Conservation of Chinese Room in the Wilanów Palace of Warsaw as a result of multidisciplinary research

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Abstract
The Royal Palace in Wilanów is one of the most treasured Baroque residences in Poland. Among its beautiful interiors is the decoration of the Chinese Room. It is a unique example of the European lacquer technique attributed to the famous 18th century craftsman, Martin Schnell, and his workshop. The conservation and restoration works of the Chinese Room were undertaken due to its poor state of preservation. This paper summarizes the results of a complex research project. The interior environment of the Chinese Room was carefully investigated. Identification of the original and later materials was necessary to establish a proper conservation and restoration program for the artworks. Additionally it was possible to reveal certain secrets of Martin Schnell’s craft. The original colour scheme of the room differs from the present one and corresponds to the painting on the ceiling.

Keywords
European lacquerwork, Wilanow Palace, Martin Schnell, aventurine
Introduction

The garden-palace complex in Wilanów was constructed by King Jan III in the years 1681-1692 as a representative Baroque residence. Due to the owners’ interest in the Orient, the Wilanów Palace obtained a collection of objects imported from the Far East or made with the technique of European lacquerwork. The jewel of the collection is the decoration of the Chinese Room [Fig. 1].
After leasing the Wilanów Residence to King Augustus II the Strong, artists from the court of Saxony were working on the new appearance of the royal apartments. In November 1730, Martin Schnell, a highly-regarded lacquer artist, came to Poland, and presumably set up a workshop in Wilanów.

The interior decoration in the chamber took a very short time to complete and was finished by July 15th 1732 [Kopplin and Kwiatkowska, 2006]. Thus a beautiful spatial composition of a rich iconography was created, with extraordinary panels, decorated in the technique of golden aventurine lacquer. Particular attention should be brought to the golden low-relief decoration that was polychromed and lacquered, and carved by a highly skilled woodcarver, whose name remains unknown until present.

Although the interior has been undergoing restoration and conservation works for more than 300 years, its current condition is very poor. Therefore, before undertaking conservation and restoration treatment, a research project has been introduced to assess the condition of the polychromy as well as to identify the technique and technology of the decoration, including the types of pigments and resins that have been used. The results obtained were compared with available studies [Kühlenthal, 2000].

Methodology

Different analytical methodologies were used for characterization of pigments and binding media.

Paint cross-sections, pigments and wood identification

Pigment identification was conducted using a SEM-EDS technique on the resin embedded cross-sections. The results were combined with observation of pigments from the particular painting layers in reflected and transmitted light [Eastaugh et al, 2004], and completed with additional microchemical tests. Dyestuff was analysed with the UV-VIS absorptions spectrometry both on the surface and on the samples of cross section. [Piening, 2006, 2010].

Sample preparation

Samples were embedded with a particular orientation in a transparent acrylic resin (Meliodent Rapid Repair, Heraus Kulzer), then were ground and polished parallel to painting layers with sandpaper up to grit size of 2000.

Wood identification

Small block samples of the wooden support (approximately 1.5cm long in fibre direction) were obtained from different parts of the wooden decoration. The transverse surface of the sample was smoothed with a sharp knife and examined with a stereomicroscope (Nikon SMZ 1000).

Instrumentation and operating conditions

Visual examination of paint cross-sections were carried out using a Nikon Eclipse 50i clinical microscope. For examination of paint cross-sections under UV light, an ultraviolet fluorescence attachment for a Nikon Eclipse 50i microscope was used [Arszyńska et al, 2000]. The scanning electron microscope (SEM), JEOL JSM-6380LA, equipped with an energy dispersive X-ray spectrometer (EDS) was also used. The analyses were carried out under low vacuum conditions (40 Pa). The backscattered electrons (BSE) detector was used to obtain images of the stratigraphical samples. The electron-gun working conditions were set at 20kV, 70µA, live time 100 sec.
Binding media identification


GC-MS

Chromatographic analyses were carried out by means of a Hewlett-Packard gas chromatograph with an Ultra 2 capillary column (equivalent of DB-5) and a HP-5971 mass spectrometer. The carrier gas was helium 1 ml/min, the Feeder temperature was 270°C for silylated samples and 350°C for mixtures hydrolysed with tetramethylammonium hydroxide. The initial temperature was 50°C and maintained for 5 min., then the temperature was raised by 5°C per minute to temperature 300°C. At this temperature the column was heated for 5 minutes. Large samples, containing a minimum of several tens of milligrams of the organic substance were fed by the split technique, and small samples by the splitless technique. The chromatograms obtained and recorded mass spectra of the corresponding peaks were most often compared with the spectra stored in the spectra library (NIST library, 75,000 spectra). When in doubt the spectra were subjected to individual interpretation. In some cases the retention times were compared with those of the standard mixtures analysed.

