Technologies of using colored clay in the manufacture of ceramic products

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Abstract. The article is devoted to the history and technology of using colored clay in the art of ceramics. The paper provides a classification and description of techniques for working with colored clays to create ceramic products.

1 Introduction

The world of contemporary ceramic art today is very multifaceted. Artists working with clay use, in addition to traditional techniques, completely modern technologies and materials. But along with innovation, there is also room for reinventing fairly ancient but less common techniques, such as dyeing the clay mass itself with pigments and working with polychrome clay.

Techniques for working with colored clay were known more than 4,000 years ago, but were largely ignored in the evolution of Western European ceramics in favor of colored glazes and work with product surface decoration, with the clay base itself being more of a sculptural structure than a self-sufficient decorative material.

When studying the technology of using colored clay in the art of ceramics, we should elaborate on the history of its appearance.

One of the most ancient objects made of colored clay are ancient Egyptian figurines and amulets, dating back to the II century BC. Their study shows that copper oxide was added to the clay mass, which gave the clay shades of blue and green colors. It may have been the way Ancient Egyptian craftsmen replaced the more complex technique of making religious objects, such as carving stone, for example, by imitating turquoise.

Next, the period of the Tang dynasty (AD 618-906), which saw the flowering of Chinese pottery some 1,200 years ago, is worth mentioning. This was the period when many polychrome glazes appeared, and the objects themselves became various forms and were richly decorated with decorative ornaments. Also a separate group of works of ceramic art of this era are products made with the use of marmorization techniques - the creation of colored patterns in clay by hand molding and on the potter's wheel with subsequent low-temperature firing and glazing.

Then, during the next few centuries, masters of the Song dynasty painted porcelain with iron oxide and created a variety of patterns of plates and other elements.

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In Europe, they managed to discover the secret of making porcelain products only at the beginning of the 18th century (Meissen porcelain).

And in the middle of 18 centuries in England, Josiah Wedgwood in his factory began to effectively use colored clay and created pottery in the technique of "agatware", the English name of which can be translated as "firm agate".

Externally, "agatware ceramics" resembles the mineral agate, the cut of which shows multicolored stripes. This is quite a complex technique, in which the ceramic mass is colored with oxides and repeatedly kneaded, but not to a homogeneous color, but maintaining the unusual color structure, reminiscent of natural stone. In this technique, the clay pattern can appear as a structured elaborate pattern, or as a random effect appearing on the surface of the product.

In the 1750s, Josiah Wedgwood fruitfully collaborated with Thomas Wilson, who at the time in England was considered one of the best ceramicists. And the result of their joint work was the invention of the finest earthenware of a delicate light yellow hue, covered with a pewter glaze. This earthenware first became known as "creamy" and later received another name - "royal" in honor of Queen Charlotte, as it was from this earthenware were made services for the royal house.

This is not the end of Wedgwood's inventions in the field of coloring clay masses. He is also the creator of "basalt ceramics" - very hard and almost non-porous black or red ceramics that resemble stone and can be worked with stone-cutting tools. Due to its high hardness, the surface of the product is brilliantly matt, and in combination with the fine white bisque pattern black basalt ceramics in the style is very reminiscent of the works of ancient masters of glyptic.

Among the many types of Wedgwood products, Jasperware is particularly famous. Jasperware is made by adding barium sulfate. It is very hard and can be polished, but at the same time it stains very well with metal oxide. In the beginning the colors of jasper were white, green, blue and bluish blue, but since 1775 shades of lavender, pink, olive and yellow were added.

Thanks to the invention of technology for dyeing earthenware in different shades, there are new techniques for decorating ceramics, such as "Pate-sur-pate", which in French means "layer by layer". The essence of this method is the layer-by-layer application of a thin sculptural relief, most often of white color on products made of colored porcelain mass. The composition of the slicer for the relief pattern consists of white kaolin clay, very fine grinding, and water with glycerine. This technique was invented at Sèvres porcelain manufactory in France in 1849 and was used to imitate ancient cameos in porcelain.

In Japan, the technique of working with colored clay has been known for a very long time, since the 5th century AD. Extant items created in this technique and now can be seen in museum collections. They were made by craftsmen of different times, such as the Momoyamai Edo period (1568-1603).

Today this technology is called "nerikomi" and "neriyagi. "Neri" is the word for the verb "to mix," and "yage" for "to pull up. "Nerikomi" translates as "to crush" or "to push away," which suggests the idea of pushing away layers of clay into shapes. Therefore, the technique of "nerikomi" implies hand modeling with colored clay, and "neriyagi" is working with colored clay on a potter's wheel.

As professional terms, these names first began to be used in the 1970s to describe the work of the famous Japanese sculptor and ceramist Yusuke Aida. His works made a vivid impression on viewers and quickly gained great popularity and fame.

