

PRIMERS OF MODERN RUSSIAN ARTISTS: COMPOSITION, STRUCTURE AND DATING

Irina KADIKOVA^{1,*}, Svetlana PISAREVA¹

¹Independent Researcher

Abstract

The article presents an overview of the results of a study of primers of more than 200 paintings by modern Russian artists who worked at the turn of the 19th and 20th centuries. To identify the composition, microsamples of the primers were examined by means of analytical methods, such as polarizing microscopy (PLM), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS) and μ -FTIR spectroscopy. Also, cross-sections were prepared for the investigation of the paint layer structure. Both commercial primers and primers made by the artists are considered with an emphasis on their technological characteristics. The study revealed some unique features that can be used as a reliable sign in the determination of the time of paintings creation. The study revealed that the presence of a mixture of chalk and gypsum/plaster of Paris in the ground is a significant sign that a painting was executed in the first third of the 20th century. Another type of ground that is characteristic of modern Russian artists is commercially prepared two-layer white primers with various compositions of the bottom and upper layers.

Keywords: Russian art of the 20th century; Russian Avant-garde paintings; Primer made by artist; Two-layer primer; A mixture of chalk and gypsum; Lithopone; SEM-EDS; Polarizing microscopy

Introduction

Since ancient times, knowledge of painting techniques has been an integral part of an artist's work. Numerous recipes for a preparation of grounds, pigments, and paints, as well as recommendations for their use were prescribed in treatises and passed down from Master to his apprentice [1]. A choice of support and preparation for painting process is one of the most important stages in an artist's work and plays an essential role in a creation of a painting. For instance, a primer arranges a surface for painting: it can be smooth, rough, revealing the structure of the support or hiding it, which in turn, largely determines the texture of the paint layer. The way of preparing a ground, its structure, composition, and color varied in different regions and art schools of historical development of easel painting. That is why the ground is one of the most important structural elements that may be indicative of the time and place of the work's creation and its authenticity [2-4].

Modern Russian artists, like their predecessors, generally used paint materials imported from Europe: paints of Winsor & Newton, G.B. Möves, Lefranc and others were widely available in the specialised stores (Fig. 1a). This is primarily due to the fact that until 1930s¹ only few small factories² in Russia produced paints and they could not supply a large

* Author for correspondence: kadikovaif@gosniir.ru

¹ The time when Soviet industry of art materials started its developing.

² Also it should be noted that most of the factories used imported pigments for the paints production [3, 4].

community of artists with art materials. Another reason is that according to the artists' admission, the quality of the domestic paints was rather poor³ so most of them preferred the paints imported from Europe [5]. The artists could order such paints directly from abroad, as well as in many cities they could purchase them in specialized stores.

The same situation was observed with commercially primed canvases. Both Russian and European primed canvases were available to artists in the stores, however, as a rule, the composition of a primer was not specified in the price lists (Fig. 1b). For instance, Fyodor Rerberg⁴ noted in 1932: "I do not know how these canvases are prepared and the composition of the primer. Apparently, it is emulsion" [4-6].

