigment in areas of missing lacquer on the front and back covers was too dispersed for identification in-situ. The green pigment in flowers on the flap is visibly more concentrated than on the cover and appears to have colored the lacquer as well as the substrate, but there are no losses in these areas. The purple flowers on all components lacked distinctive elements in XRF, suggesting use of organic pigments. On all components, the flowers were delineated with high purity gold. As has been noted previously, the color was applied less precisely in the flowers on the flap and often fails to fill the entire area or extends outside the gold border, as can be seen clearly in Figure 10a.

No losses occurred in areas of purple flowers on the covers. However, areas of loss in purple flowers on the flap show that the purple color is present within all layers of the lacquer, and there is little evidence of pigment particles on the fibers, shown clearly in Figures 10a–b. Analysis of small samples of this purple lacquer show the use of cochineal, an insect-based organic red, as a colorant.¹⁰ This use of colored lacquer in these purple flowers on the flap is very different from the use of red or green pigment below colorless lacquer observed on the front and back

⁷ For technical studies of Persian lacquer work see Sahl and Springmann 2009; Eremin and Grech 2017.

⁸ Layer thicknesses are very variable but measurements on the covers and flap and on samples from these indicate up to 250 microns of lacquer and other materials present in the flap with up to 400 microns of lacquer and other materials for the covers, (1 micron equals 0.001mm).

⁹ See Eremin et al. in this volume.

¹⁰ Identification of cochineal by liquid chromatography with mass spectrometry (LCMS) analysis undertaken at the Museum of Fine Arts, Boston, by Richard Newman.

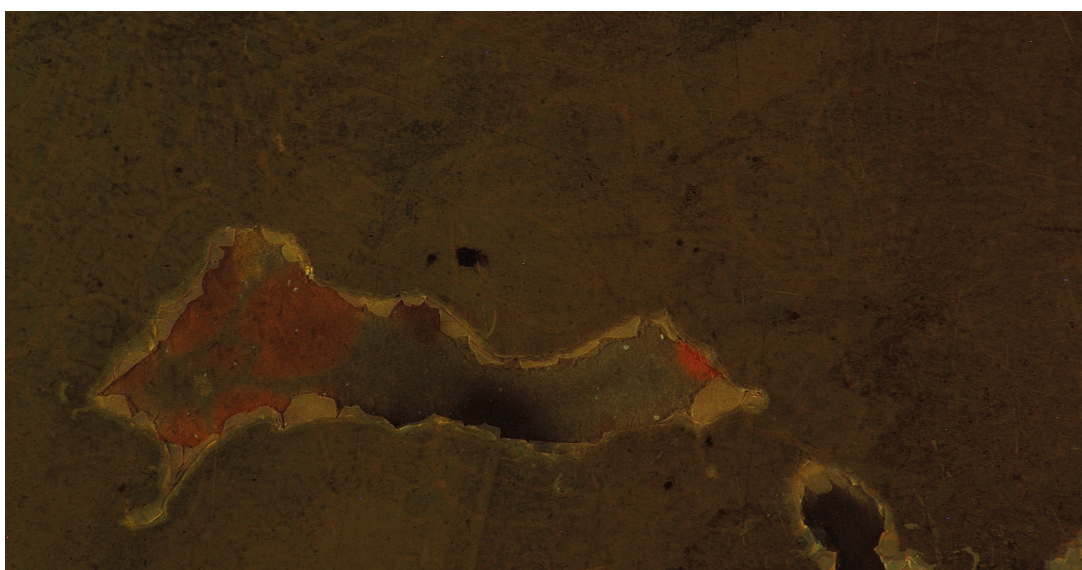
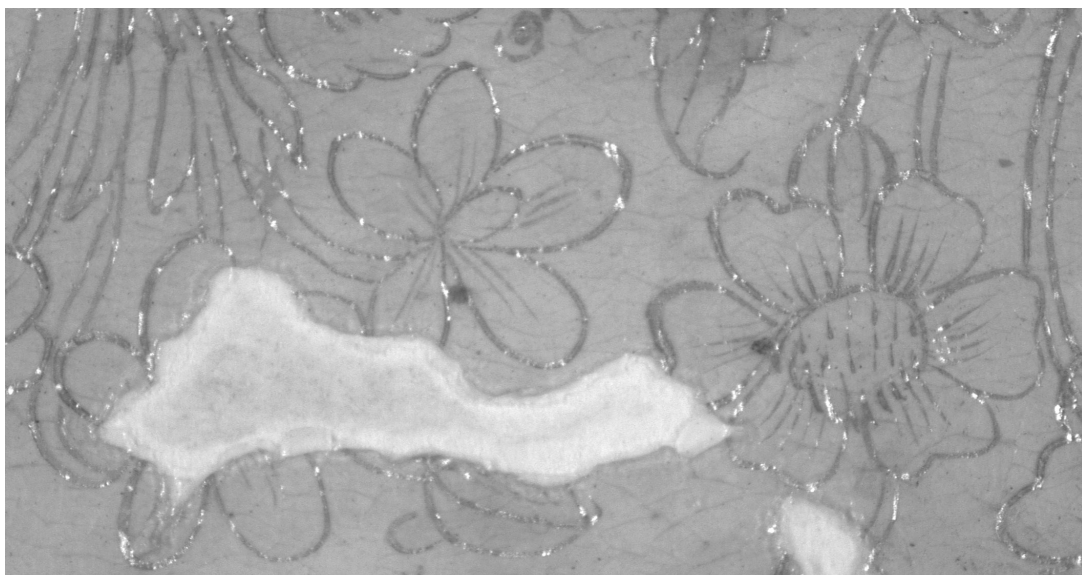
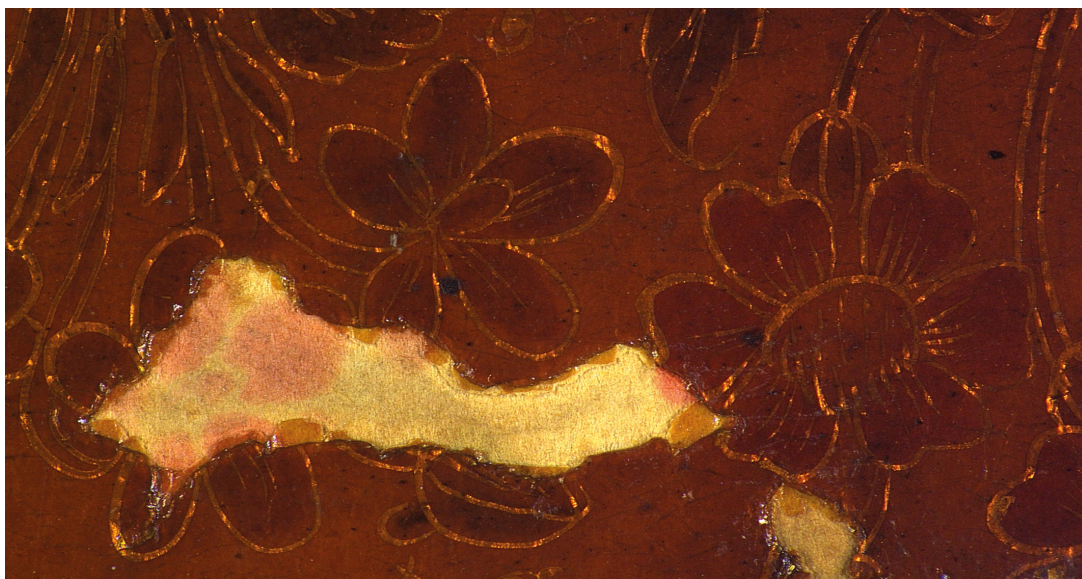


Fig. 7: Loss in lacquer on the front cover showing a red flower painted on the pasteboard – a) visible light, b) IR, c) UV showing florescence of the red pigment.