FTIR

Fourier Transform Infrared Spectroscopy provides analysis of the electromagnetic spectrum in the infrared region. The mid-infrared region is the one best identified (wavelength of 2 – 15 µm with wave number range of 5000 - 667 cm⁻¹) and it has wide application in organic compounds structure analysis. Samples obtained from the polychromy were analysed using KBr pellet technique. Spectra were recorded on a Biorad FT-IR Spectrometer FTS165.

Result and discussion

Paint cross-section examination

Analyses of the paint cross-sections raised the problem of the origin of the particular panels. It has been discovered that some parts of the wooden panelling were removed and replaced with copies painted in a different technique. An original set of layers consisted of three to five layers. On some of the samples obtained from the overpainted parts, up to seventeen layers were observed. Examination in reflected light was complemented with ultraviolet fluorescence observation, which gave the possibility to use higher magnifications (up to 840x) and to differentiate layers not visible under reflected light [Messinger, 1992]. UV fluorescence gave also a detailed view of grains of pigment and their distribution within the paint layer [Fig. 2-4]. Intermediate varnish layers, varnish running into small cracks, and original varnish soaking into drying paint were all recognizable.

Wood identification

Wood identification uncovered the presence of three types of wood. The lower part of the decoration and some of the window embrasures were made of pine wood. The upper layers and all cornices were found to be alder wood. The carved elements in the upper parts of the decoration were identified as lime wood. The presence of fungi, visible in transmitted light during wood identification, indicates higher local moisture content of the wooden panels at the bottom of the decoration.
Pigments identification

There were three different original grounds observed on the decoration: pure lead white, lead white with organic red and lead white combined with cinnabar and organic red.

Pigments used originally were as follows: lead white, cinnabar, organic red, Prussian blue, smalt, vine black, bone black, iron oxide red and yellow, calcium carbonate white, minium. Metals that were used originally were identified as gold foil, gold foil over silver base, schlagmetal leaves (Prinzmetal, gold metal), tin powder and brass powder. Metal flakes used to produce the brocade layer were identified as flakes of silver plated copper.

Four non-original grounds were discovered. That is chalk combined with small amount of barium white, pure chalk ground, chalk combined with lead white and zinc white with chalk.

Non-original pigments found in the decoration were as follows: cinnabar, minium, barium white, iron oxide red and yellow, calcium carbonate white, organic red, lithopone, chalk, cadmium red and yellow, verdigris, zinc white, chrome green and chrome yellow.

**Fig. 2:** Analysis of sample taken from original aventurine part of polychromy. a) microphotograph of the sample in reflected light b) microphotograph of the sample fluorescence induced by UV light c) backscattered electron image of the sample, the area of EDS analysis signified with blue colour d) EDS analysis of the third, brocade layer showing the presence of elements: Cu, Pb which indicates the use of copper flakes. Latter analysis revealed the flakes were silver plated.
Fig. 3: Analysis of sample taken from original overpainted part of polychromy. a) microphotograph of the sample in reflected light b) microphotograph of the sample fluorescence induced by UV light c) backscattered electron image of the sample, the areas of EDS analysis signified with blue colour d) EDS analysis of the first, pink layer showing the presence of elements: Pb, C, O which indicates the use of white lead.