a	<p>ДАЦИАРО, — ПЕТЕРБУРГЪ.</p> <p>Лучшія краски для масляной живописи въ оловянныхъ тубочкахъ фабрики ВИНДЗОРЪ и НЬЮТОНЪ въ Лондонѣ.</p> <table border="1"> <thead> <tr> <th>НАЗВАНІЕ КРАСОКЪ.</th><th>ЦѢНА въ руб.</th></tr> </thead> <tbody> <tr> <td>Бѣлыя.</td><td></td></tr> <tr> <td>Серебристая бѣлила</td><td>20</td></tr> <tr> <td>Китайскія бѣлила</td><td>35</td></tr> <tr> <td>Цинковая бѣлила</td><td>20</td></tr> <tr> <td>Желтыя.</td><td></td></tr> <tr> <td>Цинковая желтая</td><td>45</td></tr> <tr> <td>Кадмійевый</td><td>60</td></tr> <tr> <td>Корольевская желтая</td><td>20</td></tr> <tr> <td>Хромъ желтый</td><td>20</td></tr> <tr> <td>Марсовая желтая</td><td>40</td></tr> <tr> <td>Охра золотистая</td><td>20</td></tr> <tr> <td>Охра золотистая прозрачная</td><td>20</td></tr> <tr> <td>Римская охра</td><td>20</td></tr> <tr> <td>Неаполитанская желтая</td><td>20</td></tr> <tr> <td>Блестящая желтая</td><td>20</td></tr> <tr> <td>Желтый лапъ</td><td>20</td></tr> </tbody> </table> <p>Краски, отбѣлныя * прозрачныя; они употребляются также для живописи по стеклу и для фотоминиатуры.</p>	НАЗВАНІЕ КРАСОКЪ.	ЦѢНА въ руб.	Бѣлыя.		Серебристая бѣлила	20	Китайскія бѣлила	35	Цинковая бѣлила	20	Желтыя.		Цинковая желтая	45	Кадмійевый	60	Корольевская желтая	20	Хромъ желтый	20	Марсовая желтая	40	Охра золотистая	20	Охра золотистая прозрачная	20	Римская охра	20	Неаполитанская желтая	20	Блестящая желтая	20	Желтый лапъ	20
НАЗВАНІЕ КРАСОКЪ.	ЦѢНА въ руб.																																		
Бѣлыя.																																			
Серебристая бѣлила	20																																		
Китайскія бѣлила	35																																		
Цинковая бѣлила	20																																		
Желтыя.																																			
Цинковая желтая	45																																		
Кадмійевый	60																																		
Корольевская желтая	20																																		
Хромъ желтый	20																																		
Марсовая желтая	40																																		
Охра золотистая	20																																		
Охра золотистая прозрачная	20																																		
Римская охра	20																																		
Неаполитанская желтая	20																																		
Блестящая желтая	20																																		
Желтый лапъ	20																																		
b	<p>ДАЦИАРО, — ПЕТЕРБУРГЪ.</p> <p>№ 4. Разм. 8 1/2 x 6 вершк. съ замкомъ и 2-мя этюдниками 4.50 орхъвый полированный 6.— № 5. Разм. 9 1/2 x 7 1/2 вершк. съ замкомъ и 2-мя этюдниками 5.— орхъвый полированный 6.50 № 4 1/2. Разм. 8 1/2 x 6 вершк. съ замкомъ двойнымъ складнымъ этюдникомъ, 2-мя выдвинутыми крошечками и приборомъ въ видѣ мольберта для установки этюдника (фиг. 10). орхъвый 11.—, орхъвый полированный 12.50 съ выдвинутымъ метал. ножками орхъвый 16.—, орхъ. полир. 17.50 № 5 1/2. Разм. 9 1/2 x 7 1/2 вершк. съ замкомъ, двойнымъ складнымъ этюдникомъ, 2-мя выдвинутыми крошечками и приборомъ въ видѣ мольберта для установки этюдника (фиг. 10). орхъвый 12.—, орхъвый полированный 13.50 съ выдвинутымъ метал. ножками орхъвый 17.—, орхъ. полир. 18.50 Походный ящикъ разм. 38 x 27 сант. орхъвого дерева, полированный; внутри покрывается складной мольбертъ, 3 металлическихъ ножки для привинчивания въ видѣ складной стулъ, па-литра, масленка, 2 этюдника, внутри выложено мѣсто. Этюдники складные разм. 12 x 8 верш.—1 р. 60 к., разм. 16 x 8 1/2 верш. 2.— Этюдники для ношения этюдновъ съ 3-мя досочками разм. 8 x 6 верш.—3 р., разм. 9 x 7 верш. 3.50</p> <p>Лучшій русскій холстъ приготовленный и грунтованный для масляной живописи кускомъ въ 7 аршинъ. въ 16 20 24 28 32 40 48 и 66 верш. шир. по 60 к. 80 к. 1 р. 1.25 к. 1.75 к. 2.75 к. 3 р. и 5 р. за 1 аршинъ. При покупкѣ холста цѣлыми кусками дѣлается 10% скидка.</p> <p>Лучшее Дрезденское полотно спеціально приготовленное и грунтованное для живописи, масляными красками, въ кускахъ въ 16 аршинъ. въ 1 аршинъ ширины по 1.25; 1.40; 1.60 и 1.80 к. за аршинъ. 1 и 6 вершковъ ширины по 1.75 и 2.50</p>																																		

Fig. 1. The price list of Daziaro store, St. Petersburg. Year of publishing is not indicated (before 1917) [7].

- (a) The title is 'The best oil paints in the tin tubes by Winsor & Newton from London';
(b) The price list with available canvases includes 'The best Russian canvas prepared and primed for oil painting' and 'The best Dresden canvas specially prepared and primed for oil painting'
(Only the price per a piece of canvas is indicated).

The work is devoted to the research of primers by modern Russian artists – the ones who worked at the turn of the 19th and 20th centuries. Both commercial primers and primers made by the artists are considered with an emphasis on their technological characteristics. Examination of more than 200 paintings showed that a wide variety of materials and their mixtures were used as fillers, however some specific features of the primers' composition and structure were revealed. The article provides an overview of some types of primers, which can serve as characteristics of a particular period, and thus can be used as a reliable sign in determination of the time of paintings creation. The above-mentioned observations on the art materials available

³ The poor quality of paints may be connected with high amount of inert fillers that manufacturers added to the pigments in order to reduce the cost of the paint. Another known method of paints falsification was to substitute a more expensive pigment by a cheaper one [6].

⁴ Fyodor Rerberg (1865 – 1938), an artist, consultant to the Artistic Paints Factory, and author of several books on paint materials and technological aspects of painting.

to the artists at the time suggest that, generally the palette and primers of modern artists in Russia and Europe may be very similar until 1930s. This means that, to some extent, the results presented in the paper may also be applicable to European paintings as well.

