Technical Report

THE EUROPEAN PHYSICAL JOURNAL PLUS



Iveron Icon of the Mother of God: reconstruction based on physical–chemical tests as an element of conservation

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Received: 11 February 2021 / Accepted: 21 December 2022 © The Author(s) 2023

Abstract Recently art conservators tend to wonder which of the possible intervention paths to undertake while planning a conservation project and how deep their interference with the original substance should be. Limiting intervention to ceasing the ongoing degradation process and securing the object for the future without restoring any missing parts of the composition is just one of the many available approaches. Making a brand new copy of the painting where all the missing parts could be fully reconstructed and exposing it along with the original is a good alternative to traditional restoration practice. This method has been used by Danuta Stepień during conservation of a Russian icon entitled "Our Lady of Iver" (Moscow, 1908–1917, egg tempera on a wooden panel partially covered by a silver *oklad*, $10.8 \times 13.2 \times 0.8$ cm). The silver *oklad* was executed by the workshop of Smirnow. Technology and materials have been identified via different analytical techniques: VIS, UV, IR and X-ray photography, microscopic photography, SEM-EDS analysis and FTIR. Specific medical radiological instruments have also been used as non-invasive analytical tools. The following materials have been identified: yellow ochre, cinnabar, cadmium red, red iron oxides, silver, gold and copper. The oklad is made of an Ag-rich silver-copper alloy. Its whole surfaces are richly engraved with traces of gold detected inside the engravings. Based on this fact, an assumption has been made that originally the upper part of the oklad might have been entirely covered with a layer of gold. The information gathered during research allowed to execute a fine copy of the icon using similar materials and techniques. An alternative to classic restoration approach is to create a faithful but fully reconstructed copy that could be exposed along with the original painting. This solution not only assures maximum respect for the original substance but also allows the recipients to better understand its history and technique.

1 Introduction

The article describes the purpose, course and results of the research project no. ASP/WK/19/PB by Dr. hab. Danuta Stępień, professor at the Academy of Fine Arts in Warsaw, entitled *Knowledge of ancient painting techniques in the aspect of sustainable development,* performed as part of statutory research at the Academy of Fine Arts in Warsaw, Faculty of Conservation and Restoration of Works of Art (Fig. 1).

In one of the tasks forming part of the project, an icon depicting the *Iveron Mother of God* was subjected to conservation and restoration. The conservation and restoration of icons represents a broad scope for further investigations because they only started in the 1960's [1].

The main problem during conservation was the fact that the icon had been seriously damaged by candle flame or fire, resulting in irreversible losses and making it impossible to interpret crucial elements of the composition such as the face and hands of the Infant Jesus.

To read these elements, it was essential to perform specialist physical-chemical tests. The tests were also meant to reveal what pigments and adhesives were used, an important fact when producing a technological copy that was planned to be made.

More and more often, an art conservator considers the extent to which it is necessary to interfere in the material of a work of art. His work methods include action to protect the work against further degradation and the creation of a copy of the work, without complete reconstruction. In this case, a process of conservational intervention was selected in order to preserve the aesthetics of the icon, displaying signs of its antiquity. On the other hand, a copy-reconstruction allows us to admire the former beauty of the original work [2, 3].

The scope of work included:

Focus Point on Scientific Research in Cultural Heritage. Guest editors: L. Bellot-Gurlet, D. Bersani, D. Neff, A.-S. Le Hô, L. Robinet, A. Tournié.

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Fig. 1 *Iveron Icon of the Mother of God*, face side with silver oklad, photographed using VIS. Photograph by Roman Stasiuk



- conducting detailed non-destructive tests of all technological layers of the work and, as a supplement—micro-destructive analyzes limited to the necessary minimum;
- making a technological copy combined with reconstruction based on the obtained analysis results;
- conservative conservation of the original icon along with the wrap.

The innovative aim of the work was to enable the display of the destroyed original together with a faithful technological copy, allowing for the aesthetic reception of the icon in accordance with the intention of its author.

To sum up: the main goal of the project was to determine the details of the artist's workshop and to make a faithful reconstruction, in every respect as close to original as possible. An additional goal was to carry out conservation of the original icon.

