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Two mid-19th-century Chinese lacquered folding screens still in use – Research and conservation

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ABSTRACT

This paper describes the research and conservation treatments on two Chinese black lacquer folding screens with gold and silver decorations from the middle of the 19th century. The two screens are part of the Danish royal collection and have been in use at different palaces for the last 170 years. Both of the lacquer screens required conservation treatment due to natural ageing and degradation, and mechanical damage. The degradation was highly visible on the reverse of one of the screens. The two screens were examined by cross-sectional samples, x-radiography, pyrolysis-gas chromatography/mass spectrometry, Fourier transform infrared

INTRODUCTION AND PROVENANCE

Works of art from China, such as lacquerwares, have been admired in the West for centuries. With the East Indian trade, these kinds of artefacts and furniture were shipped to Europe. In 1847, a Danish scientific expedition resided in Canton, China for a short period of time. It brought several Cantonese lacquer furnishings back to Denmark for King Christian VIII, including an eight-section black-lacquered folding screen with gold and silver decorated landscapes, figures and fabulous creatures (Figures 1 and 2) (Clemmensen 1980). Today, this screen (hereinafter referred to as screen A), as well as another similar lacquered folding screen, are part of the historical furnishings at Amalienborg Palace in Copenhagen and are still in use by the royal family. The provenance of the second screen is not documented, but it is ascribed to the same geographical area and time period and is hereinafter referred to as screen B (Figure 3) (Hornby 2014).

Figure 1. The front of screen A before conservation. The lacquer and decoration on section V is a later reconstruction and therefore has a marked colour difference. The red numbers and likewise in Figures 2 and 3 designate samples areas (Table 1)

Due to everyday handling, natural ageing and degradation through years of light exposure and unstable climate, the two lacquered folding screens required conservation treatment. This was especially relevant for screen A. Ethically, the restoration level and choice of materials had to be considered and balanced. Since the objects were still in use, there was an expectation

spectroscopy and x-ray fluorescence spectroscopy. The analyses not only revealed a classical structure and materials typically used for exported lacquerware from the same period, but also brought forth results which explained the highly visible degradation. Conservation and restoration treatments were performed based on the knowledge obtained by the research and taking into consideration the ethical dilemmas involved in the conservation of historical items that are still in daily use.

of usability and a reconstruction leading to a regenerated and uniform appearance, but at the same time, because they are historical items, there was a demand for restraint, reversibility and preservation of the original materials and patina.

Figure 2. The reverse of screen A with the highly decomposed lacquer surface before conservation

Figure 3. The front of screen B

Starting in 2014, the two folding screens were subject to scientific study and several questions arose during this examination: how was the wooden core joined together? Why was the visual degradation of the different sections so different – could it be due purely to differences in light exposure or was there also a difference in the original material composition and quality (for example, on the front and back sides of lacquer screen A)? Research has shown that lacquerwares imported to Western countries often contain potentially less stable lacquers like *Rhus succedanea* (laccol), in addition to the well-known *Rhus verniciflua* (urushi) (Petisca 2011, Schilling 2014). Could this also be an issue in these lacquered objects? There was also interest in learning about the various metals and pigments used for the decorations. Several analytical methods were used to answer these questions and to find proper methods for conservation. Based on the results from the technical examination, the folding screens were restored in 2015–16 by conservators at the National Museum of Denmark.

Figure 4. Example of a crack in the lacquer layers on screen B caused by shrinkage of the wooden core and separation of the joints

Figure 5. Screen B: loss caused by deformation in the wooden section frames and following repeated collisions with the neighbouring section

DESCRIPTION OF CONDITION

It was visually obvious that the wooden cores of both folding screens had shrunk, probably due to unstable climate conditions. The lacquer and ground layers had lifted and cracked along the construction joints (Figure 4). In addition, both screens exhibited mechanical damage like abrasions, scratches and losses, often due to the deformation of the screen sections, leading to increased chances of collision each time the screens were folded or unfolded (Figure 5). Many disfiguring stains and fingerprints from handling and cleaning were also observed on the two screens.