Experimental part

Paintings

More than 200 paintings of modern Russian artists (Ivan Aivazovsky, Pyotr Konchalovsky, Lyubov Popova, Kazimir Malevich, Robert Falk, Konstantin Korovin, *etc.*) from museums and private collections were studied.

Samples and methods

Microsamples of primers were carefully taken under a microscope. To identify their pigment composition, as well as binding medium the microsamples of primer were examined by means of analytical methods, such as polarizing microscopy (PLM), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS) and μ -FTIR spectroscopy. The study of the paint layer structure was carried out using cross-sections which were prepared according to the methodology [8, 9].

PLM

For the examination of samples using PLM a POLAM L213-M (LOMO) microscope was employed. The specimens were examined under 720x magnification.

FTIR

Infrared spectra in the spectral range from 4000 to 600 cm^{-1} were collected using a LUMOS microscope (Bruker) in the attenuated total reflection (ATR) mode with a Ge ATR crystal. Experiments were carried out at the spectral resolution of 4 cm^{-1} ; routinely, 64 scans were averaged for each spectrum. FTIR spectra were compared with IRUG (Infrared and Raman Users Group) database.

SEM-EDS

For the elemental analysis and high-resolution images of the samples we used electron microscopes LEO 1420 VP (Carl Zeiss) with INCA-350 spectrometer (Oxford Instruments), Mira 3 XMU (Tescan Orsay Holding) coupled with X-MAX 50 (Oxford Instruments Nanoanalysis) energy dispersive X-ray spectrometer, and TM4000 Plus (Hitachi) with Quantax 75 spectrometer (Bruker Nano GmbH). The accelerating voltage was 15kV, working distance varied in range 5.5-6.5mm.

Results and discussion

White primers based on zinc white

Most of the primers of the first third of the 20th century were commercially prepared⁵, however some artists preferred to prime canvases themselves. Predominantly, zinc white was the main component of both industrial and author's grounds, while lead white or mixture of lead and zinc whites were less common. One of the distinctive technological features of primers of this period is presence of different additional components⁶, such as chalk, barium sulfate, gypsum, plaster of Paris⁷, and sometimes calcite and kaolinite (Fig. 2). However, gypsum and

⁵ In most cases, the type of primer can be determined by examining the edges of the canvas. If the canvas is commercially prepared, the edges will be covered with an even layer of primer. The artists usually size and prime their canvases after stretching them on the stretcher, so the edges remain unprimed.

⁶ Interestingly, most of additional components served as the regular additives also in the white and chromatic paints; kaolinite and talc were found only in individual instances.

⁷ 'Plaster of Paris' or 'casting plaster' ($\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$) is obtained by calcining gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) at temperatures between 100–180 °C to drive off some of the crystallization water. Such a treatment purifies gypsum and makes the material much more suitable for the smooth grounds. Along with gypsum and anhydrite (CaSO_4), plaster of Paris was used in Southern Europe as a ground for panel paintings. Also, it was used in wall paintings and for making molds, sculptures, and casts [2, 9].

plaster of Paris are worth special mentioning because they were used very extensively only in the first third of the 20th century. This type of ground was detected in the works of such artists as Natalya Goncharova, Kazimir Malevich, Olga Rozonova, and others [10].