These techniques were brought to Europe and America in the twentieth century during the Mingei movement aimed at reviving Japanese craftsmanship.
2 Results

The sequence of work with colored clay in the "nerikomi" technique involves several important steps:

- Selection of raw materials suitable for this technique;
- Dyeing the clay mass with dyes;
- Creation of patterns of colored clay;
- Cutting the veneer of decorative plates and inlaying them;
- Cleaning the surface by smearing the pattern;
- Drying, duck firing and baking;

When selecting raw materials for the technique "nerikomi" can be used different types of clay, it is important that they match each other on the technical characteristics - density, plasticity, porosity, stickiness, the coefficient of shrinkage when drying and sintering temperature during firing. It is important that the product at firing remains homogeneous in its properties.

When working with colored clays, both natural clay of different shades and material colored with coloring oxides or special heat-resistant pigments for ceramics are used. As a basis for dyeing, white clay or porcelain is used more often, because the natural yellowish-brown shades of clay strongly influence the color range in the final result, white clay does not change the hue of the paint used. The standard dye oxides impart different shades to the clay mass (Table 1).

<table>
<thead>
<tr>
<th>Dyeing oxides (chemical formula)</th>
<th>The colors and shades of clay, obtained by adding oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe2O3 iron oxide and ferric oxide Fe3O4</td>
<td>Pink, reddish brown and red yellow</td>
</tr>
<tr>
<td>lime CaCO3</td>
<td>black</td>
</tr>
<tr>
<td>Manganese dioxide MnO2</td>
<td>pink or purple</td>
</tr>
<tr>
<td>carbonate manganese MnCO3</td>
<td>different shades of blue</td>
</tr>
<tr>
<td>cobalt oxide CoO</td>
<td>bright blue</td>
</tr>
<tr>
<td>cobalt nitrate Co(NO3)2</td>
<td>green</td>
</tr>
<tr>
<td>Cobalt oxide CoO and chromium Cr</td>
<td>turquoise</td>
</tr>
<tr>
<td>CuO copper oxide</td>
<td>Pink, reddish brown and red</td>
</tr>
</tbody>
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Another way to produce colored clay is to color the clay mass with ceramic heat-resistant pigments. These are special synthetic high-temperature powders for coloring clays and glazes. They are produced by various companies that produce materials for ceramicists. These are Prodesco, Spain, Colorobbia, Italy, Mason (MasonStains) England and others.

The percentage of added oxide or dye determines the degree of color saturation in the clay, but for different dyes different concentration is needed. For example, 3% of cobalt carbonate (CoCO3) in relation to the white ceramic mass will give a very saturated dark blue clay, while for obtaining a saturated dark brown clay you need 6-7% red iron oxide (Fe2O3).

The color is better manifested by firing at higher temperatures, and, accordingly, the lower the firing temperature, the more dye is needed to show color. A deep black color of the clay can be obtained by adding 25% of the dye Mason 6600 BestBlack. In general, a good color can be achieved by adding from 3% to 10% dye for high temperature firing, from 5% to 15% for low temperature firing. The same pigments, but in smaller quantities, can be used to obtain bed colors.

The introduction of pigment into the clay mass is carried out as follows. Dry pigment of about 10% (depending on the desired color intensity) is poured into the wet clay in a recess.
and poured with a small amount of water until it becomes a pulp. Then the clay is mixed very carefully until a homogeneous colored mass is obtained.

The technique of making a product in the "nerikomi" technique requires the utmost care in observing the sequence of work.

1. First you need to take two pieces of clay of different colors, suitable to each other on the technical characteristics and the same moisture content. The clay must be sufficiently moistened, so that in the process of work there are no seams and cracks in the product. To moisten the clay, you can wrap it in a wet cloth and let it absorb the necessary amount of liquid. Then humidified clay roll into a thin layer with a thickness of 5 to 8 mm. There is another way - the workpiece of the desired thickness can be cut from a large briquette of clay with a special tool - a string for cutting clay layers or removing the finished product from a ceramic circle. Such a string comes in steel or nylon.

Two plates of different colors must be tightly joined together and twist the resulting "sandwich" on both ends in the form of spirals (Fig. 1).

![Fig. 1. Twisting workpiece.](image)

2. To form the central block of the workpiece, connect the two twisted parts to each other (Fig. 2).

![Fig. 2. Formation of the central block.](image)

3. Of the remaining plates you can form a block, alternating black and white clay and consisting of 4-5 layers of such "sandwiches" (Fig. 3).
Fig. 3. Formation of the laminate block.

4. The resulting billet should be cut in half with a fishing line and once again connect to each other, which turned out 8-10 layers. And then, ready block cut into four equal parts (Fig. 4).

Fig. 4. Cutting the laminate block.