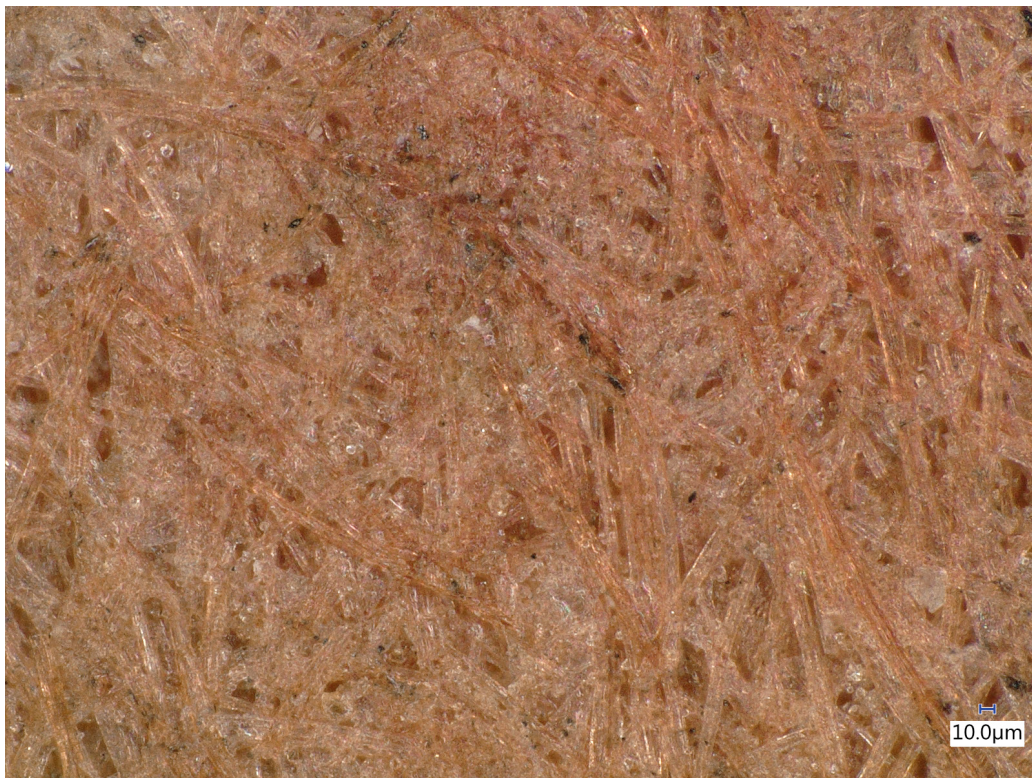
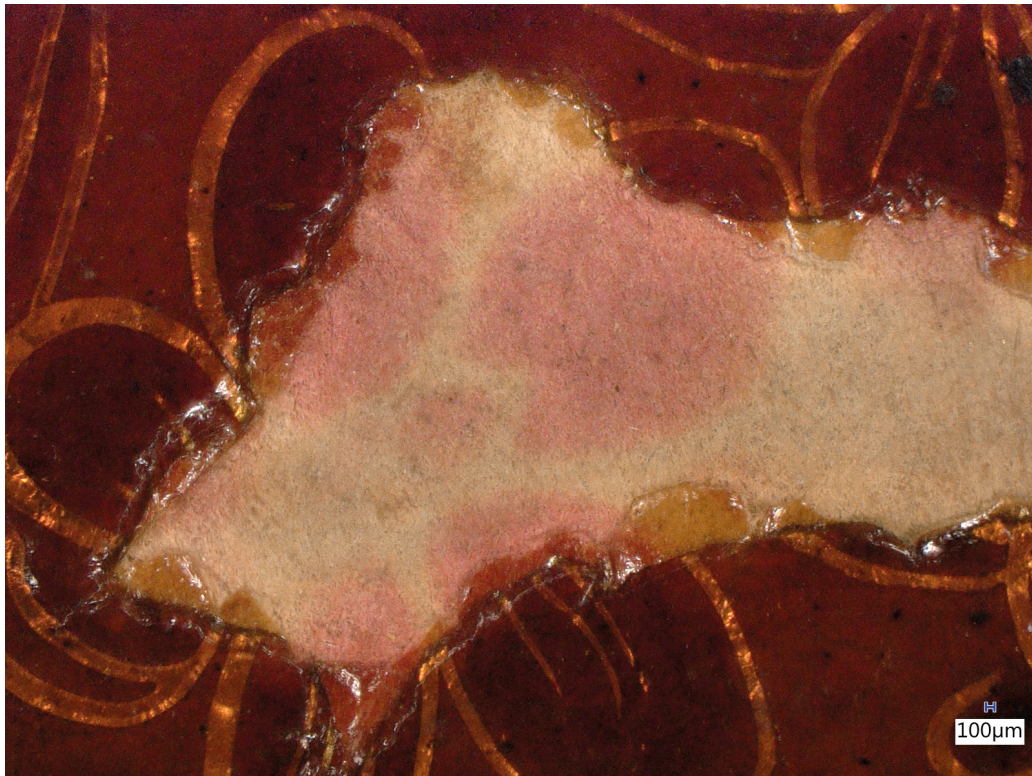


Fig. 8: Detail of the red flower painted on the pasteboard – a) showing the thick darkened lacquer and pink pigment on the pasteboard, b) at higher magnification showing penetration of the red color into the paper fibers.

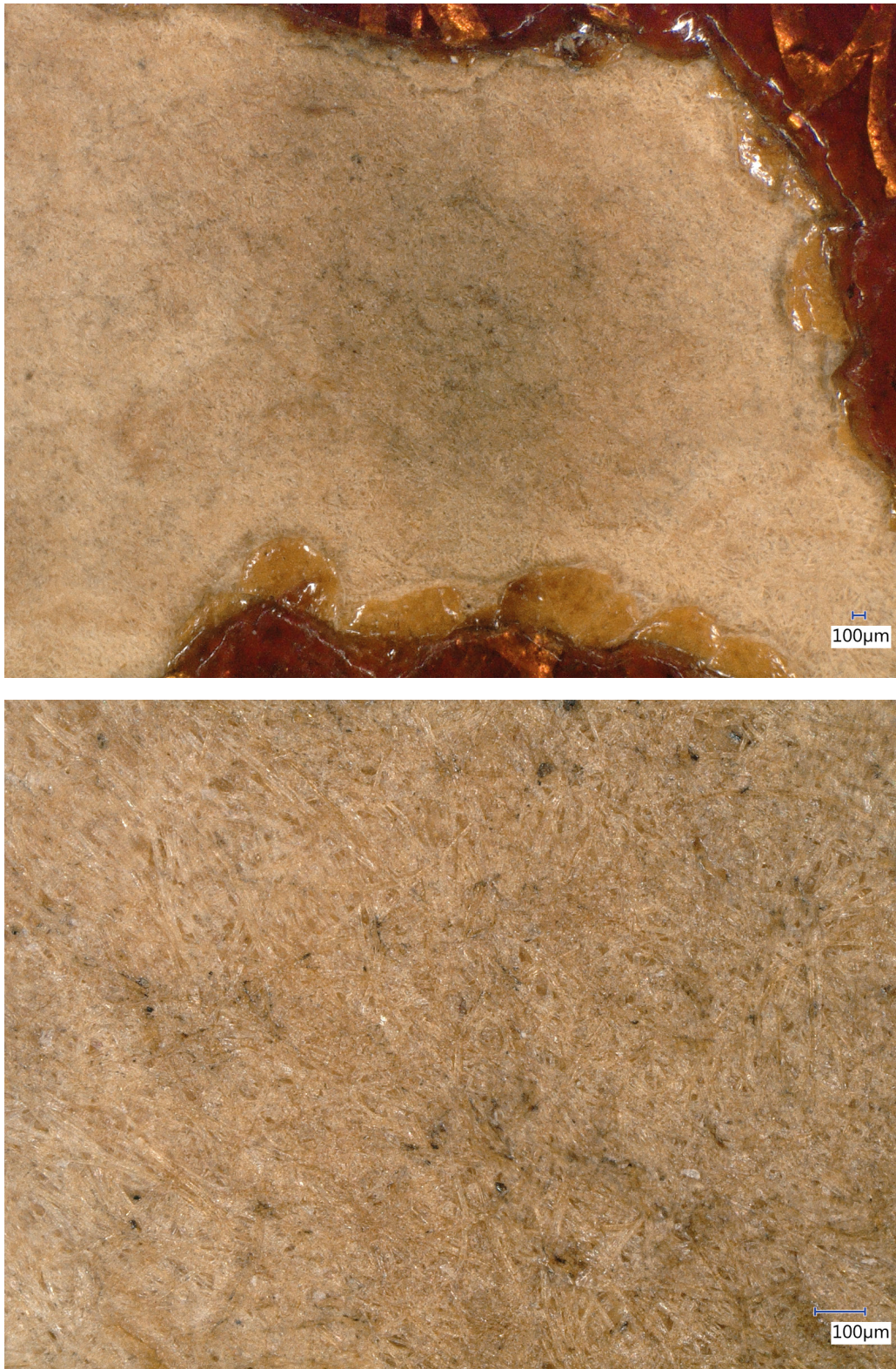


Fig. 9: Detail of a loss in the lacquer on the front cover – a) showing a green leaf painted on the pasteboard, b) at higher magnification showing fine pigment particles on the paper fibers.