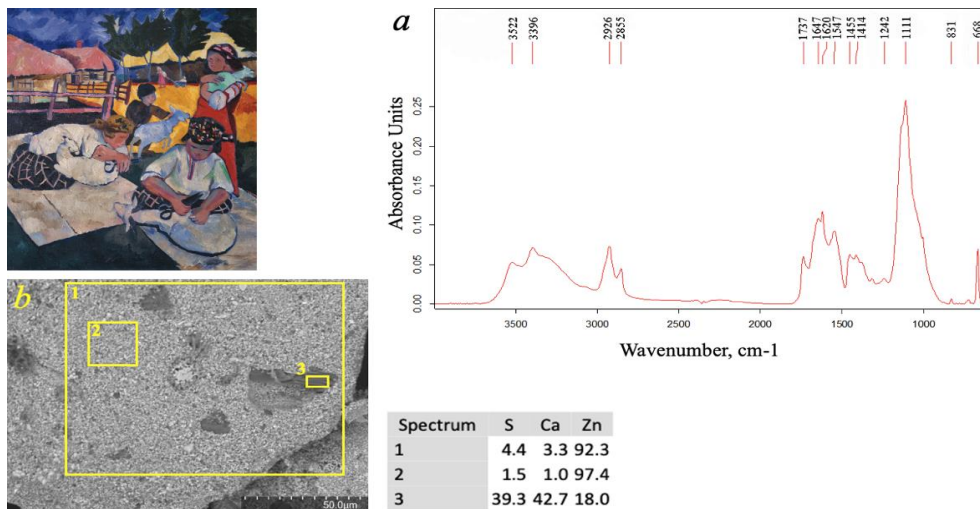


Fig. 2. Natalia Goncharova. *Sheep Shearing*. 1908-09. Serpukhov History and Art Museum. The study of commercial ground by means of FTIR-microspectroscopy (a) shows that emulsion on the basis of oil (absorbance bands 2926, 2855, 1737 and 1242cm⁻¹) and protein (absorbance bands 3080, 1647 and 1547cm⁻¹) was used as a binding media, also the presence of gypsum (absorbance bands 3522, 3396, 1620, 1111 and 668cm⁻¹) was detected. The result of SEM-EDS analysis (b) shows the presence of Zn, Ca and S (at. %), which suggests that in addition to gypsum zinc white (ZnO) is also a component of the ground.

Primers made by the artists: a mixture of gypsum/plaster of Paris with chalk

A mixture of gypsum/plaster of Paris with chalk was very specific for the paintings, created in the first third of the 20th century. Such a mixture was revealed in six pictures by Pyotr Konchalovsky executed between 1908 and 1919 and is distinctive for the early period of his oeuvre (Fig. 3).

Pyotr Konchalovsky was one of the few Soviet masters who emphasized the importance of technological aspects of artist's work. He said: "You must know the materials with which you paint, understand their properties and peculiarities; then they will not interfere with the painting, but will be your best assistants" [5].

Konchalovsky paid great attention to priming, preferring to work on canvases primed by himself. A composition of primer and the process were described in the monograph by Alexey Vinner, who recorded, analysed, and published interviews with leading Soviet artists on technological aspects of their work. Vinner wrote about Konchalovsky's grounds the following: "He took casein glue of the same consistency as for gluing the canvas, and mixed it with powdered lumpy chalk," and then noted that Konchalovsky pointed out the "extraordinary strength and stability" of such a primer and preferred it to a factory made one [5].

However, the research of 15 artist's works revealed that the author's early works contained a mixture of chalk and gypsum or plaster of Paris, and "Konchalovsky's favourite casein and chalky ground, which he used for almost 50 years" was discovered only in some works created since 1920s onwards. The discrepancy between the written and the experimental data could be explained by the fact that the filler for this primer could be sold labelled as a pure chalk at the market.

A mixture of gypsum/plaster of Paris with chalk was also revealed in three works by Robert Falk, as well as in the works of Lyubov Popova, Olga Rozanova, Alexandra Exter and others. Kazimir Malevich used such primer for his works executed in 1928-29 on plywood (Fig. 4) [10]. A mixture of gypsum and chalk was also identified in the painting by Konstantin

Korovin which was created in the late 1920s-1930s, in the period when the artist lived in Paris (Fig. 5). Examination of this type of ground by means of FTIR-microspectroscopy showed that protein was used as a binding media in all the paintings.

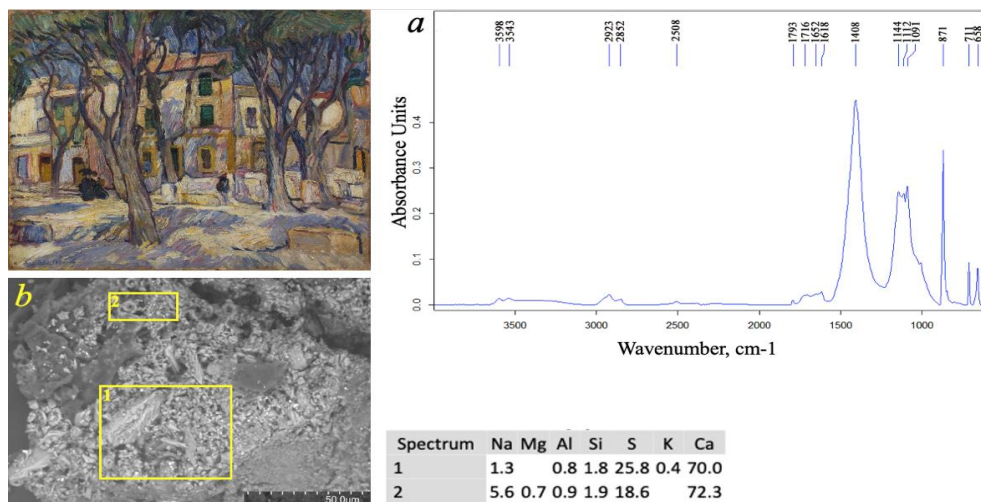


Fig. 3. Pyotr Konchalovsky. *Arles. Quarries*. 1908. Private collection. Examination of the ground by means of FTIR-microspectroscopy (a) shows that the ground consists of a mixture of plaster of Paris (absorbance bands 3598, 3543, 1618, 1144, 1112, 1091 and 658 cm^{-1}) and chalk (absorbance bands 2508, 1793, 1408, 871 and 711 cm^{-1}). The SEM-EDS results (b) indicate the presence of Ca and S (at. %), which is in agreement with the FTIR-microspectroscopy and PLM results

