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STUDIES AND RESEARCH ON OBTAINING GLASS INLAYS IN METAL

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ABSTRACT

The paper presents research on obtaining glass inlays in metal, with the aim of obtaining a decorative object, using the intarsia technique. For this purpose, we studied the samples that we made from glass shards of different sizes, over which different metal oxides were added to colour the glass. The samples were made with different amounts of metal oxide, respectively 4%, 7%, and 10% to obtain different shades of colour. We also conducted experimental research to achieve the embedding of some pieces of glass in a defined metallic contour. The decorative object was made through the thermoforming process, with the glass intarsia in metal, in a stainless-steel plate, used as a background.

KEYWORDS: intarsia, glass, design, metal, thermoforming

1. Introduction

Thermoformed glass is becoming increasingly well-known and sought after, especially among architects and designers. Thermoformed glass is created by fusing glass of different shapes and colours. Products made from thermoformed glass are considered unique items.

Thermoformed glass can be used with confidence, both indoors to create various decorative objects, and outdoors in place of classic windows, by replacing them with personalized stained glass. The major advantages of thermoformed glass are the ingredients used, which differ from one product to another, and thanks to the technology used, stained glass is considered to be a resistant, durable and easy-to-maintain material.

Intarsia is an artisanal marquetry technique that involves inlaying small pieces of different materials on a surface. Traditionally, this technique uses wood, but it can be transferred to other materials. Intarsia requires precision and meticulous cutting of the pieces to create complex and varied designs [1, 3].

2. Experimental research

One of the objectives of the study was the production of decorative intarsia-type objects. The first experiments were carried out in the direction of obtaining the embedding of pieces of glass in a determined metallic contour. The frames were obtained by welding, side by side, separate pieces of steel sheet. They did not have a perfectly delimited surface, and the material used showed strong oxidation tendencies. Some of the shapes used are shown in Figure 1.

Fig. 1. *Metal frames used for the study of glass embedding inside them*

The flat pieces of glass were cut to dimensions as close as possible to the inner contour of the frames, and where there were deviations from their configuration, they were removed by grinding. Some of the frames prepared for the study are shown in Figure 2.

The samples obtained could not ensure a good fit between the inner walls of the frame cavity (Figure

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3). This is necessary when inlaying the glass in metal, which replaces adhesive bonding.

Fig. 2. *Frames with glass plates inside*

I also analysed the possibility of using pieces of glass slightly larger than the size of the mould (round samples), aiming to see if, through thermoforming, the desired relief could be obtained, by deforming the glass under its own weight (so that the glass plate rests on the edges of the mould) and falls inside the mould, thus perfectly occupying the inner surface of the mould.

The test results can be seen in Figure 4b.

The glass used for the two samples was cut differently; for the larger diameter sample, a diamond cutting tool was used, and for the smaller sample, the disk was obtained by carving the piece of glass with special pliers. The impossibility of obtaining glass contours as close as possible to the dimensions of the shape led to the use of shredded glass, which, by heating at higher temperatures, resulted in obtaining the exact configuration of the metal cutouts.

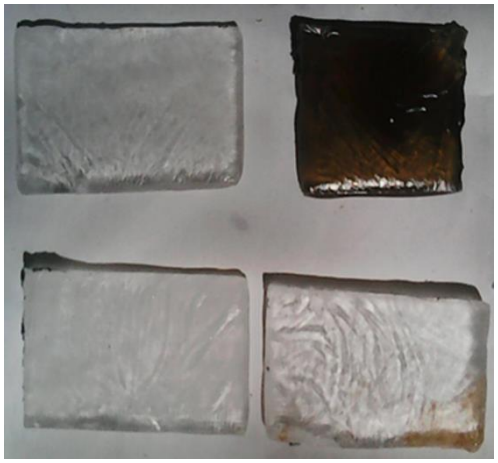

Fig. 3. *Samples after removal from the oven*

This option also offered the possibility of colouring the glass, to obtain the decorative object.

I made the samples with glass shards of different sizes, over which I added different metal oxides, with which I coloured the glass.