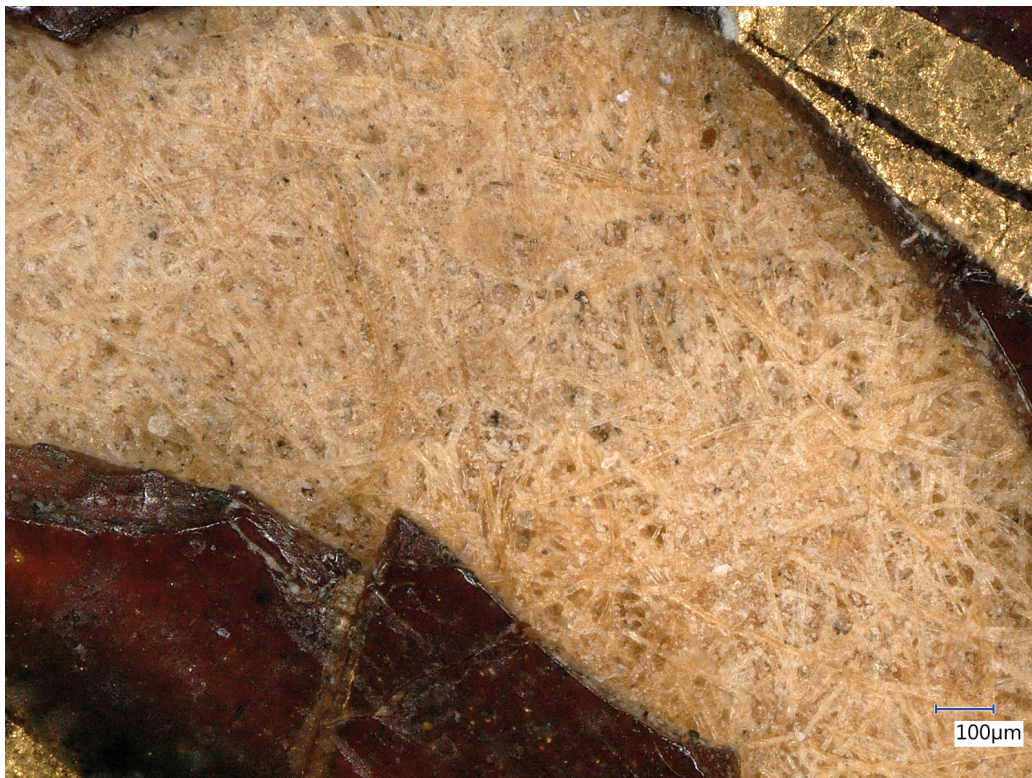


Figure 10: Loss in the lacquer on the flap in a purple flower – a) showing the damaged petal, b) at higher magnification showing the purple color throughout the lacquer and the lack of pigment on the paper fibers.

covers. Unfortunately, due to the differences in location of the losses, it was not possible to compare the structure of colors on the flap with the same colors on the front and back covers.

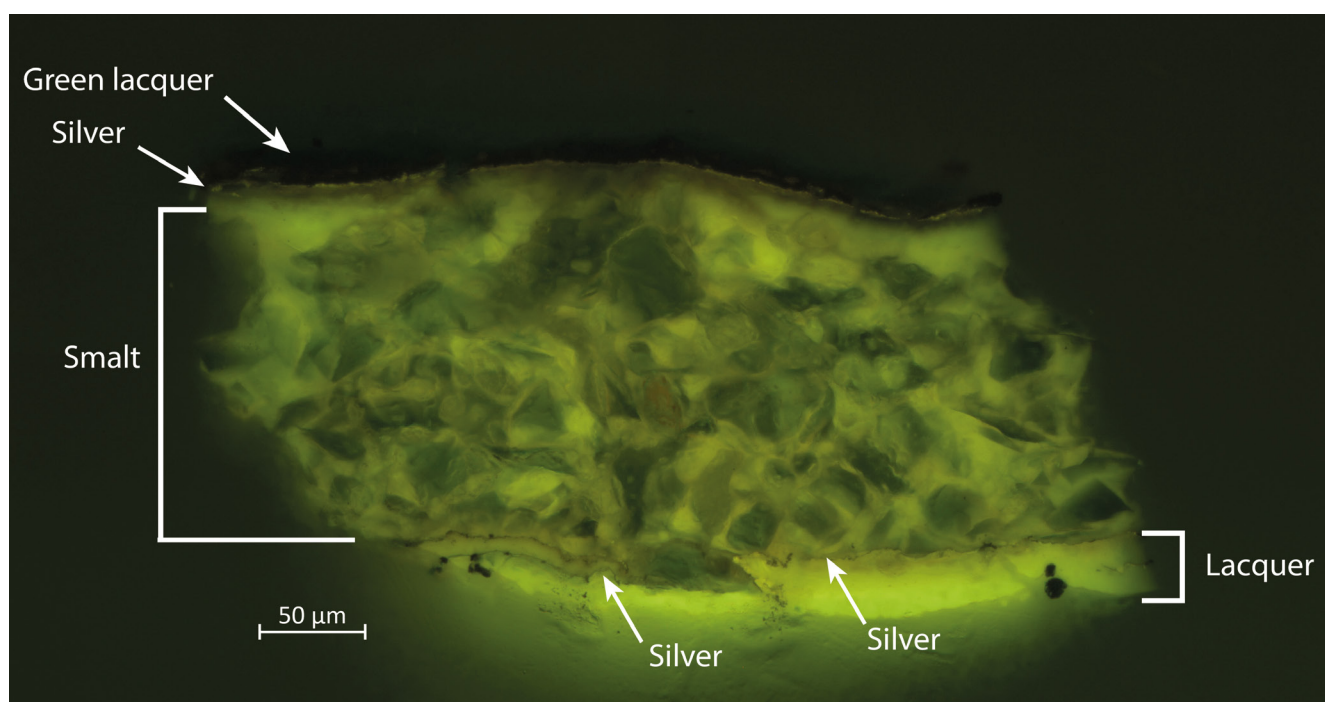
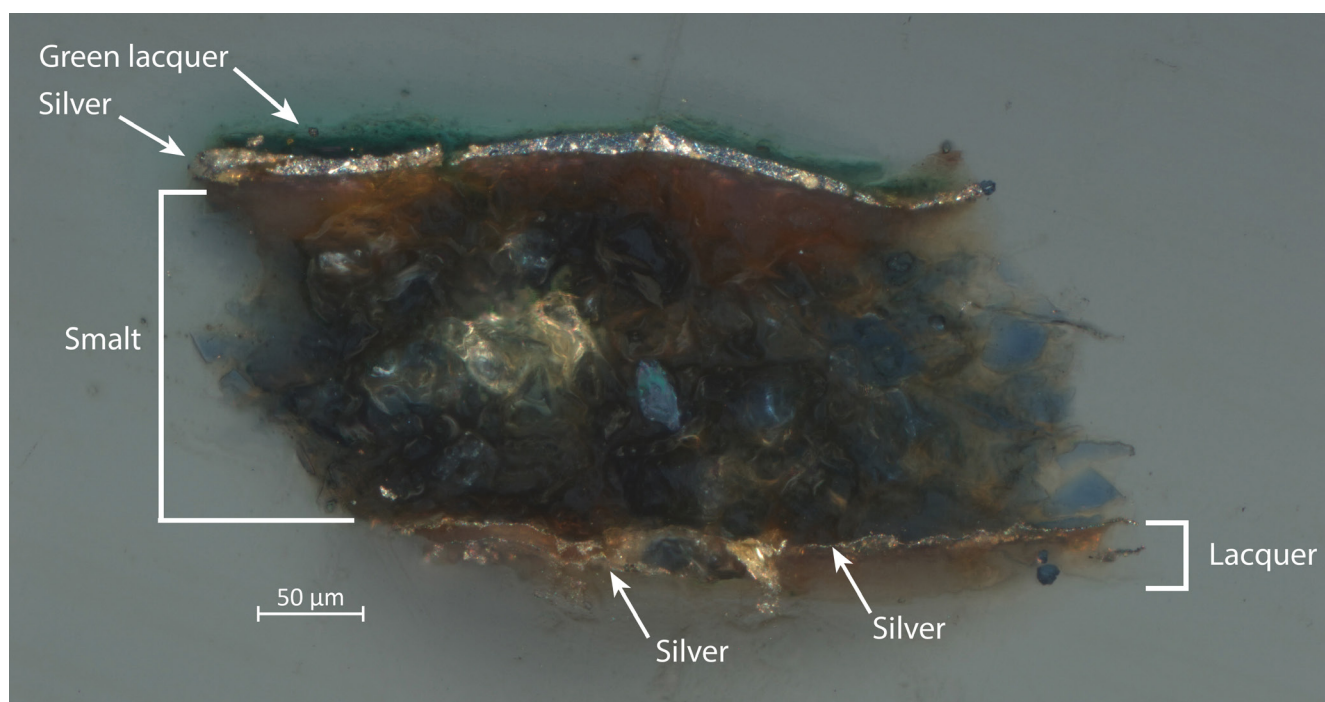
The colored border of all components is more complex than the central area and is very similar on all three components, both visually and in terms of the materials and techniques used. In all borders, additional layers of colored materials were placed between the pasteboard and uppermost colorless lacquer. The materials and construction of the borders of the flap, front cover and back cover appear to be identical, consistent with the visual similarity of the borders and support the hypothesis that these three components were made together. Examination of cross sections of samples from damaged edges enabled the construction sequence to be determined in all three components and is demonstrated in Figures 11 and 12, cross-sections of samples from areas of green lacquer in the border on the front cover (Fig. 11) and red lacquer in the border on the back cover (Fig. 12).