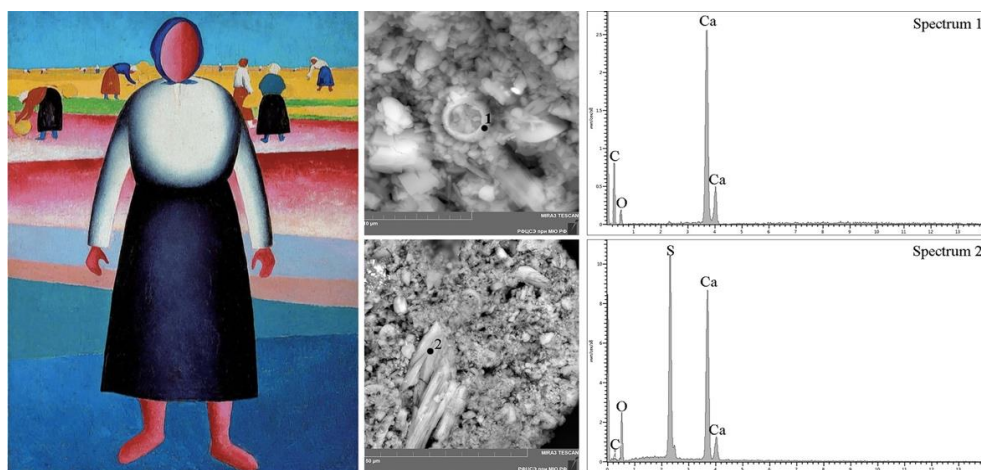


Fig. 4. Kazimir Malevich. *The Harvest*. 1928-29. The State Russian Museum. SEM-images and EDS spectra of characteristic particles of chalk (top) and gypsum (bottom), which are the main components of author's ground

Such a primer was not identified in the works created prior to the early 20th century and after the 1930s⁸. Moreover, there are no recommendations or references to the use of such a mixture as a filler in the artist's Handbooks of materials and techniques. A study of Russian art of different periods demonstrates that the first third of the XX century is a unique period when gypsum and plaster of Paris were actively used by as one of the components of the ground.

⁸ The only exception is a painting by a Soviet artist Andrei Vasnetsov (1924-2009), executed in 1958.

Thus, the presence of different types of calcium sulfates in the ground' composition is a significant sign that a picture belongs to this period.



Fig. 5. Konstantin Korovin. *The Seaside Town Promenade*. Late 1920s-1930s. Private collection.
The surface of the ground with coarse white gypsum particles

Two-layer white primers

Two-layer white primers were rarely used in Russian modern painting, although they deserve the attention of conservation scientists and experts. Known examples of this type of ground application by modern Russian artists are listed in the Table 1.

An artist who used two-layer commercially primed canvases is Ivan Aivazovsky. Technological examination of 83 paintings by Aivazovsky from the collection of Feodosia Gallery conducted by the specialists of the National Research Center for Restoration of Ukraine showed that the artist regularly used two-layer white primers in the last years of his life between 1898 and 1900 [11]. Among eight studied works of this period, six were painted using such ground, however some differences in the composition of the bottom layer are observed. While the composition of the upper layers of the ground was the same and it consisted of lead white, the composition of the bottom layer was different. Zinc white in a mixture with chalk was identified in two paintings and in the other paintings chalk was the only filler of the bottom layer. However, today the earliest case of a two-layer white ground in a painting by a Russian artist date back to 1865 and it is also a work by Ivan Aivazovsky. In the painting named *The View of Levadia* the bottom layer consists of chalk and the upper layer consists of the mixture of lead white and chalk [11].

Table 1. Two-layer white primers in the works of modern Russian artists

№	Painting	Year	Primer composition
1	Ivan Aivazovsky <i>Among the Waves</i> . Oil on canvas, 285×489. Feodosia Art Gallery	1898	Upper layer – lead white; Bottom layer – zinc white with chalk
2	Ivan Aivazovsky <i>Moonrise</i> . Oil on canvas, 207×336. Feodosia Art Gallery	1899	Upper layer – lead white; Bottom layer – zinc white with chalk
3	Ivan Aivazovsky <i>Seascape</i> . Oil on canvas, 40×59,2. Feodosia Art Gallery	1900	Upper layer – lead white; Bottom layer – chalk
4	Ivan Goryushkin-Sorokopudov <i>Portrait of a Wife</i> . Oil on canvas, 182,5×76. Penza Regional Art Gallery	1904	Upper layer – lead white; Bottom layer – zinc white with chalk
5	Aristarkh Lentulov <i>Portrait of N.A. Solovyov</i> . Oil on canvas, 104×176. Penza Regional Art Gallery	1907	Upper layer – zinc white; Bottom layer – chalk
6	Konstantin Yuon <i>In Sergiev Posad</i> . Oil on canvas, 132×200. All-Russian Museum Association of Musical Culture named after M.I.	1911	Upper layer – lead white; Bottom layer – chalk (Fig. 6a)