Possibly due to the degradation of Asian lacquer in natural light, both screens were very sensitive to moisture and polar solvents. The surface of the reverse side on screen A, which had been exposed to additional light, was porous and powdered. In addition, the lacquer layers in several sections looked reddish, especially near the bottom, which was interpreted as a discolouration/bleaching caused by the cumulative effects of sunlight and humidity. In previous treatments, a secondary surface application was applied to some of the damaged sections in order to restore the original dark and glossy surface. This treatment had decomposed over time resulting in an exfoliating whitish surface. No traces of such a surface application could be found on screen B despite probable prior conservation treatments.

Both screens had clearly been subject to restoration several times in the past, although to different degrees and with more alterations on screen A. Retouching was found on the metal decorations on both screens. On screen A, the edges of all of the sections had been painted over and some areas showed reconstructions with an unidentified lacquer. The front of section V of screen A had apparently been so damaged that the entire surface and motif were reconstructed.

RESULTS OF ANALYSIS

Construction and structural layers

Both screens had distinct long, vertical cracks in the lacquer and ground layers. Section VIII of screen A was examined using x-radiography to investigate the wooden construction. Figure 6 shows a composite x-radiograph of the lowest portion of section VIII from the back with the small foot on the bottom left. The x-ray shows that the wooden frame was attached to the boards with coarse nails, while the three vertical boards were pinned together using horizontal pins of slightly higher x-ray density than the wooden boards. These pins may be made from bamboo. Some separation of the boards is visible in the x-ray and was most likely due to shrinkage of the wood due to low humidity. Enclosed within the stiff lacquer layers, the damage to the wooden construction was deemed irreversible and unsolvable without aggressive alteration of the object.

To study the structural layers, cross-sectional samples were taken from both screens (samples 2, 6 and 7). All of the cross sections revealed a similar technical structure (Figure 7): one ground layer followed by a paper layer, another ground layer, three black lacquer layers, and finally gold, silver and pigmented lacquer decorations. This layer build-up is similar to what has been documented in previous research on Cantonese export lacquerwares (Petisca 2011). Some areas on screen A have two paper layers and therefore three foundation layers. Fluorescence microscopy of the cross sections revealed three layers of lacquer over the ground layers on both screens. In addition, the outermost layers appear to be darker than the inner layers.

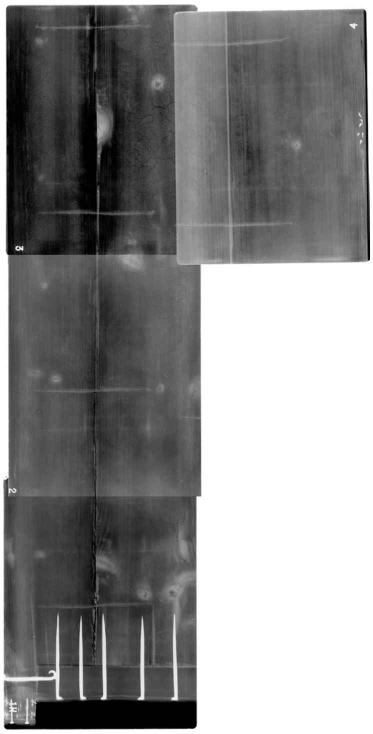

Figure 6. Composite x-radiograph of the lower left corner of screen A, section VIII, seen from the front

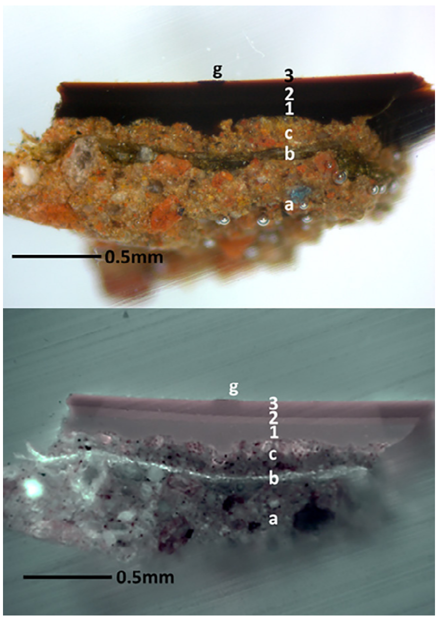

Figure 7. Cross section from screen B seen in darkfield (top) and UV-fluorescence (bottom): a, c = ground layers; b = intermediate paper layer; 1, 2, 3 = lacquer layers; g = gold decoration. The structural organisation on the two screens is similar

The ground layers

Attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR) suggested that kaolin, chalk and hematite could be present in the ground layers (sample 3B). This was supported by x-ray fluorescence (XRF) (samples 4, 5, 9 and 10), which detected zirconium, yttrium and niobium, all elements found in clay minerals.[1] The thermally assisted hydrolysis and methylation gas chromatography/mass spectrometry (THM-py-GC/MS) analysis (sample 1A) detected urushi carbohydrates, fatty lipids, blood, cedar oil and urushi in small amounts as the organic constituents in the ground layers[2] (Table 1).