Figures 11 and 12 show cross-sections through samples from the borders of the cover viewed with different techniques to highlight the layering and materials present. Due to deterioration of some layers, oil was placed on the samples to improve imaging, resulting in the unusual appearance in bright field, shown in Figure 12b. Figures 11a–c and Figures 12a–d were taken with an optical microscope with different filters and light sources, whilst Figures 11d and 12e were taken with a scanning electron microscope. The color of the layers can be seen best in the polarizing light images, Figures 11a and 12a, whilst images using UV light and different filters highlight the lacquer and other organic materials as these fluorescence white/pale blue/ pale yellow in Figures 11b–c and 12c–d. The different metallic layers show most clearly in the bright field image, Figure 12b, and the scanning electron microscope images, Figures 11d and 12e. The scanning electron microscope images also show the particle shape and size most clearly.

A thin layer of lacquer was applied over the pasteboard substrate and covered with a layer of silver less than 2 microns thick. This lowermost silver layer was then covered with another fine layer of lacquer, around 8 microns thick, and a further layer of silver of 1–2 microns applied over this. The two lowermost silver layers can be clearly seen in the cross-section of green lacquer (Fig. 11, S3), most obviously in the SEM image, Figure 11d. In the cross-section of red lacquer

(Fig. 12, S1), the lowermost silver layer was lost during sampling. The upper silver layer was covered with a substantial layer, 150–200 microns thick, of blue smalt mixed with an organic matrix similar to the clear lacquer. Smalt is a blue pigment composed of a cobalt-colored potassium-rich glass produced in Europe and widely used in paintings in place of the more expensive ultramarine from at least the fifteenth century onwards. The angular smalt particles can be seen clearly in the SEM images, Figures 11d, 12e. The smalt particles in both samples are heavily altered chemically and visibly due to reaction with the lacquer matrix, resulting in a crumbly, friable layer that has darkened from the original bright blue to dark grey or black. This alteration can be observed in the polarized light images of the cross-sections, where most smalt particles appear dark and only a few show the original blue color (Figs 11a, 12a). Discoloration of smalt due to the presence of organic binders is a common problem in oil paintings.¹¹ Given this discoloration, the black areas of the border may originally have been bright blue in color, with their current appearance due to alteration of the smalt and surrounding organic matrix. In these dark areas of the border, the smalt layer is overlain by multiple layers of originally clear lacquer that has also now darkened, with no other materials over the smalt. However, in green and red areas of the border, the smalt layer is overlain by a third and thicker layer of silver, 10–20 microns thick, most clearly seen in Figures 11a, 11e and 12a, 12b and 12e. The uppermost, thicker, silver layer contains some particles of gypsum (hydrated calcium sulfate), which may have been mixed with the fine silver particles to provide more texture or aid application. This silver layer was covered with a layer of red or green lacquer, which was sealed beneath multiple layers of originally clear lacquer, now darkened on the covers but not on the flap. This uppermost silver layer provided a reflective surface to enhance the effect of the lacquer, particularly where this is colored red or green. The green lacquer over the silver can be seen in Figure 11a but the overlying layers of clear lacquer were lost during sampling. The red lacquer is clearly visible in Figures 12a, c, d, and differences in the fluorescence of the clear and red layers show the uneven surface of the red layer, which was smoothed out by the less viscous clear lacquer, seen in Figures 12c–d. The difference in texture and viscosity between the red and clear layers is also evident in the SEM image, Figure 12e, with visible cracks in the red

¹¹ The degradation of smalt in oil paintings has been widely studied, for example Spring et al 2005; Robinet, Spring, and Pagès-Camagna 2011; Van Loon et al. 2020.