PRIMERS OF MODERN RUSSIAN ARTISTS: COMPOSITION, STRUCTURE, AND DATING

№	Painting	Year	Primer composition
	Glinka		
7	Victor Vasnetsov <i>The Eucharist</i> . Oil on canvas, 116×210. The State Historical Museum	1911	Upper layer – lithopone; Bottom layer – chalk (Fig. 8)
8	Kazimir Malevich <i>The Lady at the Piano</i> . Oil on canvas, 67×44,5. Krasnoyarsk Art Museum	1913	Upper layer – zinc white; Bottom layer – chalk
9	Ivan Kliun <i>Non-objective Composition. Self-Portrait with a Saw</i> . Oil on canvas, 71×62. Astrakhan State Art Gallery	1914	Upper layer – zinc white with barium sulphate; Bottom layer – chalk
10	Boris Kustodiev <i>Portrait of E.A. Gize</i> . Oil on canvas, 80,3×62,3. Private collection	1914	Upper layer – lithopone; Bottom layer – chalk
11	Konstantin Korovin <i>Summer Landscape</i> . Oil on canvas, 53×80. Private collection	1914	Upper layer – lead white with small addition of zinc white; Bottom layer – chalk (Fig. 6b)
12	Boris Shaposhnikov <i>Cubist Composition. Divine Justice</i> . Oil on canvas, 60,5×40,5. Ivanovo Regional Art Museum	1915	Upper layer – lead white with zinc white and barium sulphate; Bottom layer – chalk
13	Aristarkh Lentulov <i>Mosque</i> . Oil on canvas, 123,7×106. Astrakhan State Art Gallery	1916	Upper layer – zinc white; Bottom layer – chalk
14	Robert Falk <i>Landscape. In the Mountains</i> . Oil on canvas, 81×118. Ivanovo Regional Art Museum	1916	Upper layer – zinc white; Bottom layer – chalk with plaster of Paris
15	Wassily Kandinsky <i>Gray Oval</i> . Oil on canvas, 104×134. Ekaterinburg Museum of Fine Arts	1917	Upper layer – lead white; Bottom layer – chalk
16	Wassily Kandinsky <i>Musical Overture. Violet Wedge</i> . Oil on canvas, 60×67,5. Museum Association of Tula	1919	Upper layer – zinc white; Bottom layer – lead white
17	Konstantin Yuon <i>The Skiers</i> . Oil on canvas, 76×111. Private collection	1910-20s.	Upper layer – lead white; Bottom layer – chalk with addition of lithopone
18	Robert Falk <i>A Self-Portrait in a Red Fez and a Yellow Scarf</i> . Oil on canvas, 65×50. Private collection	1935-36	Upper layer – lead white; Bottom layer – chalk with zinc and lead whites (Fig. 7)

Other artists such as Wassily Kandinsky, Aristarkh Lentulov, Kazimir Malevich, Ivan Kliun, etc. occasionally used this type of primer as well. But most often they used primer with the chalky bottom layer topped with either pure zinc or lead whites or with inert fillers (Figs. 6 and 7).

A separate group comprises two-layer white primers, in which a thin upper layer is made of lithopone⁹. This kind of ground filler was identified, for example, in the paintings by Viktor Vasnetsov (Fig. 8) and Boris Kustodiev.

And in some works, such as *Portrait of a Wife* by Ivan Goryushkin-Sorokopudov and *Musical Overture. Violet Wedge* by Wassily Kandinsky (Table 1), different types of whites are the main components of both the upper and bottom ground layers.

Among all the studied two-layer white primers one stands out for its composition. In the painting *Landscape. In the mountains* by Robert Falk, it was not clear whether the ground was commercially prepared or made by the artist. The study showed that the bottom layer consists of a mixture of plaster of Paris and chalk, and the top layer consists of zinc white. We can assume

⁹ White pigment composed of a mixture of zinc sulfide (ZnS) and barium sulfate (BaSO₄). In addition to PLM, SEM-EDS, and FTIR-microspectroscopy, microchemical testing was used to confirm the presence of lithopone. The sample was treated with nitric acid solution, and then AgNO₃ was added. The formation of black Ag₂S precipitate was observed in presence S²⁻ anion.

with a high degree of certainty that the artist primed the canvas himself as such mixtures as plaster of Paris and chalk were not detected in the commercially primed canvases.