Fig. 4: Microphotographs of paint cross-section of the sample taken from original red painted upper part of wooden decoration a) in reflected light b) fluorescence induced by UV light.
Table 1. Original pigments and metal identification

<table>
<thead>
<tr>
<th>Layer description</th>
<th>Identified pigments</th>
</tr>
</thead>
<tbody>
<tr>
<td>White ground found under brocade layers and carved elements in upper part of decoration</td>
<td>lead white</td>
</tr>
<tr>
<td>Pink ground found on flat decoration surfaces, wooden cornices and over the brocade layers</td>
<td>lead white, organic red</td>
</tr>
<tr>
<td>Pink ground found on upper wooden cornices</td>
<td>lead white, cinnabar, organic red</td>
</tr>
<tr>
<td>Original grounds</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>lead white</td>
</tr>
<tr>
<td>Pink</td>
<td>lead white</td>
</tr>
<tr>
<td>Red</td>
<td>cinnabar, organic red (organic red was observed to be in a form of glaze). Though its presence in red layer must still be confirmed by further analysis.</td>
</tr>
<tr>
<td>Blue</td>
<td>lead white combined with prussian blue and/or smalt</td>
</tr>
<tr>
<td>Black/grey</td>
<td>vine black, bone black, combined with lead white</td>
</tr>
<tr>
<td>Pink</td>
<td>lead white combined with organic red</td>
</tr>
<tr>
<td>Orange found on carved elements</td>
<td>lead white, iron oxide red and yellow, vine black and calcium carbonate</td>
</tr>
<tr>
<td>Orange layer found under some gildings</td>
<td>minium, lead white, iron oxide red and yellow, cinnabar</td>
</tr>
<tr>
<td>Brocade layer</td>
<td>flakes of copper covered with thin silver layer</td>
</tr>
<tr>
<td>Metal foils and powders</td>
<td>gold foil, tin powder, gold foil over silver base, schlagmetal leaves (Prinzmetal, gold metal), brass powder</td>
</tr>
</tbody>
</table>

Table 2. Non-original pigments and metal identification

<table>
<thead>
<tr>
<th>Layer description</th>
<th>Identified pigments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounds</td>
<td>chalk with small barium white addition</td>
</tr>
<tr>
<td></td>
<td>chalk</td>
</tr>
<tr>
<td></td>
<td>chalk with lead white addition</td>
</tr>
<tr>
<td></td>
<td>zinc white with chalk addition</td>
</tr>
<tr>
<td>Red layers</td>
<td>cinnabar</td>
</tr>
<tr>
<td></td>
<td>minium, barium white, iron oxide red and yellow, calcium carbonate and organic red</td>
</tr>
<tr>
<td></td>
<td>organic red, lithopone, chalk, iron oxide red and yellow, cadmium red</td>
</tr>
<tr>
<td></td>
<td>minium, zinc white, iron oxide red and yellow, chalk</td>
</tr>
<tr>
<td>Green layers</td>
<td>verdigris</td>
</tr>
<tr>
<td></td>
<td>chrome green, zinc white, iron oxide yellow</td>
</tr>
<tr>
<td></td>
<td>organic green (not yet identified), lithopone, calcium carbonate, iron oxide yellow, cadmium yellow</td>
</tr>
<tr>
<td>Yellow layer</td>
<td>chrome yellow, chalk, zinc white, barium white</td>
</tr>
<tr>
<td>Metal foils and powders</td>
<td>gold foil, imitation gold foil (brass foil), aluminium foil, brass powder, silver foil</td>
</tr>
</tbody>
</table>
Non-original metal powders and foils were identified as: gold foil, schlagmetal leaves, aluminium foil, brass powder, silver foil.

The SEM-EDS spectra were analysed along with the microscopic appearance of pigments in transmitted light. These analyses were completed with additional microchemical tests. The identification of pigments brought useful information concerning dating of particular overpaint layers [Gettens and Stout, 1966].

Identification of particular original layers along with paint cross-sections studies allowed full comparison of materials, making it possible to exclude non-original parts of decoration.

**Binding media identification**

The analysis of binders used in paintings, polychromed sculptures and illuminated manuscripts is one of the most difficult problems in the preservation of historic monuments. It is associated with the use of mixtures of chemical substances consisting of compounds of natural origin with various functional groups. Gas chromatography combined with mass spectroscopy is the best method for the analysis of complex mixtures, since gas chromatography, involving capillary columns, permits separation of such chemical mixtures into hundreds of component substances.

Fourier Transform Infrared Spectroscopy identifies functional groups present in an analysed compound, and allows to draw conclusions about its structure. A complete FTIR spectrum of a compound provides a possibility to compare it with the standard spectrum and decide whether they are identical or not.

The FTIR analysis of the binding media were combined with the GC-MS results and showed compatible outcome of using as follows: linseed oil combined with probably animal glue, sandarac combined with animal glue, mastic with addition of copal resin and shellac as in the case of brocade layer [Fig. 5].