1.1 Details of the icon

The very form of the work (canon) defines it work as an icon, in other words a painting on a board produced in accordance with iconographic canon [4].

This type of icon (*Iveron Icon of the Mother of God*) is associated with the monastery Iveron, founded by Georgians on Athos. In 1648, a copy of the *Iveron Icon* was brought to Moscow. Here it was still duplicated.

It is tempera on wood, measuring $13.2 \times 10.8 \times 0.8$ cm. If we talk of small icons (a few centimeters by a dozen), we automatically have in mind "travel icons". We can assume that the *Iveron Icon of the Mother of God* is such a travel icon, of the Hodegetria type [5].

The icon we are discussing here was produced to a very high standard of artistry. It as a valuable oklad [1] of precious metal—silver, originally gilded, made in the workshop of Smirnov. In Smirnov's workshop, icons were clothed in valuable oklads. The iconographer often worked with a goldsmith.

The punctures on the oklad represent the Cyrillic letters JIC [6], in other words DS in the Roman alphabet. This is probably the hallmark of the goldsmith called Dmitriy Smirnov [7], who was active in Moscow in 1905–1917. Beside it is a Russian state hallmark used in 1908–1926, so one can narrow down the date of the object to 1908–1917. The state hallmark includes a visible Δ (delta), representing Moscow [8], which confirms that the casing was made in the workshop of Smirnov.

The subject of the *Iveron Icon of the Mother of God* has been treated in a way suggesting that it was made to fit a specific oklad. The *Iveron Icon of the Mother of God* was probably made in Moscow during the period 1908–1917.

The icon was rescued from the fire. That's why it is so damaged. Now it is privately owned and is currently kept in Warsaw (previously: Zaborce Wielkie near Dubno in Ukraine).

The base of icons of small dimensions was usually a single board. The layers of paint and tempera were applied thinly. Small icons were sometimes covered with an amber or shellac varnish. The stratigraphy structure of small icons without gilding may have lacked a primer.

To find out more in this case (essential in order to carry out the reconstruction), we carried out specialist tests whose results are discussed below.

2 Experimental part: physico-chemical tests

2.1 Non-invasive tests

The following tests were performed to read a drawing of details of the composition (e.g., face and hands):

- observation under diffused light;
- UV-induced luminescence;
- infrared reflectography 1000–1200 nm;
- X-ray photographs;
- Computer tomography (CT) using X-rays.

Different types of non-destructive testing were carried out, as each of them provides different information (see Results and discussion section).

2.1.1 Observation under diffused light

The object was observed under diffused light (VIS) with the naked eye end using a Nikon MSZ 1000 stereoscopic microscope. Photographs in diffuse light were taken under the illumination of Elfo MiqroPro flashstudio lamps of 5500°K color temperature. The photographs were taken with a Nikon D 850 camera.

2.1.2 UV-induced luminescence observation [9]

Ultraviolet photographs in the range of visible light und ultraviolet excited luminescence (UV) were taken using Philips TLD UV excitation lamps equipped with Wood's filter. Wood's filter absorbs visible light and transmits only UV light in the range 350–390 nm, in which the maximum radiation of the UV lamp falls. Bright yellow filter was used. The photographs were taken with a Nikon D 850 camera.

2.1.3 IR reflectography

Infrared (IR) photography in the 1000–1200 nm range (or IR REFLEKTOGRAPHY in the 1000–1200 nm range) was done under the illumination of Elfo MiqroPro flash studio lamps with a color temperature of 5500°K. The photographs were taken with a Nikon D 800E camera with IR conversion.

2.1.4 X-ray photographs

X-ray photographs were taken with an Eresco 42 MF4 X-ray device. The image was recorded on a Perkin Elmer Panel digital cassette. Registration range—28 kV, 8 A.

2.1.5 Computer tomography (CT)

In this case, transmission tomography was used (using X-rays).

The CT scanner used was Philips Brilliance iCT SP 128. Specifications of this device: full (360°) scan time—0,27 s, minimum slice thickness—0,625 mm, spatial resolution—16 lp/mm (line pairs per mm), number of slices—128.