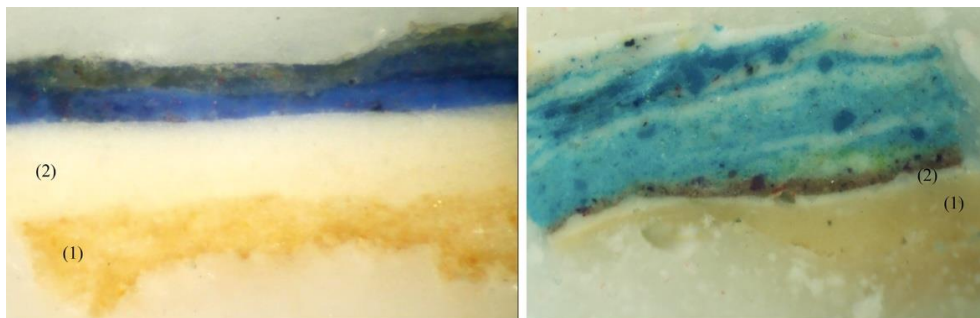


Fig. 6. Cross-sections of the blue paint layer of the paintings: (a) Konstantin Yuon. *In Sergiev Posad* and (b) Konstantin Korovin. *A Summer Landscape*. The numbers (1) and (2) indicate the bottom and the upper ground layers, respectively

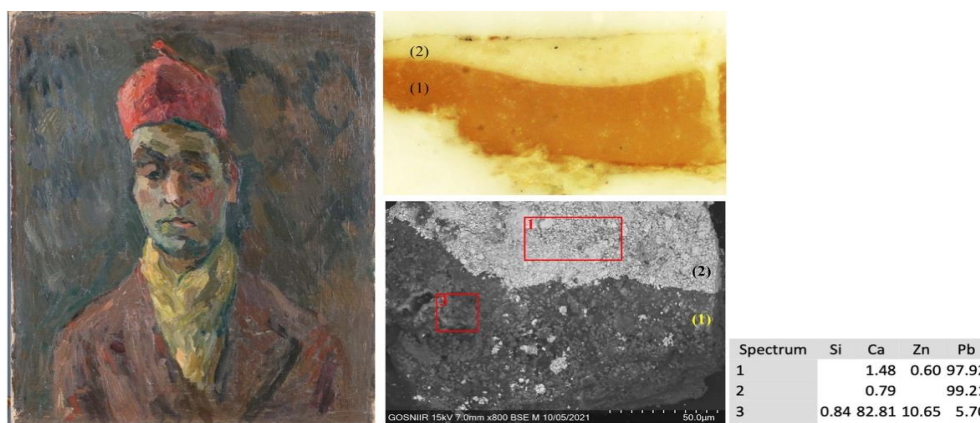


Fig. 7. Robert Falk *A Self-Portrait in a Red Fez and a Yellow Scarf*. Cross-section of the ground and its study by means of SEM-EDS (at. %) (the numbers (1) and (2) indicate the bottom and the upper ground layers, respectively). In the bottom layer (1), Ca and minor amounts of Zn and Pb were detected (Spectrum 3), indicating the presence of chalk with addition of zinc and lead whites; in the upper layer (2), predominantly Pb was detected (Spectra 1 and 2), which allows the conclusion that lead white is the main component of the upper layer¹⁰

At the same time, in the Handbooks on painting techniques, a number of authors mentioned two-layer primers. For example, Fyodor Rerberg wrote: «Recently another method of priming the canvas was proposed (by Rybnikov). The canvas, glued and covered with two or three layers of emulsion primer, is wiped with a thin layer of lead white oil paint diluted with petrol. This thinnest layer of oil paint does not require drying throughout the year (three-four months are enough) and makes natural transition from emulsion to oil paint layer: presence of lead white under the layer of oil paint promotes more uniform drying of the paint layer» [12]. A so-called combined ground, which is actually a two-layer ground, was suggested by Bohuslav Slansky¹¹: «The priming process is as follows: first, the glued canvas is covered with a thin layer of zinc white and chalk primer (1:1 by volume), then a layer of a mixture of lead white and linseed oil is applied» [13].

¹⁰ PLM and FTIR spectra of both of the layers confirmed the presence of chalk in the bottom layer and lead white – in the upper one. Also, in both layers oil was identified as a binding medium.

¹¹ Bohuslav Slansky (1900-1980), Czech conservator-restorer, founder of the modern conservation-restoration in Czechoslovakia and of the formal conservation-restoration education in Prague (at the Academy of Fine Arts and Design in Prague in 1946-47).



Fig. 8. Cross-sections of the paint layer in the painting *The Eucharist* by Viktor Vasnetsov. The numbers (1) and (2) indicate the bottom and the upper ground layers, respectively

Despite the fact that these formulations do not coincide completely with the materials we found in the painting by Falk *Landscape. In the mountains*, even the presence of these recommendations for priming the canvas shows that artists could have primed their canvases with such combined primers.

Conclusions

Having studied more than 200 paintings by Ivan Aivazovsky, Pyotr Konchalovsky, Lyubov Popova, Kazimir Malevich, Robert Falk, Konstantin Korovin, *etc.*, we revealed a number of technological features of primers that are characteristic of modern Russian artists' works created in a fairly short period between the late 19th century and the 1930s:

1. The presence of various additional components (inert fillers) in the primer, such as chalk, barium sulphate, and especially gypsum and plaster of Paris.