Coloured glass is obtained by adding quantities of iron, copper, nickel, silver, gold or other metal combinations. In this way, almost infinitely many colour variations can be obtained [2, 4].

a) b)

Fig. 4. *Sample for the study of glass embedding in the form under its own weight: a) sample preparation; b) thermoformed sample*

For example, red glass contains copper oxide, yellow glass contains cadmium sulphate, blue glass contains cobalt oxide, green glass contains chromium oxide, and violet glass contains manganese oxide.

After studying the samples, we observed that on larger shards, the adhesion of the dye was lower, resulting in incomplete colouring due to the difference in melting temperature between the two components (Figure 5), leaving the outline of the shards highlighted by oxides visible.

The very small shards trapped the metal oxides between them, leading to uniform colouring. We

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made samples in which, in the very fine glass fragments, we introduced 4, 7 and 10% metal oxides. We used shards from green and brown bottles, obtained from bottles of these colours (Figure 6).

The top row shows samples with green glass; the bottom row shows samples with brown glass.

For the green glass powder, we used the addition of green chromium oxide, and for the brown glass, yellow iron oxide.

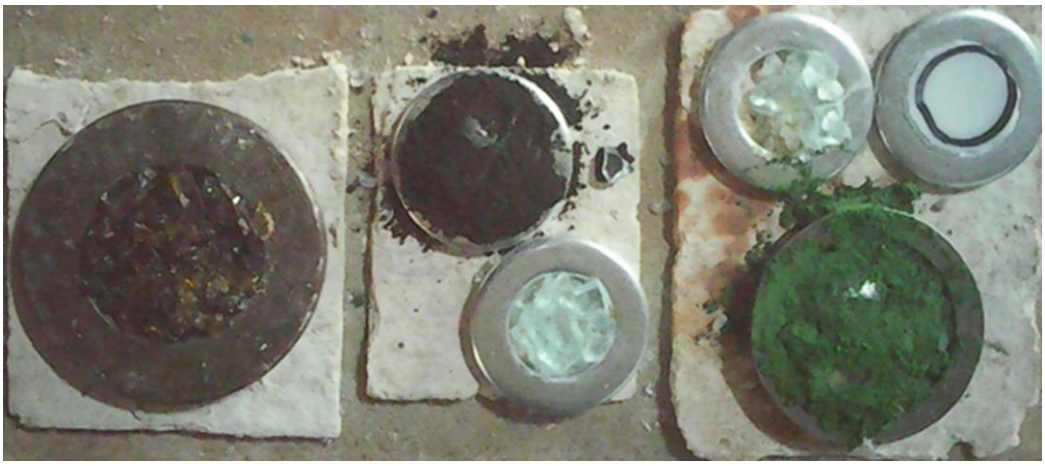

Fig. 5. *Staining sample with glass shards and metal oxides*

It was found that in the samples with 4% oxide (Figure 7 a), the powder and oxide gave rise to a glass with different colour intensities than those of the standard samples, which originated only from fine glass powder of the same green and brown colour, respectively, and with characteristics close to those of glass (such as gloss and smoothness).

In the samples obtained with the addition of 7% oxide (Figure 7b), the colour intensity of the two samples increased. Instead, their appearance diverged from that of glass, losing smoothness and gloss.

In the sample with 10% oxide addition (Figure 7c), a change in the colour intensity of the samples is observed, and the appearance, lacking smoothness and gloss, is very close to that of grindstones.

a) b) c) d)

Fig. 6. *Rings with mixtures of glass and oxides prepared for treatment: a- powdered glass with 10% oxide; b) powdered glass with 7% oxide; b) powdered glass with 4% oxide; d) powdered glass colour standard*

Due to the characteristics of the surface and the resulting colours for subsequent processing operations of glass waste, the most suitable materials are mixtures made only from glass powder, or from glass powder with a maximum of 7% oxide addition.

For special ornamental effects, mixtures obtained with an addition of 10% oxide can also be

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used. The final product differs from the initial, monochromatic powder by its rough appearance and the stronger intensity of the colours.

In the research carried out, I proposed creating a small painting using the intarsia of some pieces of glass in a metal base plate. When creating the decorative object, because some elements could not be cut from glass, I resorted to the help of glass powder, to obtain them.