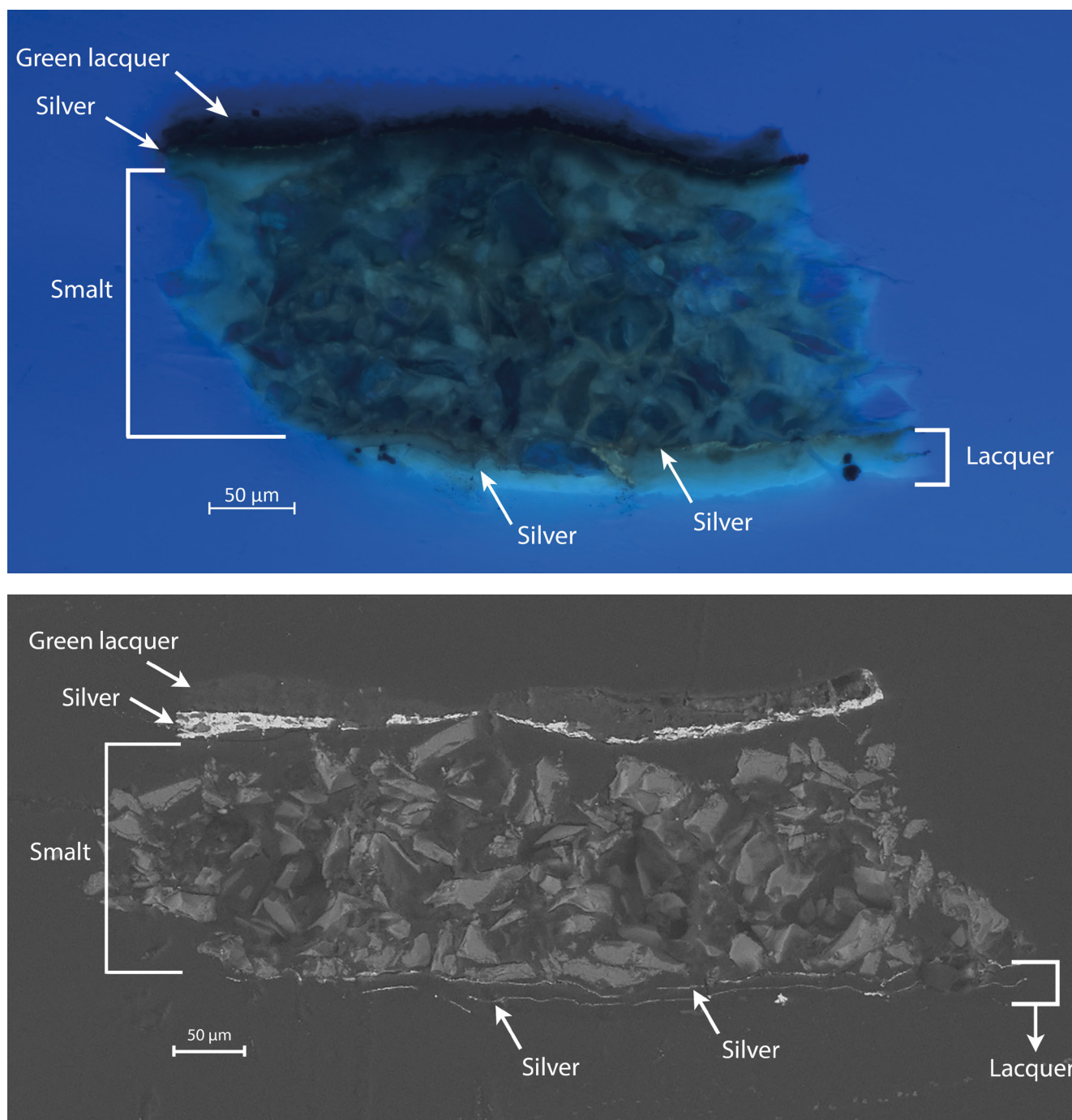
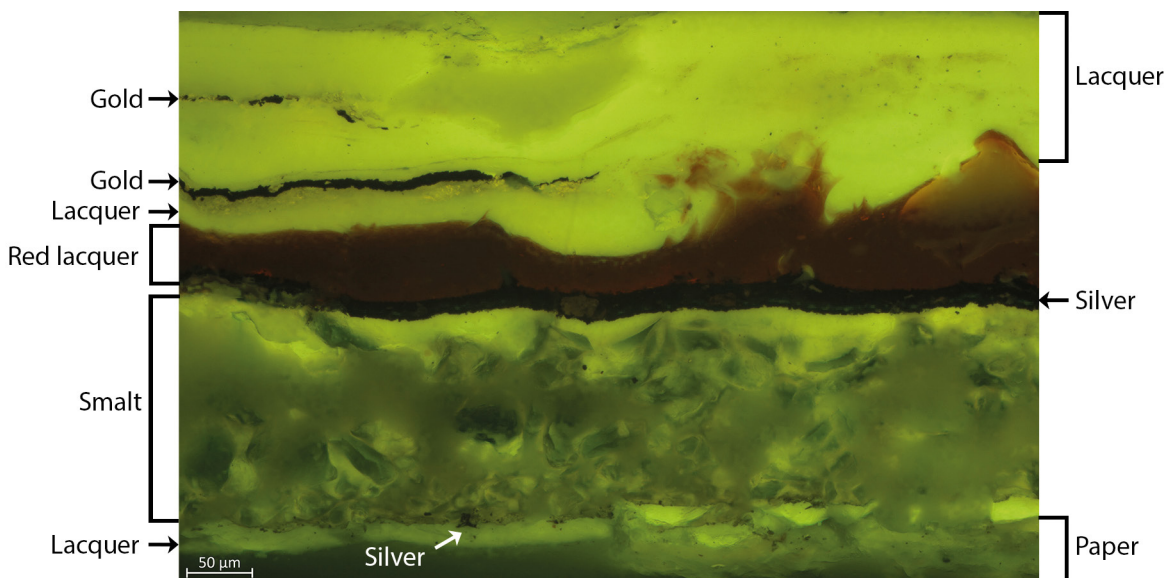
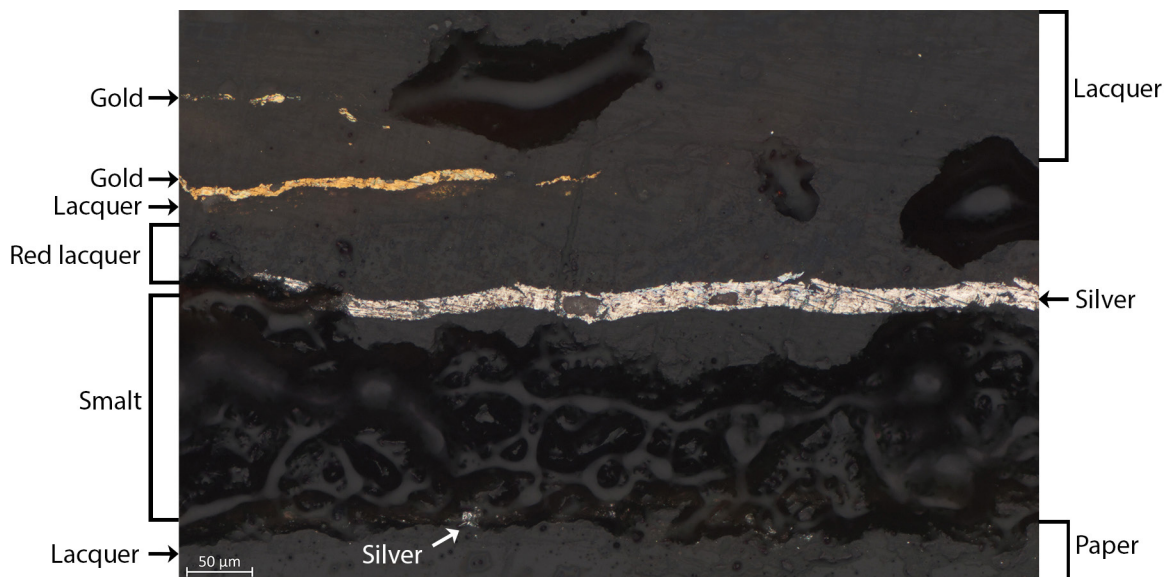
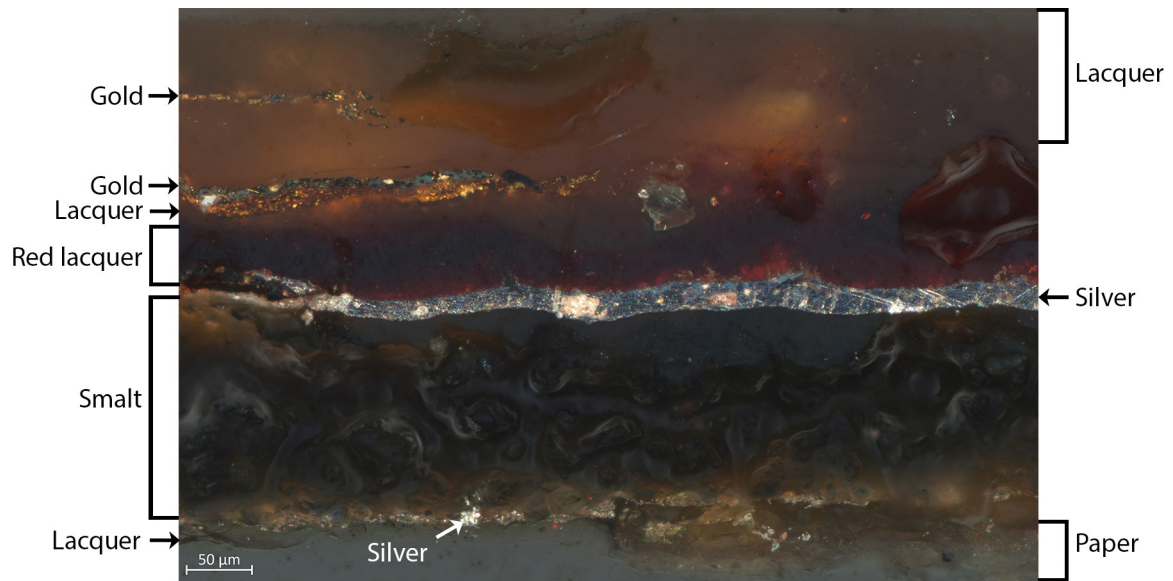


Fig. 11: Cross section through a sample taken from the border of the front cover in an area of green lacquer. The images are labeled to show the different layers and consist of: a) optical microscope image with polarized visible light showing the true color of the sample, b–c) optical microscope images with UV light and different filters showing fluorescence of lacquer, d) back scattered electron (BSE) image from scanning electron microscope (SEM), clearly showing the angular smalt particles and bright metallic layers. In the BSE image, organic materials appear dark, the smalt is lighter, and the metallic layers (gold and silver) are the brightest.