The images were produced with the RadiAnt DICOM Viewer 5.5.0.

2.2 Invasive tests

To determine the type of wood used for the base, and the stratigraphic structure of the paint layers it was necessary to take samples of the material. However, the samples were very small because of the size of the icon.

The wood, pigments, metal in the oklad and stratigraphic structure were examined under an optical and scanning microscope.

These studies were carried out to determine the technique and technology of the execution of the icon—to determine the number of layers, the composition of the binders, the type of coating and the quantity of pigments used.

2.2.1 Identifying the wooden base

The type of wood was examined in the following manner: the surface of the section of the sample was evened out with a scalpel and examined under a stereo microscope (Prolab MSZ). Then, thin scrapings were taken from the sample, from which water-based preparations were made, capable of being viewed in transmitted light (Nikon E200 biological microscope).

2.2.2 Determining the stratigraphic structure

The microscope photos of the stratigraphy sections were done with a Nikon Coolpix 8400 digital camera combined with a Nikon Eclipse 501 microscope.

These sections were also examined under enhanced UV light by means of a Nikon Eclipse 50i biological microscope with an attachment for fluorescence microscopy and a UV2A filter (induction: 330–380 nm, cut-off filter: 420 nm).

2.2.3 Identifying the pigments and metals in the oklad

The pigments in the paint layers and the metal in the oklad were determined by means of the following observations and tests:

- Microscope observation in reflected light using a Nikon MZS stereo microscope (max. magnification 160×).
- Analysis of elemental composition using a JEOL IT500 LA scanning microscope with EDS (JEOL) microsonde with an analytical range from beryllium (Be) to uranium (U). The test possessed a qualitative nature.

The attached pictures were captured with a diffused electron detector which provided information on the chemical contrast (elements with a higher atomic figure have a brighter color). Conditions: accelerating voltage—20 kV; working distance (WD)—10 mm; duration of chemical composition analyses (live time)—60 s; vacuum—50 Pa (low vacuum technique).

2.2.4 FTIR analysis of the binder

The binders were examined by the IR spectroscopy method combined with Fourier transformation (FTIR). The FTIR analysis of the sample taken by the conservator was performed with a *Thermo Fisher Scientific Nicolet iS 10* camera, using attenuated total reflectance (ATR) attachment with single reflection ATR diamond crystal. The spectral resolution was 4 cm⁻¹.

To make a precise analysis of this spectre received, a series of FTIR images of model substances was performed.

3 Results and discussion

3.1 VIS observation

A VIS observation of the face both with the naked eye and with the use of a microscope leads to the conclusion that the paint layer has suffered considerable irreparable damage (Fig. 2).

It has shrunk, shrivelled and even darkened (see the face of Jesus) probably as a result of exposure to candle flames or fire. But it is difficult to determine the extent of the damage—does it apply to all the paint layers, or just the varnish?

Traces of soot and carbon an also be seen in the bottom right edge, directly on the wooden base. The general outline of the composition and its coloring are discernible, but no details are visible. The face of Jesus has suffered the most. The facial features are completely invisible.

The paint layers have melted in parts, so that some sections of the icon are covered in paint "spilled over" from neighboring sections. This makes an iconographic analysis difficult.

3.2 UV-induced luminescence observation [9]

A photograph of the UV-induced luminescence shows most of all a green-yellow shade of the varnish. We can see it uneven spread, probably the result of overheating, followed by the melting and partial transposition of the main component—natural resin (Fig. 3).

Dark lines disclose the outlines of the rectangular framework of the composition, figures and haloes. A detailed microscopic examination of the face under lateral lighting has revealed grooves in the outlines made by a sharp precision instrument, probably a pencil. These grooves might have been so deep that the varnish penetrated the base in some parts, and the lack of luminance in these parts may be attributed to the missing varnish.

The dark irregularly-shaped blotches are traces of the "overspilled" paint caused by overheating and evidence of missing layers of paint all the way to the board.