The drawing of the painting that I proposed to "paint" by thermoforming is the one presented in Figure 8.

a) b) c)

Fig. 7. *Samples obtained: a) with 4% addition; b) with 7% addition; c) with 10% addition*

We opted for a stainless-steel sheet as the background, and inlays obtained in two ways, respectively: cut glass and powdered glass. The sheet of metal was sectioned into several pieces, processed by grinding, and, finally, the plate was reconstituted by welding (Figure 9).

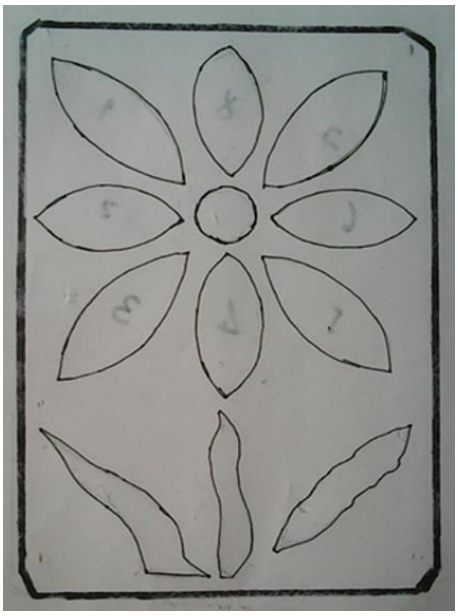

Fig. 8. *Drawing of the painting, with glass inlay in metal*

The glass inlays, such as the petals, were quite difficult to make (Figure 10).

To ensure the fixation (embedding) of the glass in the metal plate, between the two components, sheet metal and glass, we introduced fine glass powder, which, by softening at the same time as the glass, ensures the best possible connection of the glass elements with the metal base plate (Figure 11).

The small elements, such as leaves, were made of fine glass powder (Figure 11). The thickness of the powder layer was twice the thickness of the 2 mm plate, because during thermoforming the layer loses

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its height, and the desired relief can no longer be achieved. After thermoforming, cooling was done together with the oven, to ambient temperature [5].

The central area of the flower was modeled by placing a the ceramic separator, fixed, in turn, on the support plate of the entire assembly, with a thin piece of white glass, then coloured by covering it with larger fragments, also from glass of the same quality and colour.

The decorative object obtained, upon removal from the oven, is shown in Figure 12.

a) b)

Fig. 9. *Base plate (a), plate after assembly (b)*

Fig. 10. *The base plate and inlays in the process of formation*

Fig. 11. *Preparation of the plate-inlay assembly for thermoforming*

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Fig. 12. *Decorative object made by inlaying glass in metal (stainless steel) through thermoforming*

4. Conclusions

Intarsia is an artisanal marquetry technique that involves inlaying small pieces of different materials onto a surface. Traditionally, this technique uses wood, but it can be transferred to other materials. Intarsia requires precision and meticulous cutting of the pieces to create complex and varied designs.

The decorative object was made through the thermoforming process and the inlay of glass in metal, in a stainless-steel plate, used as a background.

We also conducted experimental research to obtain the embedding of glass pieces in a determined metallic contour.

Following various attempts, a unique and personalized decorative object was created by inlaying glass in metal through thermoforming.

References

[1]. Karen L. Cohen, *Art of Fine Enameling*, Editura Stackpole Books, ISBN 9780811737920, 2020.
[2]. Carole Ferrer, *Vitralii-2014*, Cod: MAS978-973-1822-99-0, Editura: MAST, 2014.
[3]. Kathy Wise, *Intarsia: Woodworking Projects [With Patterns]*, Editura: Fox Chapel Publishing, ISBN 1565233395, 2007.
[4]. Kathy Wise, *Intarsia Woodworking for Beginners: Skill-building Lessons for Creating Beautiful Wood Mosaics*, Fox Chapel Publishing, 2009.
[5]. Florea Gh., Chiriac Al., Mărginean I., *Procedee performante de punere în formă*, partea I, Editura Europlus, Galaţi, 2008.