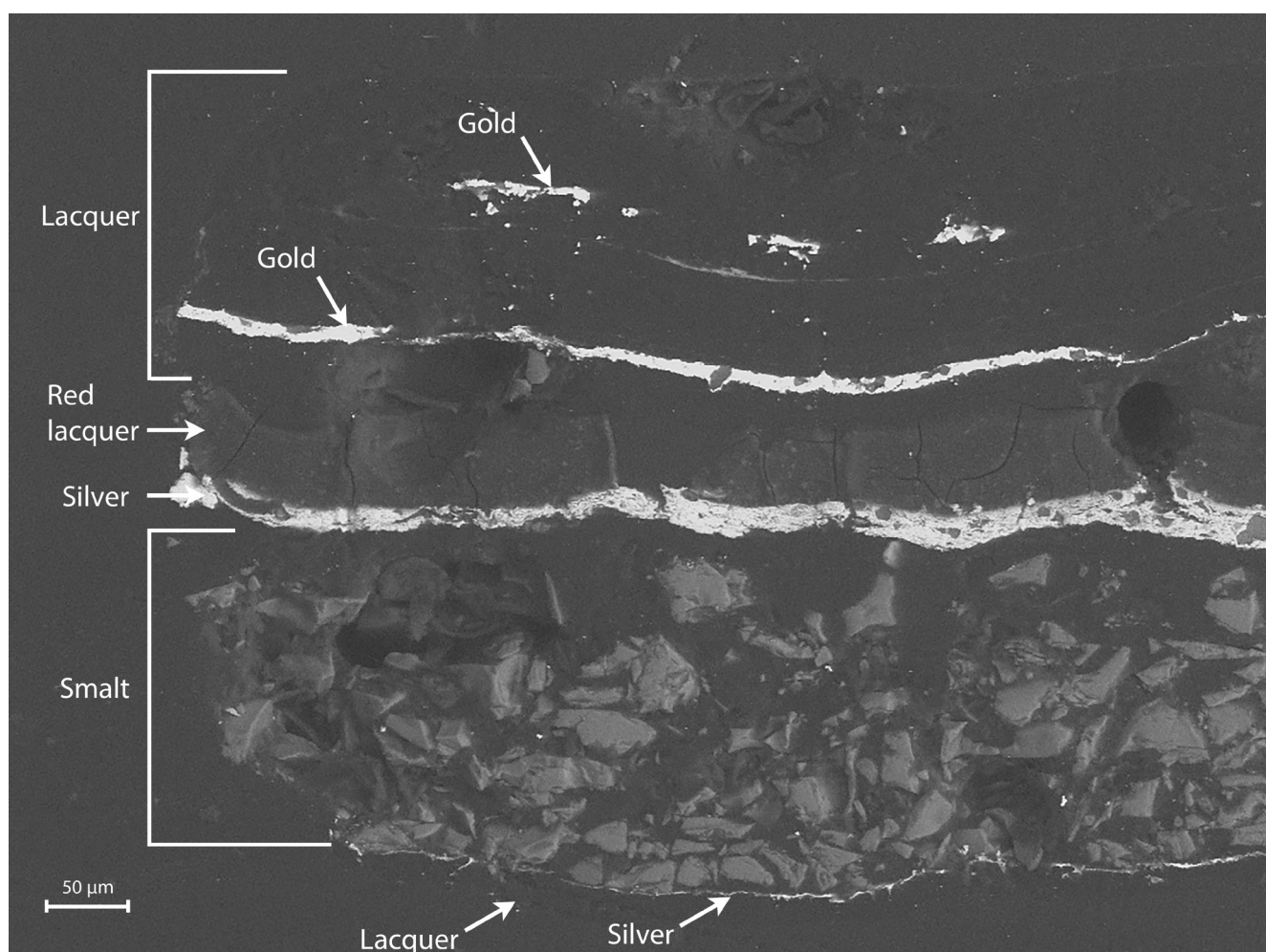
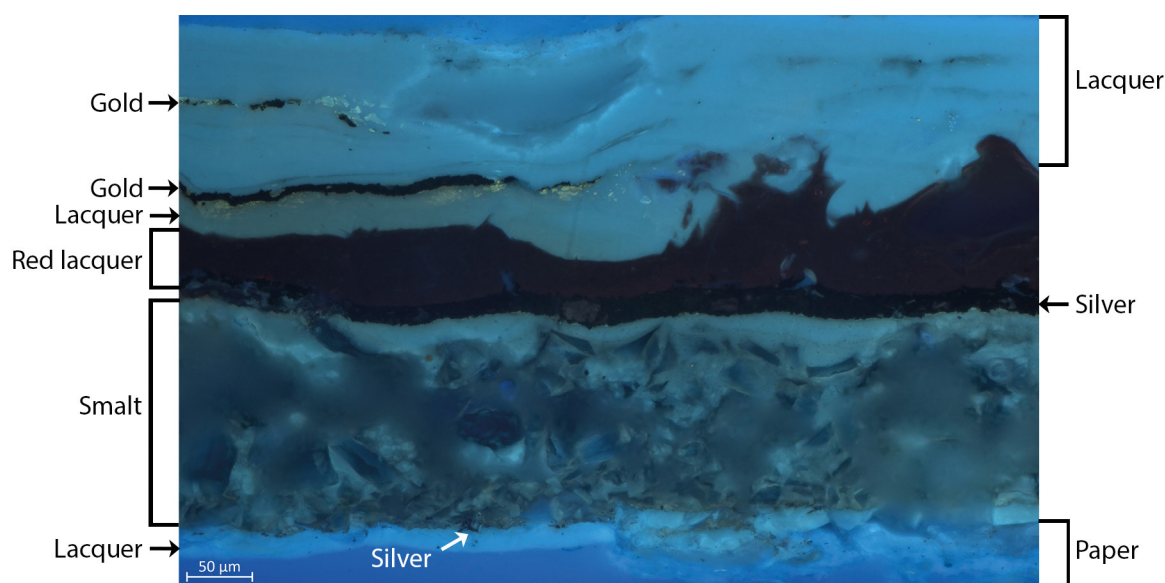


Fig. 12: Cross section through a sample taken from the border of the back cover in an area of red lacquer. The images shown are labeled to show the different layers and consist of: a) optical microscope image with polarized visible light showing the true color of the sample, b) optical microscope bright field image clearly showing the different metallic layers, c–d) optical microscope images with UV light and different filters showing fluorescence of lacquer and boundary between the red and colorless lacquer, e) BSE electron image from SEM, clearly showing the angular smalt particles and metallic layers. In the BSE image, organic materials appear dark, the smalt is lighter, and the metallic layers (gold and silver) are the brightest.