The lacquer layers

Using THM-py-GC/MS analysis, the lacquer composition on screen A was identified as urushi lacquer combined with an unidentified drying oil (sample 1B), which is in agreement with the ATR-FTIR analysis that was carried out on another lacquer layer (sample 3A). Besides urushi, oil and tannins (sample 1C), camphor (sample 6A), shellac, cedar oil and larch turpentine (sample 6B) were detected in the lacquer layers (table 1). The substances identified, other than the urushi lacquer, oil and tannins, may be attributed to various additives or later repairs.

The lacquer layers on screen B were not analysed by THM-py-GC/MS.

An iron signal was detected with XRF on a black area on screen B (sample 10), which is interpreted as hematite from the red ground layers. It is likely that the black colour of the lacquer itself comes from an organic colorant like carbon black since no elements associated with black pigments were found with XRF.

The reverse of screen A, which had been exposed to natural light over many years, was found to be extremely sensitive to water and solvents. THM-py-GC/MS showed an increased ratio of carboxylated benzenes to saturated benzenes in the outermost lacquer layer on this side of the screen (sample 6C) which is indicative of light ageing.

The decorations

XRF analysis indicated that the darker metallic decorations (sample 4) contained gold. Silver was added to the gold to create a lighter metallic colour (compare samples 4 and 5 in Table 1). Both areas contained a significant amount of mercury, which can be attributed to a layer of vermilion under the metal seen in a cross section taken from this area. In addition, arsenic was found with XRF in the green leaves on the border of screen B and is attributed to the yellow pigment orpiment (sample 9). ATR-FTIR and a chemical spot test identified the accompanying blue pigment as Prussian blue (sample 11).

CONSERVATION TREATMENT

With water-soluble ground layers and very moisture-sensitive lacquer layers in mind, a non-aqueous glue was desirable for the consolidation and adhering of the ground and stiff lacquer layers. A strong non-aqueous

Table 1. Overview of the analytical samples, applied techniques and results

Nr.	Description	PY-GC/MS			FTIR absorbance		XRF***
		Peak area composition*		Light ageing index**			
		Compound	%		cm^{-1}	Assignment	
1A	Screen A, panel VI, front, ground layer	Urushi Fatty lipids Blood Urushi carbohydrates Cedar oil	0.1 56 23 4 18	0.0			
1B	Screen A, panel VI, front, two outermost layers	Urushi Drying oil P/S 5.2 Urushi carbohydrates	9 90 1	0.0			
1C	Screen A, panel VI, front, outer layer	Urushi Drying oil P/S 4.1 Urushi carbohydrates Tannins	2.0 95 1 2	0.0			
2	Screen A, panel VI, front, sample for cross section						
3A	Screen A, panel VIII, front, outer layer				2933 2868(sh) 1701 1655(sh) 1161 1090	Spectrum similar to urushi spectra in the literature (Heginbotham, 2008)	
3B	Screen A, panel VIII, front, ground layer				1643	Maybe from urushi	
					1415	Chalk plus urushi	
					1009	Kaolin	
					532 463	Kaolin plus Hematite	
4	Screen A, panel VIII, front, measurement through yellow orange metal decoration						Au, Hg, Fe, (Cu), Y, Zr, Nb
5	Screen A, panel VIII, front, measurement through light yellow metal decoration						Au, Ag, Hg, Fe, (Cu), Y, Zr, Nb
6A	Screen A, panel VIII, back, gilded, outer layer	Urushi Drying oil P/S 4.6 Urushi carbohydrates Cedar oil and camphor	19 78 1 3	0.0			
6B	Screen A, panel VIII, back, ungilded, outer layer	Urushi Drying oil P/S 5.5 Urushi carbohydrates Shellac, cedar oil Larch turpentine	4 93 2 1	0.0			
6C	Screen A, panel VIII, back, ungilded, outer layer	Urushi Drying oil P/S 4.7 Urushi carbohydrates Tannins	2 91 1 5	6.4			
7	Screen A, panel VIII, back, sample for cross section						
8	Screen B, panel VI, front, sample for cross section						
9	Screen B, panel VIII, front, measurement through blue green leaf decoration						As, (Ca), (Mn), Fe, (Au), (Y), Zr, (Nb)
10	Screen B, panel VIII, front, measurement through black part of decoration						(Ca), (Mn), Fe, (Au), (Y), Zr, (Nb)
11	Screen B, panel VII, front, Spot test for Prussian blue on green leaf decoration						

