

# RESEARCH OF WEAR RESISTANCE OF DRAWINGS PERFORMED BY ACRYLIC PAINTS IN HAND PAINTING TECHNIQUES

VODZINSKA OKSANA\*, BILOTSKA LARYSA, VORONA NADIYA AND DONCHENKO SVITLANA

Kyiv National University of Technologies and Design, Nemirovich-Danchenko str., 2, 01011 Kyiv, Ukraine

## ABSTRACT

The article considers a modern way of decorating clothes - hand-painted with acrylic paints based on motifs of Petrykivka's paintings. The possibility of using acrylic paints for hand painting of denim products in the technique of Petrykivka is investigated. The evaluation of the process of making drawings with different types of acrylic paint on denim fabric is performed. An experimental study of the wear resistance of the finished garment, namely: color fastness of the applied pattern to rubbing and to the washing. Based on the obtained data, a variant of acrylic paint is proposed, which provides high-quality production of competitive garments with hand-painted finishing in the technique of Petrykivka.

## KEYWORDS

Properties of acrylic paints; Petrykivka paintings; Washing quality; Color fastness to rubbing; Manual application technique; Denim fabrics; Decorative painting of fabrics.

## INTRODUCTION

Nowadays, changes in the world economy and, consequently, in the fashion industry against the background of restrictions related to the spread of the COVID-19 pandemic have led to a reassessment of consumer needs and changes in demand for certain clothing in the world and in Ukraine. The trade of products that are easy to use, simplified designs and shapes, and clothing for everyday use has become more widespread. This category of goods includes denim clothing, which has not lost popularity for several decades and became the classic and can be worn even at home.

On the other hand, in the era of mass production, individuality and uniqueness are the main value for a huge number of people who want to attract attention, including through appearance. The trend of customizing clothes has been and remains quite popular, which involves changing the product to the individual request of the consumer. Customization is a popular design and at the same time marketing move, which involves providing the product with certain properties to enable a person to show individuality, modify the product for the buyer or collect it completely from scratch. One of the types of customization of garments is hand-painting, which is quite popular among young people.

Today Petrykivka ornament is an artistic business card of Ukraine. This is not only Ukrainian decorative and ornamental applied art, but also modern painting, which

is actively developing. Since 2013, Petrykivka painting has been included in the UNESCO list of cultural intangible heritage, which testifies to its relevance and importance in the development of Ukrainian and world culture [1].

Petrykivka motifs are actively used not only in everyday life, but also reflected in the work of world-renowned designers for decorating modern clothing. Researchers of Petrykivka painting traditions have confirmed the need to expand the implementation of Petrykivka traditions in modern clothing design from the use of traditional ornamentation to the development of new professional technologies for transferring ornamental art into clothing [2, 3]. Thus, the decoration of clothes in the style of Petrykivka with the use of hand-painted paints is modern, and the problem of studying the technology of decorating products to create competitive clothing is relevant.

## REVIEW OF RELATED LITERATURE

Drawing on fabric or clothing is possible using various techniques: printing on fabric, hand-painting of details or painting the finished product. Coverage of the issues of drawing by machine printing methods is presented in works [4-8], in which the researchers analyzed the technologies of drawing images on the fabric by printing methods, methods using foil, transfer printing and more.

\* Corresponding author: Vodzinska O., e-mail: [vodzinska.oi@knuutd.com.ua](mailto:vodzinska.oi@knuutd.com.ua)

Received May 20, 2022; accepted September 19, 2022

The authors [7-9] considered the issue of creating high-quality clothing of various assortments, including fabric and knitwear with drawings decorated with direct digital and transfer printing. The results of experimental studies of image quality indicators are presented and conclusions are given on the influence of various factors on the wear resistance of the image applied by direct digital and transfer printing methods.

The effect of paint on special fabrics used for sewing of working clothes of building specialties were investigated in [10]. The definition of fabrics resistance to variety kinds of paint and the rigidity of fabrics after paint's effects was assessed.