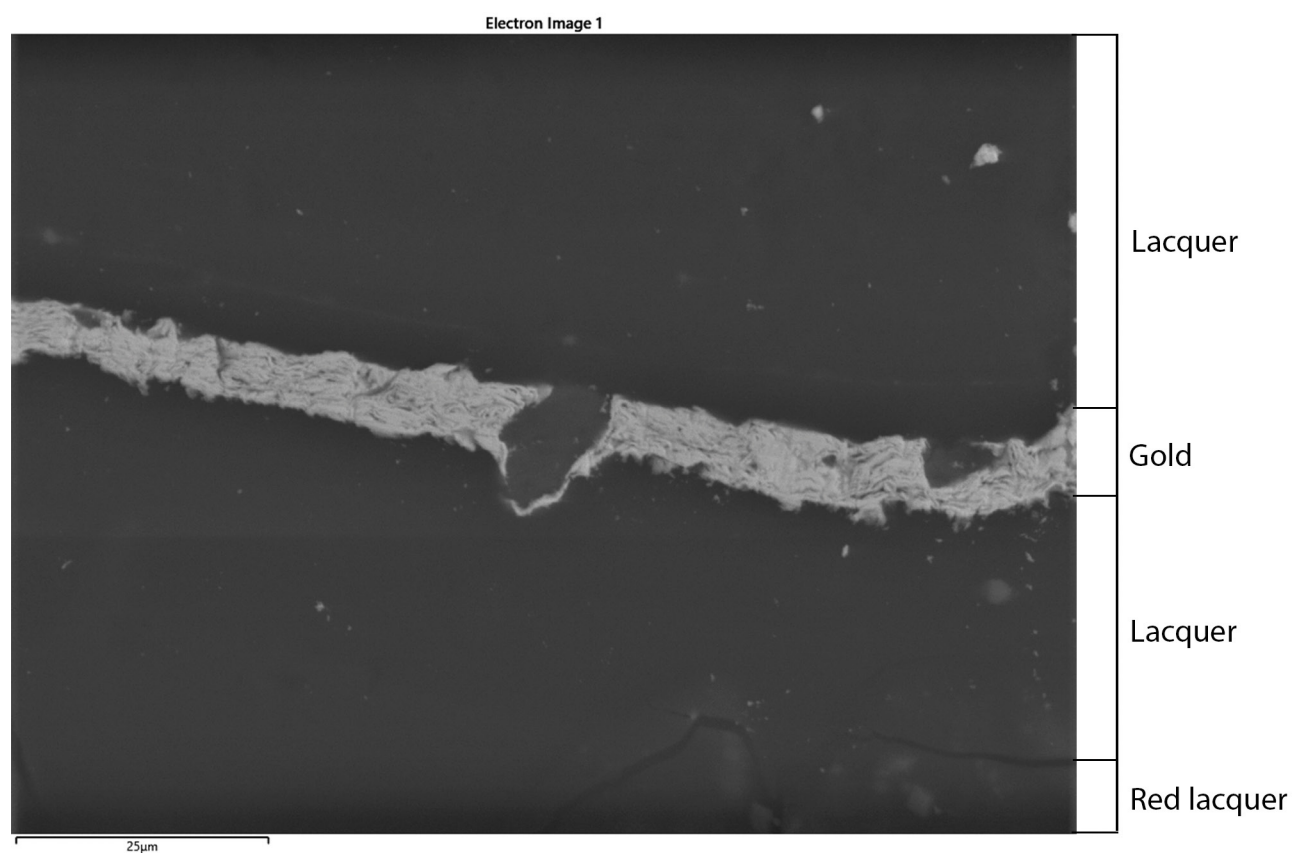
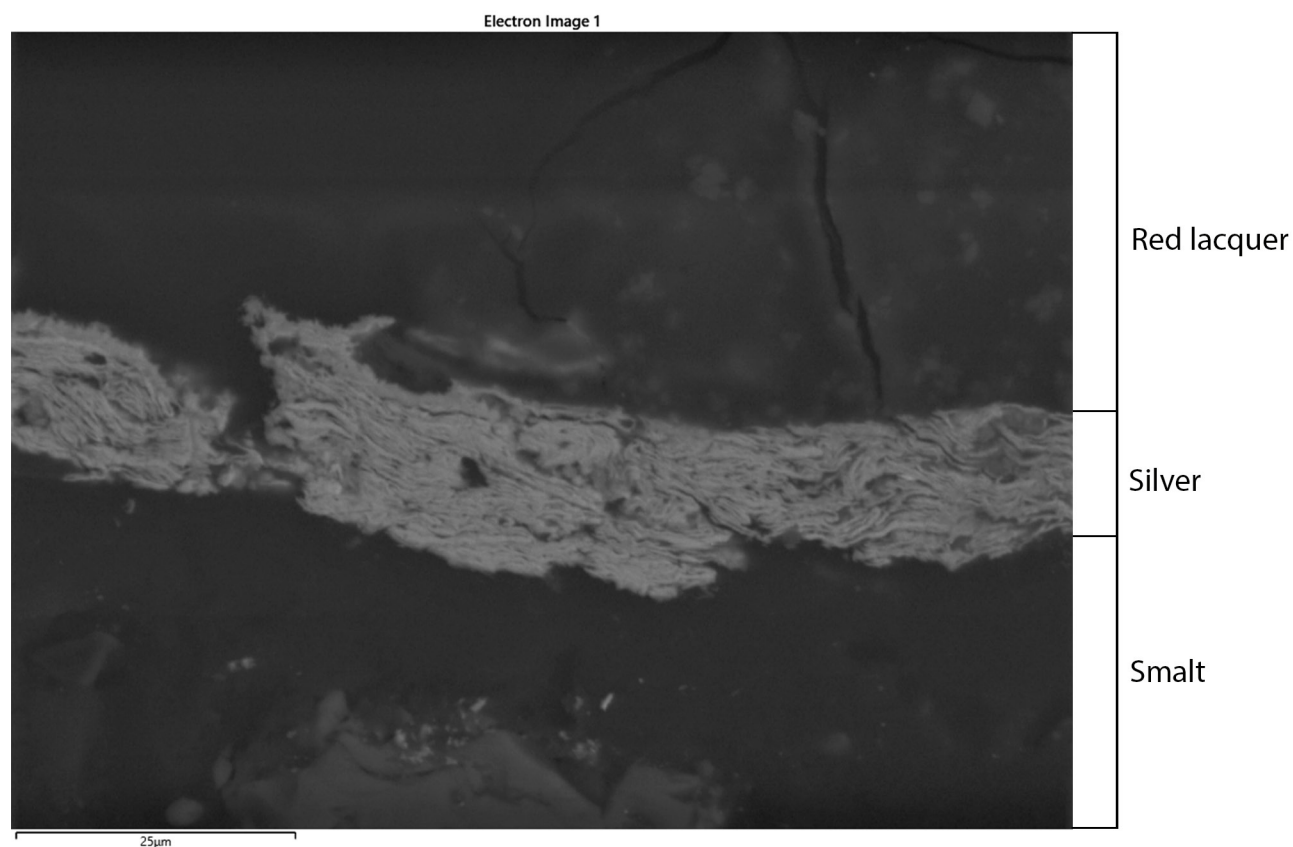


Fig. 13: BSE images showing the fine particles in the metallic layers present in the sample from the red border. Images are labelled to show the different layer – a) uppermost silver layer between red lacquer and smalt layer, b) gold layer within the lacquer.

layer. The thickness of the red lacquer layer in this sample varies from 35–50 microns, with at least 160 microns of clear lacquer over the red layer. Analysis shows that the green layers were colored by mixing verdigris (basic copper acetate) into the lacquer, whilst the red layers contain cochineal.¹²

The sample from the red area of the border clearly shows fragmentary layers of gold around 5–10 microns thick within the clear lacquer over the colored layers, seen most obviously in Figures 12a, b, e. The bright field image, Figure 12b, demonstrates the color difference between the upper gold layers and the lower silver layers. This gold was used to form the text and surround the flowers and other motifs. Analysis shows that both the gold and silver used on the covers and flap were of high purity and would hence have been extremely malleable. Examination at high magnification shows that the gold and silver layers are made up of minute aligned particles of shell silver and shell gold, as seen in Figures 13a–b. It is notable that in the border, the smalt layer extends under all other layers and is hidden by subsequent layers of silver and colored lacquer in many areas. This shows the artist painted the border around the entirety of the cover and flap and then added extra layers in selected areas to fulfil the desired decorative scheme.