Fig. 2 Face of icon prior to removing the oklad for conservation (VIS). Photograph by Roman Stasiuk



Fig. 3 Iveron Icon of the Mother of God, face of icon, UV-induced luminescence. Photograph by Roman Stasiuk

3.3 Observation under infrared light (IR) [9]

Infrared light lets us see deep layers of paint invisible to the naked eye. In this case, we can see the careful artistry, very useful when producing a reconstruction of the icon (Fig. 4).

Fig. 4 *Iveron Icon of the Mother of God*, IR image. Photograph by Roman Stasiuk



It has been noted that the hand of the Child is positioned differently compared to the original version. The right hand is somewhat higher and larger. Originally, the left hand leaned gently on the robe covering the Child's feet, and after the change—*pentimento*—it is raised (enlarged), pointing toward the Mother. An iconographer did not always match the composition of the image to the casing and did not always perform a *pentimento*.

The damage done to the icon through overheating prevents us from clearly identifying the position of the hands and the type of attributes.

On Mary's right cheek, we notice two slanting lines representing scars—a typical feature conforming to the original pattern of the *Iveron Icon of the Mother of God*.

The brushstrokes with which the dark-ochre background was painted can also be seen.

3.4 X-ray image [9]

An X-ray of the icon provides valuable information about the layer of paint. Because pigments that contain heavy elements absorb X-rays well, the delicate shading of the face, hands and feet can be seen. This shows that the paint in these places is better preserved than an observation in ordinary light would suggest. The intense absorption of radiation in these places suggests that white paint with a lead ($Pb_3(CO_3)_2(OH)_2$) or baryte (BaSO₄) content was used (Fig. 5).

An additional advantage of the X-ray image is that it shows the features of the faces of both figures. This is a reliable basis on which to reconstruct the painting (Fig. 6).

The brushstrokes visible in the background exactly match the strokes observed in IR, except that the latter represents a negative image. This means rather, we are dealing with a single coat of opaque paint.

We can also see the structure of the wood, the place where the boards were joined (despite the small size, the background wasn't a single board) and small fragments of nails.

3.5 Tests using computer tomography [10]

The tests were performed by Łukasz Kownacki, a specialist in radiology and diagnostic imaging at the European Health Centre in Otwock, ArtApp Sp. z oo. The tests were financed out of the funds of the Academy of Fine Arts in Warsaw, earmarked for the research task entitled "Use of Innovative Means of Resources in Documenting, Examining and Conserving Works of Art," headed by Dr. Rafał Nijak. The test results were interpreted by Marlena Koczorowska.

In our icon, one can see the density of individual components, the thickness of individual components of the painting, the type of material used, and the type an extent of damage.

Fig. 5 *Iveron Icon of the Mother of God*, X-ray image. Photograph by Roman Stasiuk



The CT tests have allowed to identify the structure of the wooden base. The joints of the three elements of the board appear very clearly. The tests on the *Iveron Icon of the Mother of God* have shown that the base is in a very good condition and that the layer of paint adheres well to it.

The remaining conclusions regarding the paint layer correspond to those obtained from the X-ray analysis (Fig. 5).

3.6 Identifying the wooden base of the Iveron Icon of the Mother of God

The tests were carried out by PhD Elżbieta Jeżewska (Academy of Fine Arts in Warsaw, Department of Conservation and Restoration of Works of Art, Centre for Specialist Testing and Documentation Techniques).

When the preparations were made and examined under transmitted light, only fragments with a radial section could be seen. Interpretation was difficult because it was impossible to view a transverse section.

The examined sample is probably limewood (Tilia sp.).

3.7 Determining the layer structure and identifying the pigments [11] and metals (composition of the metal in the oklad)

It was determined that in the stratigraphic structure one can identify a maximum of three paint layers. Directly on the wood lies a layer containing iron yellow of natural origin ochre ($Fe_2O_3 \cdot nH_2O$). Above this, in the dark part of Mary's coat, sample 1, is a layer containing cinnabar (HgS), while sample 2, taken from the brighter section of the coat, contains cadmium red (n·CdS·CdSe).

The painting is poor in terms of colors-red and brown are dominant colors.

The presence of lead was also detected, probably from the use of lead-based whitening to brighten the colors.