A several scientific works are devoted to the decoration of hand-painted products, which can be done with acrylic paints in various techniques: hot batik, cold batik (reservation), knotted batik, free painting, a variety of which is raw painting on moistened fabric and Petrykivka, as well as painting airbrush [11-12]. In particular, in the work [12] authors developed a specific method for simulation of the batik printing patterns with cracks. Widespread use and relevance of hand-painted types of fabric was confirmed in [13].

The authors [14-16] considered the issue of hand painting of silk and cotton fabric, the combination of traditional design methods and innovative manufacturing technologies. Different types of natural dyes for fabrics are discussed in publications, that provide them eco-textile labelling.

Scientific works [17-21] are devoted to the study of dyeing processes of natural fabrics with various types of natural dyes. The chemical technology of the dyeing materials is also considered.

The paper [22] presented a novel computational approach to simulating hand-painted printing patterns on cloth, according to the real process of this ancient folk handicraft. This method can produce vivid hand-painted printing patterns on cloth of different woven structures.

Authors [23] proposed a general classification of types of finishes for denim clothing by method of production, which also includes hand-painted paints on fabric. Confirmation of the relevance of various types of finishes, including hand-painted products with acrylic paints, is presented in [24].

The work [25] is devoted to the study of the peculiarities of hand painting in the technique of batik, in which the authors confirmed the possibility of using acrylic paints for high-quality drawing in the technique of batik on fabrics of mixed raw materials. In [26] the principles of combining batik decoration with constructive-technological methods of clothing design are proposed.

The issue of designing the author's collection of clothes with hand-painted acrylic paints on the fabric is shown in work [27], which proposed the use of acrylic paints to create the effect of a "chameleon"

when manually applying paints of different shades on the surface of plain fabric.

In [28] the friction resistance of acrylic patterns made on different types of materials (denim, raincoat and silk fabrics) was studied. The authors found that the most resistant to friction was acrylic coating applied to the raincoat fabric, based on which a model of women's summer coat with decoration in the form of a floral motif, applied to the product by contour painting with acrylic emulsion.

Works [29-34] are devoted to the development of author's textiles for clothing decoration, including the application of products with applique and embroidery. In [35, 36] the authors proposed the use of acrylic paints to decorate the author's collections of products developed on the basis of a creative source.

Thus, the analysis of literature sources on the research topic shows that the problem of decorating fabrics and clothing is dealt with by many scientists. A number of works are devoted to the issues of finishing clothes with hand-painted acrylic paints. However, the issue of wear resistance of drawings made of acrylic paints requires further research.

## DISCUSSING IDEAS

The research is aimed at determining the possibility of using acrylic paints for hand painting of denim products using the technique of Petrykivka drawings.

To achieve this goal, the tasks that need to be solved are formulated:

- to analyze the features of the process of painting with acrylic paints on denim;
- to carry out experimental assessment of wear resistance of the executed furnish.

## METHODS

Study used a comprehensive approach, and methods of system analysis to justify the choice of quality indicators of finishing elements, made in the technique of hand painting with acrylic paints on fabric. To achieve this goal, standardized experimental methods for the study of color fastness to rubbing and color fastness to washing, as well as a standardized device ПТ-2 were used. The principles of comparative analysis were used to evaluate the process of painting with acrylic paints on denim fabric, as well as to evaluate the results of experimental studies.

## EXPERIMENTAL

The quality of application of pigments on the fabric, namely, their resistance to operating conditions, is determined by the properties of film-forming substances, which have certain requirements:

- high adhesive strength, i.e., the ability to stay on the surface of the fibers of the material and firmly retain pigments;
- elasticity;
- mechanical stability;
- resistance to light and weather conditions;
- non-toxicity.

It is difficult to choose an individual polymer that would meet the whole set of requirements, so in practice, a combination of several polymers is used. Water-based acrylic paints are now the most common for hand-painted fabrics. According to the manufacturers, acrylic paints have a number of advantages. They do not penetrate into the structure of the fiber, but cover the fabric, forming a film on its surface, are characterized by a wide range of colors, mix easily with each other, creating unique shades, are not afraid of moisture. Paints are recommended for outerwear and not suitable for bed linen, which can be washed frequently. It is not recommended for products that are dry cleaned due to the possibility of wiping, as well as for children's things, as it can cause allergies. Paints are non-toxic because they do not contain harmful chemicals [11]. Thus, to make drawings on denim products, it is proposed to choose acrylic paints, the range of which is widely represented on the Ukrainian market. For the experimental study, the choice was based on paints of a similar price segment, but different manufacturers. As blue denim is chosen for the products, it is taken into account that the fabric is light when purchasing the paint. This is due to the fact that some manufacturers classify and produce paints for light and dark materials. Tables 1 and 2 show the characteristics of the selected paints and denim.