* THM-PY-GC/MS data was analysed according to Schilling et al. (2016).
** Peak area ratio of carboxylated benzenes to saturated benzenes indicative of light ageing.
*** Elements detected by XRF measurement through the lacquer surface and into the underlying layers: weak signals in parenthesis, strong signals underscored.

Figure 8. The decomposed lacquer surface of the reverse of screen A section VII before and after application of a new varnish layer (Laropal A 81)

synthetic adhesive was searched for. After tests and consideration, Paraloid B-72 (10% in ethanol) was chosen. Although the lacquer layers on most of the sections were sensitive to ethanol, this procedure could be successfully carried out by using a syringe to apply the consolidant where needed. To ensure the fixation of the stiff lifted lacquer, a method combining moderate heat and pressure was used.

Cracks were filled with Baohartwax 120 (pigmented paraffin and hydrocarbon waxes and natural resin). Larger losses along the edges were filled with a mixture of Mowiol 18-88 (polyvinyl alcohol), EP1 (pEVA dispersion) and chalk. To avoid damage from the aqueous adhesive in the filling material, the lacquer surfaces around the losses were isolated with Regalrez 1126 (hydrocarbon resin) in white spirit which could be removed afterwards.

The exfoliating whitish surface on the reverse of screen A, thought to be due to degradation of a previous application of a secondary varnish, could not be removed without destroying the original lacquer layer. It was therefore decided to apply yet another, but reversible, secondary varnish: Laropal A 81(aldehyde resin) 1:3 in Shellsol A and Shellsol TD (1:1) (Figure 8). The front surface of screen A and both surfaces of screen B were in comparatively good condition and without a secondary varnish. Therefore, it was decided not to apply a varnish on these surfaces.

Gamblin Conservation Colours (binding media Laropal A 81) were used for retouching the long, vertical wax-filled cracks. The larger losses filled with chalk, Mowiol 18-88 and EP1 were retouched with gouache and then with the same Gamblin Conservation Colours combined with metal powders in Laropal A 81. To adjust the gloss of the retouched fillings, materials such as acrylic varnish and beeswax-based picture varnish were applied in order to match the retouch with the appearance of the lacquer surface in the specific area.

DISCUSSION

The material composition and number of ground and lacquer layers documented in the examination of the two screens are characteristic of Cantonese export lacquerware. Other lacquers, e.g. laccol, were not found on screen A's outermost layers. The finding of carboxylated benzenes in the upper damaged layer on the reverse of screen A is evidence of light damage. The variation in surface appearance on the screens is therefore primarily attributed to differences in light exposure on the screens and not to the use of different types or qualities of lacquer.

Prussian blue was identified in the decoration on screen B. Since Prussian blue has been identified in Asian and Cantonese artefacts produced since the first half of the 19th century, the identification may help to make the ascribed provenance plausible, though the screen might have been produced and shipped at a later time (Baily 2012).

For the conservation and restoration, predominantly synthetic materials were chosen because the use of allergenic traditional Asian lacquer types, like urushi, is not permitted by Danish occupational health legislation. In addition, the application of urushi lacquer demands years of experience in order to create an aesthetically satisfying result. Aqueous natural glues were not chosen because they do not hold up well in the unstable and fluctuating climate found in an inhabited historical building such as that where the two screens are placed.

For the surface treatment of the screens, it was decided to apply a new varnish only on the severely degraded reverse side of screen A because the surface was powdery and its appearance was so disturbing that radical action was needed to create a less sensitive and more uniform surface. The secondary varnish was not applied on the remaining less visually degraded surfaces, although a protective surface treatment might be reasonable considering the daily use and handling of the objects. Instead, priority was given to the principle of not altering the authentic visual expression of these surfaces by adding irreversible materials. The conservation approach aimed to preserve as much of the original untouched surfaces as possible. In addition, conservation materials for the surface treatments were selected to be as reversible as possible. Laropal A 81 was chosen because it is possible to remove without changing the appearance of the original. However, the powdery and porous nature of some of the degraded surface areas may make a complete removal of the Laropal application challenging (Coueignoux 2011).