It is worth noting that the icon is covered with a disproportionately thick layer of semi-yellowed varnish, 0.70 mm thick, whilst the yellow layer is about 0.020 mm thick and the red layer about 0.010 mm thick (Fig. 7).

The white metal of which the oklad is made is a silver and copper alloy, with a predominant silver content. The surface of the metal is covered in sulfides and oxides in part Engravings can be seen on the entire front of the silver oklad.

Yellow metal is preserved in the depths of the engravings, just like on the smooth part of the surface. The yellow metal is gold. A microscope examination of the object permits the assumption that originally, the entire front of the oklad was gilded, but the gilding is very worn now.

The samples taken from the icon were analyzed by PhD Anna Nowicka (Academy of Fine Arts in Warsaw, Department of Conservation and Restoration of Works of Art, Centre for Specialist Testing and Documentation Techniques) (Figs. 8 and 9).



Fig. 6 Image generated by the RadiAnt DICOM Viewer 5.5.0. Longitudinal section. Here we can view the object from any point and examine it layer by layer. The left of the image shows the place where the scan was performed. The grain and very good condition of the board are visible

Fig. 7 Stratigraphic section of sample 1(red from Mary's coat) in visible light. Thickness of the individual layers: 1-0.020-0.030 mm; 2-0.002-0.009 mm; 3-0.060-0070 mm. Magnification: ×210. Photograph by Anna Nowicka



3.8 FTIR analysis of a sample of the adhesive of the paint layer [12, 13]

The IR spectres of organic compounds are complex, and a correct reconciliation of a wavenumber to the relevant functional group sometimes causes problems. Also, it is very difficult to interpret the spectres of mixes of several chemical compounds. Some waves may be invisible because they overlap or are displaced due to the action of various structural factors (Fig. 10 and Table 1).

In this case, characteristic shape of the spectrum in FTIR obtained from the sample confirms the presence of lipids and proteins, which can indicate the use of a tempera binder [14]. Moreover, a signal corresponding to natural resin was interpreted (probably from varnish).

The tests were made and interpreted by Ph.D. Joanna Kurkowska (Institute of Conservation and Restoration of Works of Art of the Academy of Fine Arts in Warsaw).

Fig. 8 SEM-EDS analyses of sample no. 1-SEM picture and spectrum. In both analyses, we see a high peak caused by carbon and oxygen. This is typical of layers containing an organic adhesive. The Spc_050 analysis concerns an ochre layer (no. 1 on the VIS image). The high silicon and aluminum content indicates a pigment of natural origin. The Spc_051 analysis relates to the end layer (no. 2). The high mercury and sulfur content results from the use of cinnabar. The presence of the remaining elements (Si, Al, Fe, K, Ba) may suggest that the pigment is of natural origin, but may also result from the addition of yellow or iron red. Test performed by Anna Nowicka

Próbka 1







4 Conservation and restoration work

The conservation of the icon *Iveron Icon of the Mother of God* involved the use of non-invasive methods. The following physicochemical tests were carried out on the icon: VIS, UV and IR photographs in diffused light; X ray, microscope photographs and the identification of binders, pigments, metals and primer fillers with the aid of FTIR, microscopic analysis and SEM–EDS. As a result, it was possible to establish the icon's technical and technological structure. In addition, specialist medical apparatus for diagnostic imaging and X-rays was used.

4.1 State of preservation of object

On a wooden base of icon, we can see traces of action by xylophages. Impairment in all layers (wood, varnish) are visible. Because most of the damage was caused by fire, it is difficult to interpret the fuzzy, darkened features in order to gain an idea of the original appearance.

Fig. 9 SEM–EDS analyses of sample no 5—SEM picture and spectrum. They confirm the presence of silver (Ag), gold (Au) and copper (Cu). Test performed by Anna Nowicka



10 µm



The oklad is well preserved. In three places, one can see missing pieces of metal and a few small cracks. On the edges, the metal is buckled in places and one sees the holes from the nails that joined the oklad to the icon. The entire object has a dark patina caused by oxidization. Traces of gilding are visible.