The selected paints have similar properties and methods of application, respectively, and similar methods of care for products. However, paint Javana Sunny (Kreul) in appearance is a translucent liquid in contrast to the other two, which have a more intense color.

During the study, the same pattern was made with three types of paints to assess their characteristics and properties in the process of drawing in the technique of hand painting. During the drawing, the analysis and evaluation of the consistency and properties of paints, their ability to perform the reception of the transition smear were performed, which is used in the performance of compositions in the technique of Petrykivka painting. It is also possible to apply the contours of the drawing with a thin brush. It should be noted that brushes with synthetic bristles of different thickness, length and shape were used to apply the paints. Brushes made of bleach, columnar and cat bristles did not allow to paint with acrylic paints, as there was a need for brushes with stiffer bristles.

Table 3 describes the process of drawing with acrylic paints in the technique of hand painting. Based on the

results of the analysis of the drawing process, it can be concluded that the first two samples of acrylic paint allow to make drawings in the technique of Petrykivka painting. Acrylic paint Javana Sunny (Kreul) is excluded from further research as one that does not provide the possibility of drawing in the chosen technique. It is also established that when making a pattern on denim with twill weave, you must first apply the base white paint color (primer), which evens out the surface of the fabric, and only then apply a different layer of colored paint. Otherwise, the paint is absorbed by the material and loses color brightness.

It is known that the product quality is formed at all stages of design and manufacture of garments. To do this, consumer requirements for products are being formed at the product design stage. Based on these requirements, the nomenclature of product quality indicators is determined. Regarding the quality of the drawings on the clothes, indicators of safety of acrylic paints and reliability of sewing products with decoration deserve special attention. Reliability indicators determine fastness and durability of products under the influence of external factors. Indicator "color fastness to various physical and chemical influences" allows to estimate fastness of drawings made on denim fabric [37]. A group of indicators of fastness to external influences refers to mandatory indicators of the sewing product quality (according to GOST 4.45-86 "Household sewing products. Nomenclature of indicators" [38].

The indicators: the possibility of chemical cleaning, washing, and ironing and the strength of parts connection - belong to the group of indicators of resistance to external influences (according to the requirements of the standard). Denim outerwear is subject to repeated washing and rubbing in dry weather conditions during operation. The drawing is applied to products in the area of shoulders, thighs, chest and can be rubbed against the belt of bags, arms etc. [34]. Therefore, the two indicators (color fastness of drawings to rubbing and color fastness of drawings to washing) will be investigated.

The essence of methods for determining color fastness of painting to rubbing (according to DSTU ISO 105-X12: 2009 Textile materials. Determination of color fastness. Part X12. Method for determining the color fastness to rubbing (ISO 105-X12: 2001, IDT)) and color fastness to washing (according to DSTU ISO 105-C06: 2009 Textile materials. Determination of color fastness. Part C06. The method of determination color fastness after washing at home and in laundries (ISO 105-C06: 1994, IDT)) is that the samples of denim together with accompanying fabric (white calico) were subjected to appropriate physical and chemical effects [39]. Samples from denim (180x80 mm along the warp thread) were produced for research color fastness to rubbing (Fig. 1). A strip of white paint was applied as a base to the sample.