The environmental conditions in which the two screens are kept and used are not ideal and not compliant with climate standards for objects made of Asian Lacquer. It is also unlikely that this will change anytime soon. In addition, the location and continuous use of the two lacquer screens are seen as an important part of the objects' cultural historical value and there is no desire to interrupt this history and designate the lacquer screens as museum objects. This imposes challenges for the objects and their preservation. Preventive measures were put in place to help minimise further damage under these non-ideal conditions. During periods when the rooms are not in use, the curtains will be closed. Further, the installation of UV-filters on the windows was recommended. Vinyl or latex gloves should be used for the daily handling of the screens. In addition, it is important that the condition of the lacquer screens is monitored so that future changes can be identified.

CONCLUSION

The analyses of the structural layers of the two lacquer screens identified a production technique and material composition similar to research results for other Cantonese export lacquers. But where recent research shows a widespread use of laccol in the lacquer layers, the results of the THM-py-GC/MS analyses of screen A indicated pure urushi. The THM-py-GC/MS results also suggested that the varying degrees of degradation of the lacquer surfaces most likely result from differing degrees of light exposure over time. Overall, the research and conservation of the two lacquer screens from the Danish royal collection contributed to the current more differentiated and complex picture of the production and material composition of Chinese export lacquers.

The conservation of works of art that are still in use can pose ethical challenges for conservators. The conservation of such objects may require different approaches in terms of the choice of conservation materials and treatment methods in order to meet the expectations of the owner or user and to ensure that these objects are stable enough to be handled again. In this specific case, the challenge was solved by a compromise. Only the visually disturbing surfaces were treated with a consolidating and gloss regenerating varnish. On the rest of the sections, the losses were reconstructed, but the original almost untouched lacquered surfaces were retained without any surface treatment.

NOTES

[1] ATR-FTIR was carried out on a Bruker Alpha FTIR instrument (Bruker, Billerica, MA, USA) fitted with a diamond internal reflectance element. Twenty spectra were collected and averaged using the Opus 7.0 software. The spectra were recorded between 3000 and 400 cm^{-1} with a resolution of 2 cm^{-1}. XRF analysis of the surface decorations was performed using a handheld Bruker III-V+ instrument set at 40 kV, 10 µA with a TiAl filter. Under these conditions, the measurements include elements found both on and below the surface.

[2] THM-py-GC/MS analyses were performed on a Frontier PY-2020D microfurnace pyrolyser interfaced to an Agilent 7890A GC/5975C inert MSD. Samples placed into 50 µl stainless steel Eco-cups were treated with 3 µL of 25% TMAH in methanol and pyrolysed at 550°C. A J&W DB-5MS-UI capillary column (30 m × 0.25 mm × 0.25 µm) attached to a Frontier Vent-Free adaptor was used (40 M effective column length), with the helium flow set to 1 ml per minute. The split injector was set to 320°C with a split ratio of 20:1. The GC oven temperature programme was 40°C for 2 minutes, then 6°C/minute to 320°C with 9 minutes isothermal. Data processing and interpretation was carried out using software and databases described by Schilling et al. (2016).

MATERIALS LIST

Baohartwax 120 (a mixture of paraffin and hydrocarbon waxes, natural resins and pigments)
BAO-CHEMIE GmbH & Co. Chemische Fabrik KG
Bottrop, Germany

Ceronis picture varnish (beeswax and white spirit)
Lefranc & Bourgois (out of production)

Laropal A 81 (aldehyde resin)
Shellsol A and Shellsol TD (hydrocarbon solvents)
Kremer Pigmente GmbH & Co. KG
Aichstetten, Germany

Mowiol R 18-88 (polyvinyl alcohol)
Sigma- Aldrich Chemie Gmbh
Schnelldorf, Germany

Regal Rez 1126 (hydro carbon resin)
Gamblin Conservation Colours

Vinnapas EP 1 (pEVA dispersion)
IMCD Sweden AB
Limhamn, Sweden

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