![Fig. 5: FTIR spectrum of sample taken from brocade original varnish – shellac.](image-url)
Table 3. Binding media analysis, GC-MS analysis confirmed FTIR results

<table>
<thead>
<tr>
<th>Sample description</th>
<th>FTIR result</th>
<th>GC-MS result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door embrasure, pink ground on the external panel</td>
<td>linseed oil, traces of protein (animal glue)</td>
<td></td>
</tr>
<tr>
<td>Door embrasure, pink ground on the internal panel</td>
<td>linseed oil, traces of protein (animal glue)</td>
<td></td>
</tr>
<tr>
<td>Door embrasure, blue paint layer with some varnish</td>
<td>sandarac or calophony, protein (animal glue),</td>
<td>sandarac, animal glue</td>
</tr>
<tr>
<td>Door embrasure, original lacquer and some of original</td>
<td>mastic with addition of copal resin</td>
<td>mastic with addition of copal resin</td>
</tr>
<tr>
<td>Door embrasure, original pink layer after removal of</td>
<td>lineseed oil, traces of animal glue</td>
<td>lineseed oil, traces of animal glue</td>
</tr>
<tr>
<td>Door embrasure, original varnish, external panel</td>
<td>mastic</td>
<td>mastic</td>
</tr>
<tr>
<td>Brocade panel, original varnish</td>
<td>mastic</td>
<td>mastic</td>
</tr>
<tr>
<td>Brocade panel, top layers</td>
<td>natural resins: mastic and probably copal resins</td>
<td>natural resins: mastic and probably copal resins</td>
</tr>
<tr>
<td>Brocade panel, bottom varnish layers</td>
<td>shellac</td>
<td>shellac</td>
</tr>
<tr>
<td>Cornice, red gilded layer</td>
<td>copal resin, probability of amber presence, with addition of mastic</td>
<td>copal resin, probability of amber presence, with addition of mastic</td>
</tr>
<tr>
<td>Carved dragons from above the window, red medallion</td>
<td>mastic, carbonates</td>
<td>mastic, carbonates</td>
</tr>
<tr>
<td>Window top embrasure, overpaint ground</td>
<td>traces of linseed oil</td>
<td>traces of linseed oil</td>
</tr>
</tbody>
</table>

**Microbiological tests**

All organisms living in a museum environment could become a dangerous risk factor for possible biodeterioration. The growing number of the accumulated particulate matter and dust on artworks’ surfaces in the museum interiors may occur parallel with the rapid fluctuations of RH and T and be a cause of biological attack leading to the loss of value of ancient objects and their historical importance.

There is a general air-conditioning system in the Palace maintaining an appropriate relative humidity and the temperature, although it is very difficult to maintain suitable conditions in historical buildings. The humidity is additionally regulated by using mobile humidifiers and dehumidifiers operating according to the specific requirements. The main physical parameters, i.e. air temperature (T) and relative humidity (RH), are constantly monitored by electronic equipment.

The work commenced on the indoor air pollution with a constant monitoring of relative humidity and temperature inside of the building. Media used are listed by the Polish Committee for Standardization (PKN) as defined for cultivation of bacteria and microbial fungi (cfu/m³). Three rooms placed outside the tourist route were assessed; the Chinese Room, the Kings Bedroom and the Kings Dressing Room. Probes were taken in each season of the year between summer 2008 – winter 2009 taking into account the presence of visitors. Air samples were taken using the microbial sampler with electronic anemometer 1.5 m above the floor. After the cultivation cycles the number of cfu/m³ was counted in the laboratory using special software. The results of microbiological tests were very satisfying. The average level of bacteria
and fungi was usually lower than 300 cfu/m³. The microbial load of the air was much higher during the summer than in the winter, even though there were no visitors in all those rooms. The indoor air contamination in the palace was mostly influenced by visitors, as noticed by different kind of cultivated bacteria (Staphylococci, Pseudomonas), when the Kings Bedroom was opened to visitors. Taking into account some additional results it would be interesting to check the possibility of biodeterioration and biodegradation of some natural substances integrated in the whole structure of European lacquer.