**Table 1.** Characteristics of acrylic paints for hand painting of fabrics.

Name of paints	Manufacturer	Country / city	Cost, [UAH]	Appointment
Acrylic for painting fabrics	Rosa talent	Ukraine, Volyn region, Novovolynsk	275 UAH / pack . (12 colors x 20 ml)	Highly pigmented water-based acrylic paints for painting light and dark fabrics of various compositions, including leather and suede
Acrylic for DECOLA fabrics	Nevskaya palette	Russia, Nevskaya Palette Art Paint Factory, St. Petersburg	275 UAH / pack . (12 colors x 20 ml)	Paints for decorative creativity for cotton and silk fabrics
Acrylic Javana sunny	Kreul	Germany by C.Kreul GmbH & Co.KG	225 UAH / pack . (12 colors x20 ml)	Water-based acrylic paints for painting light fabrics, for natural and synthetic materials

**Table 2.** Characteristics of the main fabric

Type of material	Raw material composition, [%]	Type of weave	Surface density, [g/m <sup>2</sup> ]	Thickness, [mm]	Yarn density, [units/cm]		Cost, [UAH]
					warp thread	weft thread	
Denim	Cotton - 100	Twill	350	0,72	28	19	210

**Table 3.** Characteristics of the process of drawing with different types of acrylic paint

Name of acrylic paint	The image of the drawing element on the fabric	Characteristics of the paint application process on the fabric
Acrylic paint Rosa talent		The paint has a dense consistency, not transparent. The white base, when applied in one layer, sufficiently evens out the surface and provides a bright and realistic color transfer when applying the next layer of paint, the color corresponds to the manufacturer's stated on the package. The consistency of the paint allows you to perform the technique in the technique of "transitional smear". After drying, the pattern has a slight gloss, the fabric at the application site has become stiffer. The surface of the figure does not form cracks and kinks when bending. With a thin brush, the contour is applied with little complication, the paint needs to be dissolved. During dissolution, a slightly grainy consistency of the paint is observed, which slightly complicates the application of a thin uniform contour. Water was used to dissolve the paint. There are no special solvents on sale from this manufacturer.
Acrylic paint DECOLA		The paint has a dense consistency, not transparent. The base of white color, when applied in one layer, sufficiently evens out the surface and provides a bright and realistic color transfer of the next layer of paint, the color corresponds to the stated on the package. The consistency of the paint allows you to perform the technique in the technique of "transitional smear". After drying, the picture has a slight gloss, but compared to the previous sample made of acrylic paint Rosa talent, less pronounced. The fabric at the application site has become stiffer. Does not form cracks and kinks when bent. The contour is applied very well with a thin brush, the paint does not need to be dissolved, at the same time from dissolving with a special solvent of the same manufacturer there is a uniform fine consistency of the paint, which allows applying thinner uniform layer and contour. Therefore, it is possible to make a finish that will not overburden the material and seal it. The image is more realistic compared to the previous version.
Acrylic paint Javana Sunny (Kreul)		The paint has a translucent consistency, which is significantly different from the previous two samples. The basis of white color put in one layer on material, after drying does not appear, is absorbed by material completely that complicates drawing of a color layer of paint on the same contour. After applying the second color layer and drying it, the paint is also absorbed and impregnated on the reverse side of the fabric. On the front surface, the color of the drawing is not bright and does not correspond to what is stated by the manufacturer on the package. The consistency of the paint does not allow to perform the technique of "transitional smear". After drying, the picture has a dull appearance, re-applying a colored layer of paint does not change the situation. Despite the technique of applying layers of paint, the image is similar to watercolor application and looks blurry. Contours with a thin brush are difficult to perform, there is a difficult application, the paint is kept on the brush with a thick drop, at the same time there is impregnation of the paint on the reverse side. The pattern after drying does not form cracks and kinks when bent.

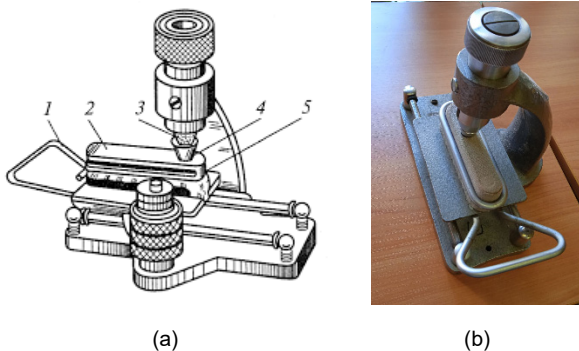




**Figure 1.** Sample of material with a strip of acrylic paint (Rosa talent, red)

A strip of acrylic paint with a width of 20 mm was applied in one layer evenly by hand to the sample (imitation of hand painting). Two colors of paint (green and red) were used for the experiment as the most contrasting to the main fabric.