4.2 Conservation of icon and silver oklad

Before work commenced, tests were carried out to determine the appropriate method of cleaning. The most effective cleaning substance proved to be silva sintetica from the firm Bresciani (undiluted). Next, missing portions of wood were filled with small lime tree wedges. Cracks were repaired with bonding water (rabbit glue).

Retouching imitating the background of the icon was performed. In those places with skin, scoring was done only to highlight the complexion.

An important process was the retouching of the scars on the cheeks of Our Lady.

The same pigments were used as those identified as having been used originally, and tempera paint was prepared on the basis of an egg-yolk binder.



Fig. 10 FTIR spectre obtained for a sample of the red paint layer

Table 1	The	table	describing	signals	of the	above	spectrum
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Range cm ⁻¹	Wave intensity	Description of waves
3317	m	Oscillation of hydroxyl groups OH
2924, 2854	VS	Oscillation extending carbon-hydrogen aliphatic clusters
1735, 1705	S	Oscillation of carbonyl-ester groups
1648	m	I urea band C=O
1568	m	II urea band C–N
1447, 1385	v	Deformative oscillations C-H, typical of aliphatic compounds
1229, 1077, 1030	v	Oscillation extending ester compounds C-O-C imposed on bands of on-organic derivatives

The following symbols have been used to indicate wave intensity in the table: m medium intensity, s strong, vs very strong, v variable intensity

The surface received a coat of orange shellac as protection.

The silver oklad [15] was cleaned of dirt and deposits with *Silvo Duraglit*. Once the silver had been carefully cleaned, it was polished with a soft tissue. Next, the bent parts of the metal were carefully straightened out. Cracks in the metal were soldered from the reverse of the oklad. The soldering was performed using a soldering tool and tin–lead TOPEX solder with a diameter of 1 mm. When this work was completed, the entire metal was protected against repeated oxidization with acetone-based Paraloid B44 (Fig. 11).

4.3 Producing a copy of the icon with damaged places repaired on the basis of a physico-chemical examination of the original object and comparative material [16]

A copy of the icon was made on the basis of physic-chemical tests. The drawing was interpreted, and the stratigraphic structure of the original and the use of the base, pigments and adhesive identified. On the copy, the Child has a bright red robe. It was not possible to identify the original color because of the damage to the paint surface. Mary probably wore an azure cap. The blackening caused by high temperature make it impossible to determine its outline or color, despite a series of tests (Fig. 12).



Fig. 11 Iveron Icon of the Mother of God, after conservation (left-before attaching the oklad, right-after attaching the restored oklad)

Fig. 12 Copy of the icon. Author: Danuta Stępień



5 Conclusion

Iveron Icon of the Mother of God was painted on the (probably) limewood board in tempera technique. The CT tests have shown that the wood of base is in a very good condition and that the layer of paint adheres well to it.

The stratigraphic structure of icon is simple. There are only two thin paint layers and one thick layer of varnish. The paint layers covers the lines of the drawing, which can only be seen in infrared. Thanks to this radiation, one can also notice the author's small changes in the composition—*pentimento* (shifting Christ's hand).

The following pigments were identified: iron yellow, cinnabar, cadmium red. The intense X-ray absorption of radiation in places of the faces, hands and feet suggests that lead white or baryte content was used.

The icon's oklad was made of a silver and copper alloy with a predominant silver content. The entire surface of the silver plate has an engraving. Traces of gold in the lower parts of the engraving suggest that the entire front of the oklad was originally gilded [17].

On the basis of the interpreted results, a copy of the icon was made, presenting a reconstruction of the parts damaged by high temperature.

Objects exposed to fire are subjected to serious specific types of damage (loss of material, blackening and various deformations) which make it much more difficult to establish what the author originally had in mind. But increasingly precise measurements with the aid of instruments are helpful in this.

When proceeding to conserve an icon, we must make sure not to lose its historic substance. Only occasionally does an icon serving as an object of prayer require complete reconstruction.

My proposal is to exhibit in the museum an icon that has gone through conservation, next to a copy of the same icon in which damaged fragments have been fully restored.

Data Availability Statement No data associated in the manuscript.

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