5. The next step is to connect the center block and the four parts of the workpiece. To do this, it is necessary to tap the central block against the table with the sides so that it becomes flat on all sides. After that, the stripe pattern blanks are attached to each side of it (Fig. 5).

Fig. 5. Compound parts of the central block.
6. It is necessary to squeeze the block into a square so that the sides of the striped part of the workpiece are connected to each other. After that, tap the sides of the block so that it becomes square again (Fig. 6).

![Fig. 6. Formation of the central block.](image)

7. The next stage of the work is to wrap the entire assembled block with a thin layer of light clay to give it a clear boundary and carefully pat it carefully on all sides in order to get a tight connection between the material (Fig. 7).

![Fig. 7. Formation of the central block.](image)

8. When the pattern block is ready, you need to start cutting the veneer. To do this, place the block on a clean surface and place 5-8 mm high plywood or heavy cardboard slats on both sides of the block. After that, use a fishing line to cut the necessary amount of patterned veneer. The veneer should not be too thick in order to avoid the appearance of cracks in the base during joining. The rest of the block can be wrapped in cellophane film and placed in a plastic box with a closing lid and used for other work (Fig. 8).

![Fig. 8. Cutting the veneer.](image)
9. The cut veneers should be placed under a damp cloth so that they soak in water for a better connection with the base of the product (Fig. 9).

10. When the patterned veneer soaked in moisture to the required plasticity, you need to roll out a layer of clay with a thickness of about 10 mm. Then slightly sprinkle the layer with a solution of vinegar and without pressure lay the patterned veneer on it (Fig. 10).

11. After the patterned veneer is laid out on the layer, it should be covered with a thin cloth, carefully smoothed out, so that there would be no folds and carefully easy rolling with a rolling pin several times in different directions, so that the veneer is connected to the
base. And then you can roll the layer with the veneer more thoroughly, for a homogeneous connection of decorative inserts and the base (Fig. 11).

![Fig. 11. Compound veneer with the formation.](image1)

12. You can make a dish, for example, from the ready-made layer in the technique of battering in the clay mold. If in the process of shaping the product the surface of the pattern has become worn and lost its clear boundaries, it can be cleaned with a flexible metal scraper. It is better to do it already in a leather-solid or completely dried condition. After complete drying, the product is fired and glazed with transparent glaze (fig. 12).

![Fig. 12. Dish in the technique of "nerikomi".](image2)

In the technique of "nerikomi" you can create not only individual patterned blocks, but also a whole layer of colored clay, with which later you can work in the technique of tempering and hand modeling (Fig. 13).
Fig. 13. Formation in the technique of "nerikomi".

You can decorate the product with patterned veneer both in the raw and in the leather-solid state. There are works that are additionally textured with a warming of some textured surfaces - fabrics, lace, ropes, dried plants, etc.

Most often, the products made in this technique, glazed with a transparent glaze, but some artists to visually enhance the relief of the pattern using and colored glaze.

As a complement to the above technology should share some practical advice from the famous American master Vince Pitelka (Vince Pitelka, Professor Emeritus of Art, Director of Clay Appalachian Center for Craft, School of Arts, Crafts and Design, Tennessee Tech University), whose experience in ceramics has more than forty years.

In his book, Clay: A Studio Handbook, Vince Pitelka writes, "When bending layers lined with colored clays, a few simple techniques will allow you to reduce the chance of surface cracking.

1. Always join on vinegar. Vinegar will make the clay more malleable. Many types of porcelain and porcelain-faience masses contain soda spars, which release soda ions into the clay over time. This has a deflocculation effect that makes the clay brittle, leading to fracture when bent. Needless to say, this problem is exacerbated when colored clay blanks are stored wet for long periods of time. Vinegar will restore flocculation and plasticity.

2. Also, when you plan to bend the soft strata into cylinders, tubes, or cones, make it a rule to smooth a piece of plastic wrap over the colored surface so it sticks well - and only then bend. This will cause the plastic to shrink on the inside instead of stretching on the outside. This method has drastically reduced the number of surface cracking problems."

3 Discussion

Products made in the technique of mixing colored clay, in most cases are characterized by very simple concise forms, because their artistic value lies precisely in the unique pattern, reminiscent of the texture of natural materials.

But these techniques of working with clay still remain relatively rare in modern ceramics due to some technical difficulties of these methods.

4 Conclusion

Techniques for working with colored clays are becoming increasingly popular in the world of contemporary ceramic art. Many have come to love them for their relative simplicity of materials, brevity, and sophistication.
The artistic possibilities of this technique have no limits, and to create a form in it you can in different ways - and hand modeling, working with the plate or on a potter's wheel.

It is worth noting again that it is colored clay that allows you to implement creative ideas in the products with many unique effects of a through pattern, the patterns of which are viewed not only from the outside, but also from the inside. Such an effect is not available in any other ceramic technique.

References

1. V. Pitelka, Nerikomi or agate ceramics