The study of the color fastness to rubbing was performed on the device PT-2 according to standard methods (Fig. 2).



**Figure 2.** The scheme (a) end appearance (b) of the device PT-2 to determine the color fastness to rubbing: 1 – lever; 2 – table; 3 – rod 1,5 cm in diameter with accompanying fabric sample; 4 – ring for fixing accompanying fabric sample; 5 – ring for fixing the main sample.

For an experiment, the rod with accompanying fabric sample is lowered onto the Table 2. The total pressure between the table and the rod is constant (10 N). With the help of lever 1, the table is moved along the guides at a distance of 100 mm 10 times in one direction and another for 10 seconds. The characteristics of accompanying fabric are presented in Table 4.

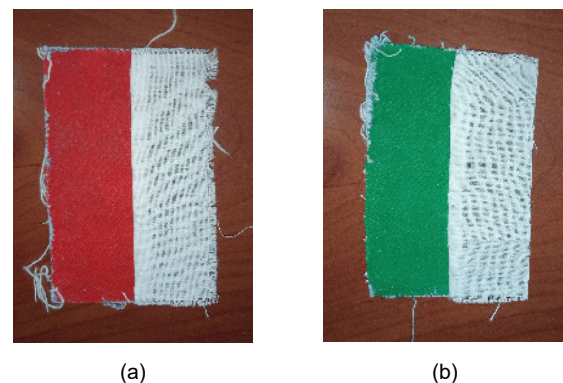
To study the color fastness of drawing after washing, samples 100x40 mm were prepared. The pattern (width of 40 mm) was applied to the entire surface of the material sample. Two colors of paint (red and green) were used to take into account the probability of different behavior of pigments to washing. The accompanying fabric sample 100x40 mm was sewn around the denim sample by hand stitches. Modes of manual washing are given in Table 5. Hand wash was carried out at the specified parameters in a glass container with a volume 250 ml with constant stirring [39].

**Table 4.** Characteristics of accompanying fabric.

Type of accompanying fabric	Calico
Color	White
Raw material composition, [%]	Cotton -100
Surface density of accompanying fabric, [g/m <sup>2</sup> ]	120
Thickness of accompanying fabric, [mm]	0,21
Sample size, [mm]	50x50

**Table 5.** Hand wash modes for samples.

Type of base fabric	Denim
Raw material composition, [%]	Cotton 100
Washing temperature, [°C]	40
Washing time, [min.]	30
Rinse time, [min.]	10
The composition of the washing solution, [g/dm <sup>3</sup> ]	Washing powder - 5
Type of washing powder	Persil Color (Henkel)



**Figure 3.** Photo samples with the applied pattern after washing: DECOLA red (a); DECOLA green (b).

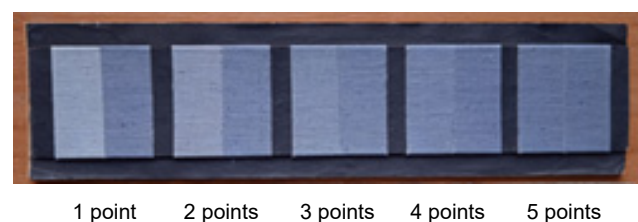
After the test, the samples are taken out, rinsed twice in cold running water for 10 minutes, wringed out, split, leaving a seam on one side, and dried in a suspended state and spread out. The image of the samples after washing is presented in Fig. 3.

## RESULTS AND DISCUSSION

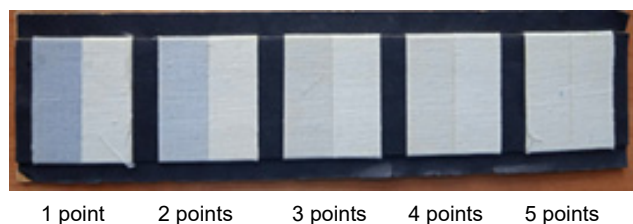
Color fastness to various influences is evaluated by two indicators:

- the lightening of the painted sample color (in points);
- the staining of the white accompanying fabric sample (in points).