The inside of the front and back cover (shown in Figures 2a–b) was decorated with areas of colorful pigments covered with gilded leather and paper filigree. On the inside of both covers, blue smalt was used in the dark blue central and corner medallions, with a lighter blue mixture of smalt and lead white in the side two medallions. The smalt on the inside of the covers is unaltered so retains the original bright blue color. Red vermilion (mercuric sulfide) was used to color the red areas of the central medallion. On the inside of the flap, smalt was applied in the corners, with a copper-based green, likely verdigris, at the center of the outer edge. The filigree over the colors on the flap is largely missing but analysis of the remnant impressions on the pigment indicates high levels of silver as well as gold, suggesting use of mixed gold-silver alloy. In contrast, only gold was present in the filigree impressions and remaining filigree on the blue and red areas on the cover.

¹² Identification of verdigris by Fourier transform infrared spectroscopy and scanning electron microscopy. Identification of cochineal by liquid chromatography with mass spectroscopy (LCMS) was undertaken at the Museum of Fine Arts, Boston, by Richard Newman.

3. Discussion

Comparison of the lacquer cover to other seventeenth-century examples of Islamic lacquer work is difficult as manuscript covers from this date are fairly rare, due both to the ease with which they were damaged and the practice of removing and dispersing folios for the market. In addition, there are few technical studies of Islamic lacquer despite its popularity in Iran and other areas, where it was widely used for artefacts such as book covers, mirror backs and pen boxes.¹³ Study of nineteenth-century Iranian lacquer art works at the Harvard Art Museums showed that the lacquer manuscript covers and pen boxes had a similar construction to that observed in the *jung*, with paste board covered in multiple layers of lacquer and metals with a variety of colorants and other additives.¹⁴ In all of the late eighteenth- and nineteenth-century lacquer works analyzed, brass, an alloy of copper and zinc, was used beneath the lacquer rather than silver. However, a silver layer occurs under the lacquer in two earlier lacquer works, a manuscript cover made in Tabriz around 1530 CE,¹⁵ and a pen box painted by Ḥajjī Muḥammad in 1692–93 CE.¹⁶ Samples from damaged areas of the sixteenth-century manuscript cover reveal a similar construction sequence to those from the *jung*, with ultramarine rather than smalt in dark areas and a copper-based pigment in green areas. The stratigraphy differs from that seen in the *jung* cover mainly in the use of fewer layers, with ultramarine only in the dark areas rather than under the green layer as well. As in the cover on the *jung*, the lowermost silver layers are hidden by subsequent layers in all areas. Similarly, in nineteenth-century lacquer work the brass layer extends below all areas and is largely covered by additional decorative layers. Smalt was also identified in the black borders of the lacquer pen box painted by Ḥajjī Muḥammad in 1692–93 CE,¹⁷ and within a black background around gold script on the interior of a lacquer manuscript cover dating to the late eighteenth century.¹⁸ In contrast, smalt was not identified in any nineteenth-century

¹³ For publications on Iranian lacquer work see Farhad, McWilliams, and Rettig 2017.

¹⁴ See Eremin and Grech 2017.

¹⁵ Cover of Harvard Art Museums 1964.149, *Illustrated Manuscript of a Divan of Hafiz*, Tabriz, c. 1530.

¹⁶ Pen box, Harvard Art Museums 2014.303, *Pen Box with Portrait Medallions on Floral Ground*, Ḥajjī Muḥammad, 1692–93.

¹⁷ *Pen Box with Portrait Medallions on Floral Ground*, Harvard Art Museums 2014.303, Ḥajjī Muḥammad, 1692–93.

¹⁸ Inside cover of Harvard Art Museums' manuscript 2014.399, *Manuscript of the Qur'an*, Iran, 1784.

lacquer work examined. The use of metallic silver within the lacquer layers thus appears to be restricted to the sixteenth to seventeenth centuries, with use of smalt in the seventeenth and eighteenth centuries. This occurs concurrently to the use of smalt as a pigment within seventeenth- and eighteenth-century Iranian miniatures and manuscripts.¹⁹

The pigments present on the sixteenth-century manuscript cover and seventeenth-century pen box are more varied than those on the cover of the *jung*, reflecting the greater range of colors present. Both the manuscript and pen box are decorated with copper-based and copper-free green colors, a yellow containing arsenic sulfide (likely orpiment), vermilion, red lead and organic red. In contrast, the cover of the *jung* is decorated only with copper-green and organic red and purple colors.

The use of areas of thick pigment to decorate the inside of the cover is also seen on a sixteenth- to seventeenth-century manuscript cover examined at the Harvard Art Museums.²⁰ In contrast to the *jung*, the blue pigment on the inside of this earlier manuscript cover is ultramarine rather than smalt.

4. Source of materials

The materials used on the cover of the *jung* include local and imported materials, most of which have a long tradition of use.²¹ The presence of silver beneath the lacquer appears to be characteristic of sixteenth- and seventeenth-century lacquer work. In later eighteenth- and nineteenth-century lacquer works the metallic layer is brass rather than silver, presumably as brass provides a cheaper but equally reflective alternative.²² Cochineal, the insect-based organic red used to color the lacquer, may have been imported into Iran from America via Europe from the sixteenth century

onwards or produced locally in Armenia and northern Iran, termed 'Armenian red'.²³ Cochineal was evidently a popular colorant for Iranian lacquer as it has been identified on several eighteenth- and nineteenth-century Iranian manuscript covers and pen boxes.²⁴ The presence of smalt as an important constituent of the lacquer layers on the exterior of the cover and to provide color on the interior of the cover is more unusual and appears to be confined to the seventeenth and eighteenth centuries, replacing the more traditional ultramarine that was found in the sixteenth-century lacquer art works studied. Study of pigments found in manuscript folios and miniatures shows that several blue pigments were available in seventeenth to eighteenth century Iran – ultramarine, azurite, indigo and smalt.²⁵ Analysis of the smalt on the *jung* and other seventeenth- to eighteenth-century Iranian art works, including lacquer work, miniatures, and manuscript folios, shows a correlation of elements such as iron, nickel, bismuth and arsenic with cobalt. This association of elements is characteristic of cobalt ores from the Erzgebirge deposits in Central Europe (today spanning the border of eastern Germany and the Czech Republic). The ores here were the main European source of cobalt from the fifteenth century and were widely exported for production of smalt and ceramic glazes within Europe. The smalt present on the *jung* and other Iranian art works was likely imported from one of the seventeenth-century European production centers, such as the Netherlands. It is perhaps surprising that this imported, hence presumably expensive, pigment was used so extensively on the cover and hidden in many areas, but this shows a continuation from the more traditional application of ultramarine seen in a sixteenth-century *Divan* of Hafiz²⁶.

¹⁹ See Eremin et al. in this volume.

²⁰ The inside cover of Harvard Art Museums manuscript cover, Object Number 1984.545, *Bookbinding for a Qur'an*, sixteenth to seventeenth century, Iran, is decorated with vermilion and ultramarine.

²¹ For a discussion of the materials found in Islamic art works on paper and the historical sources see Knipe et al. 2018 and references therein, especially Barkeshli 2013; Barkeshli 2016; Barkeshli and Ataie 2002.

²² See Eremin and Grech 2017.

²³ For use of cochineal and Armenian red see Wulff 1966.

²⁴ See Eremin and Grech 2017.

²⁵ For a discussion of pigments found in the *jung* manuscript folios and miniatures and paintings from seventeenth- and eighteenth-century Iran see Eremin et al. in this volume.

²⁶ Cambridge, Mass, Harvard Art Museums/Arthur M. Sackler Museum, Gift of Mr. and Mrs. Stuart C. Welch, Jr., Object Number 1964.149; illustrated Manuscript of a *Divan* of Hafiz Iran, Tabriz, c.1530 <<https://hvrd.art/o/216248>>.

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