**Technique and technology**

Through the research conducted, the technique and technology of the decoration of the Chinese Room in the Wilanów Palace have been identified. Moreover, secondary elements and later layers have been distinguished. Main panels were made by joining planks of alder wood into a rectangular support. On the front, their forms were shaped into a relief. The field for the aventurine decoration was selected and after sizing the wood, a thin layer of ground with lead white was applied. It was polished, probably intentionally, not very precisely. A coat of a transparent varnish (probably shellac) was applied and sprinkled with flakes of silver plated copper. Finally the surface was covered with a lacquer in a golden shade containing mastic, which has been sanded and polished. Exquisite scenes, made in all probability by the master himself, were painted layer by layer on the underpaint.

The wooden panelling that was prepared in these manners was installed in the room and then further works have been carried out at the place. At that time fragments of panels that remained around the aventurine backgrounds were primed. A small amount of cochineal was added to the emulsion ground containing linseed oil, glutine glue and probably shellac, producing a light pink shade. Then, the layers of colour were applied – the blue one closest to the aventurine (lead white with Prussian blue, with a binder composed of linseed oil, glutine glue and resin) and red on the external fragments (cinnabar and organic red). The panels with aventurine decoration and the panels, which in the centre of the composition on blue backgrounds have decorations made with different gilding techniques, are placed in flat framings covered with a pink layer of lead white and madder. The surfaces are covered with transparent varnish, of which the composition is still being verified.

All layers, applied one by one from the ground to the lacquer, were very meticulously ground and polished, which is indicated by the ideally flat surface visible in the stratigraphical cross-sections samples.

The crown cornice was made of alder wood and covered with lacquer. Similar materials were used for the red parts of the main panels, however, apart from lead white, cinnabar was added to the ground. Then two coats of cinnabar were applied, the second was blended with cochineal. The whole surface was covered with transparent lacquer and gilded.

The most important iconographic elements are extraordinary relief supraportras and other appliqués. It is known that at least a part of them is made out of lime wood. They are covered with lead white ground and polychromy. The colour layers’ sensitivity to alcohol proves that natural resin has been added to the binding media.

Gilded finish is characteristic for the Chinese Room’s decorations. According to the research, none of the studied elements had original water gilding. They were made with the use of various foils and metal powders.

The entire lower level as well as some elements of the upper level differ remarkably in terms of technology from those which were identified as the original parts. They are made of pine wood covered with white double-layered chalk-and-glue ground (in the second thin coat with the addition of lead white), then painted. On the supports prepared in this manner, copies of gilded still lives with Chinese emblems were made.
The analysis of colour scheme, technique, and secondary coatings proves that the lowest level was replaced already during the first renovation works, presumably at the turn of the 18th and 19th c. At least three more complex renovation works of the interior were identified (1850, 1900, 1956), as well as many local repairs [Figure 6].

The present state

The preservation of the individual elements of the decoration is highly diversified. Wooden supports of some parts of the panelling are greatly damaged by microorganisms and insects. There are parts where the decoration holds only to the ground. In the lowest parts of the decoration, presumably due to remarkable humidity, the adhesion of the ground to the wooden support was weakened. On large surfaces there is evidence of blistering and partial loss, also within the paint coat. There is a great problem due to weakening of the cohesion of original ground of relief decorations and crown cornice, causing cupping and flaking of paint layer, and consequently numerous losses.

In the past, the renovations and restoration works were not always carried out according to the restoration rules. On the original parts low-quality overpaintings were applied, as well as new grounds, gildings and retouches, without proper reattaching of the original paint layer and filling in the losses. The degree of damage to original lacquers is apparent in a majority of the cross-section samples.

Luckily, the most precious aventurine fragments of the panels, the upper cornice and some elements of low reliefs were not overpainted. They are covered with a coat of secondary lacquer and have retouches painted in the losses [Fig. 7].
Conclusions

The analysis of the technique and technology of the room’s decoration confirmed Schnell’s authorship. The original colour scheme of the Chinese Room was much different from the present one. Below secondary greenish parts of wooden panelling’s polychromy, blue and pink colours have been discovered. Their shades match the colours of the architecture and the sky on the ceiling painting, forming once a unified interior. The thorough research enabled making a very difficult decision on removing secondary coatings revealing the interior’s original character.

Fig. 7: View on East wall and the ceiling painting (fot. M. Kwiatkowska).

Fig. 8: Ortophotoplan. Simulation of the original colour scheme.
Acknowledgments:

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