The comparison of indicators is carried out using the scale of gray standards for evaluating the lightening of color (Fig. 4) and the scale of gray standards for evaluating the staining of the white accompanying fabric sample (Fig. 5).



**Figure 4.** The scale of gray standards for evaluating the lightening of color (1 point - maximum contrast, 5 points - no contrast).



**Figure 5.** The scale of gray standards for evaluating the staining of the white accompanying fabric sample (1 point - maximum contrast, 5 points - no contrast).

The evaluation of the research results was carried out by the contrast of the pattern before and after the test [40]. The contrast is visually equal to the scale of gray standards. The results of the experiment are presented in Table 6 and in Fig. 6. Rosa talent paint is more color fastness to rubbing.

**Table 6.** Color fastness of the drawings by acrylic paints to rubbing.

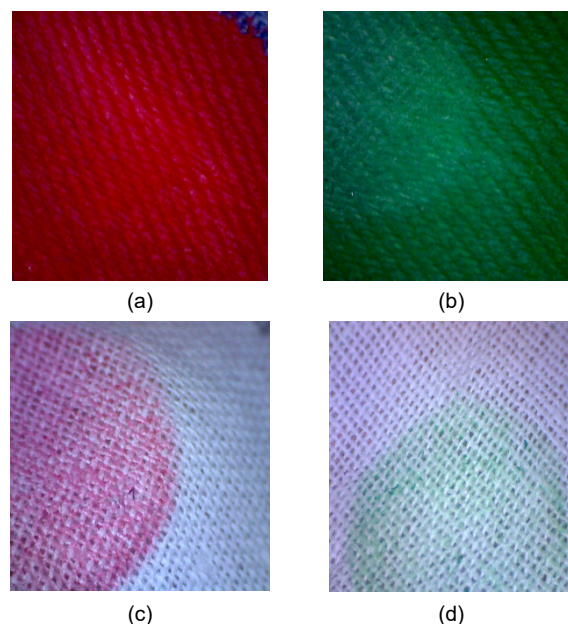
Name of the sample, type of acrylic paint	Paint color	Lightening of sample color, [points]	Staining of the white accompanying fabric sample, [points]
Test 1, Rosa talent	Red	4-5	4-5
Test 2, Rosa talent	Green	4-5	5
Test 3, DECOLA	Red	4	3-4
Test 4, DECOLA	Green	3-4	4

The results of the experiment on the color fastness after washing are presented in Table 7.

Based on the results of the study, it can be determined that the green color of the paints gave a more stable result. During washing samples DECOLA, red, the washing liquid was very colored. Paint residues were observed and peeled off during rinsing.

**Table 7.** Color fastness after manual washing.

Name of the sample, type of paint, color	Lightening of sample color, [points]	Staining of the white accompanying fabric sample, [points]
Test 1, Rosa talent, red	4	4
Test 2, Rosa talent, green	5	4
Test 3, DECOLA, red	3-4	3
Test 4, DECOLA, green	5	4



**Figure 6.** Photo of the material sample after the experiment (a – DECOLA, red, b - DECOLA, green) and accompanying cotton fabric (c – DECOLA, red, d - DECOLA, green) under a microscope.

## CONCLUSIONS

Studies allow us to conclude that the paint Javana (Germany by C.Kreul GmbH&Co.KG) is not suitable for drawing on denim fabric in the technique Petrykivka painting. The paints are impregnated into the fabric structure, move to the reverse side of the product, give a watercolor pattern and do not cover the surface of the material with film. In addition, for a stylized drawing based on Petrykivka motifs, the paint does not allow to make a transitional stroke and draw a thin line on the material.

It is established that when making drawings in the technique of Petrykivka acrylic paints on denim fabric, you must first apply a white base, which evens out the surface of denim fabric, and then perform the main drawing.

Rosa talent (Ukraine) has more color fastness to rubbing and color fastness after washing. It is recommended for the manufacture of decoration in the technique of Petrykivka painting for denim products. It was also established that red paint from the same manufacturer loses more color after washing than green paints.

Prospects of future research include assessing the stiffness of denim fabrics with acrylic paint pattern, and determining the topography of patterns on products of various assortments.

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