2. In the first third of the 20th century artists applied a mixture of gypsum or plaster of Paris and chalk to prime their canvases. This composition is atypical for the works created prior to the early 20th century and after the 1930s. Thus, a mixture of gypsum or plaster of Paris and chalk in the primer in some cases could serve as an essential attribution sign. Konchalovsky, for example, primed the canvases himself with such a mixture: it has been identified in all six examined early works created in the period between 1908 and 1919. For the painting created later he used other fillers [14].

3. Modern Russian artists used commercially prepared two-layer white primers with various compositions of the bottom and upper layers.

Throughout the art history, the artists have used different types of primers, so composition and structure of the ground in some cases can act as one of the indications of the time of painting creation. The results of the study can provide a basis for dating and attributing works by artists of this period.

Furthermore, it should be noted that none of the listed features are mentioned in the literature on the painting's techniques of the time or in the memories of the artists: all of them were revealed due to a technological study of a large number of paintings. Thus, only the

appliance of physicochemical methods of analysis provides reliable data on unique technological features of the artists' works.

Acknowledgments

The work was carried out in the State Research Institute for Restoration (Moscow, The Russian Federation) as a part of a Research Work "A Study of the Chronological Range of Application of Artistic Materials in Easel Paintings by Means of Physicochemical Methods of Analysis".

The authors are grateful to Elizaveta Koporulina (Institute of Comprehensive Exploitation of Mineral Resources of the RAS) and Ilya Afanasyev (The Russian Federal Center of Forensic Science of the Ministry of Justice) for a long-term cooperation and assistance with SEM-EDS research.

References

- [1] J. Nadolny, M. Clarke, E. Hermens, A. Massing, L. Carlyle, *Art technological source research; documentary sources on European painting to the twentieth century, with appendices I–VII, Conservation of Easel Paintings* (Editors: J.H. Stoner and R. Rushfield), Routledge Taylor & Francis Group, 2012, pp. 3-32.
- [2] M. Stols-Witlox, *Grounds, 1400–1900, Conservation of Easel Paintings* (Editors: J.H. Stoner and R. Rushfield), Routledge Taylor & Francis Group, 2012, pp. 161-188.
- [3] V.N. Gusev, F.I. Rerberg, V.V. Tyutyunnik, **Artistic Paints and Their Production**, Vsekokhudozhnik, 1936, p. 182. (in Russian)
- [4] F.I. Rerberg, **An Artist on Paints**, Izogiz, 1932, p. 193. (in Russian)
- [5] A.V. Vinner, A.I. Laktionov, **Modern Portrait Painting Technique**, Profizdat, 1961, p. 190. (in Russian)
- [6] V. Dosekin, **About Paint Materials**, Typolithography by Vladimir Chicherin, 1912, p. 68. (in Russian)
- [7] ***, https://old-stationery.kanzoboz.ru/preys_kurant_hudojestvennyih_risovalnyih_i_chertjnyih_prinadlejnostey_magazina_datsiaro_s_peterburg_do_1914_go_goda/
- [8] L.N. Lugina, Y.B. Bratushko, *The Role of Cross-Sections for the Examination of Paintings, Materials of the V Scientific Conference "Expertise and attribution of art works"*, Moscow, MagnumArs, 2001, pp. 267-270. (in Russian)
- [9] N. Eastaugh, V. Walsh, T. Chaplin, R. Siddall, **Pigment Compendium. A Dictionary of Historical Pigments**, Elsevier – Butterworth Heinemen, 2004, p. 499.
- [10] Y.I. Grenberg, S.A. Pisareva, I.F. Kadikova, **Anatomy of Russian Avant-Garde. View from the Lab**, Tri Quadrata, 2017, p. 292.
- [11] V.I. Tsitovich, L.N. Lugina, T.R. Timchenko, **Technology and Expertise of Paintings by I. K. Aivazovsky**, National Research Center for Restoration of Ukraine, 2002, p. 90. (in Russian)
- [12] F.I. Rerberg, **How to Learn to Paint in Oil Paint**, Iskustvo, 1936, p. 88. (in Russian)
- [13] B. Slansky, **The Painting Technique. Paint Materials**, USSR Academy of Arts, 1962, p. 378. (in Russian)
- [14] I.N. Shibanova, I.F. Kadikova, S.A. Pisareva, *Technological Features of the P.P. Konchalovsky' Artistic Work, Materials of the IV International Scientific Conference "Preservation of Cultural Heritage: Conservation, Heritage Science, New Discoveries"*, St. Petersburg, November 12-14, 2020 (Editors: Y.G. Bobrov, A.I. Shamankova), St. Petersburg Repin Academy of Fine Arts, 2021, pp. 249-265. (in Russian)

Received: August 22, 2022

Accepted: December 20, 2022