

(Reprinted from The Bulletin of The American Ceramic Society. Vol. 20. No. 1. January, 1941.)

APPLICATION OF PHOTOGRAPHY IN CERAMICS*

By Walter D. Ford (1906-1988)

*Presented at the Autumn Meeting, White Wares and Materials and Equipment Divisions, Uniontown, Pa., September 14, 1940. Received July 3, 1940.

Abstract

The author reviews and classifies the processes of ceramic photography. The following methods are described: (A) photoceramic processes. (1) substitution. (2) dusting-on. (3) carbon, (4) photomechanical. (5) porous tile, and (6) relief; and (B) photography in industrial ceramic decoration, (1) decalcomania, (2) intaglio printing. (3) silk-screen printing. and (4) colored glaze decoration. Solution and body compositions are given in detail, the use to which each process is best adapted is noted, and the future of photographic work in ceramics is fully discussed.

I. Introduction

The purpose of this paper is to present a resume of all known information on ceramic photography. Although a search of the literature has revealed few historical facts, it is interesting to note that in 1802, Thomas Wedgwood, son of the famous potter, Josiah Wedgwood, produced silhouettes of leaves on glass. Joseph Nicephore Niepce, in 1827, found that asphalt, which was soluble in turpentine, became insoluble on exposure to light. The photomechanical processes were the outgrowth of these early experiments which are applicable to ceramics. The substitution process was invented by Du Motay and Marechal and the dusting process by A. Poitevan. No dates could be found.

The processes, generally speaking, may be classified as follows: (1) substitution process; (2) dusting-on process: (a) use of ferric chloride and (b) of gum bichromate; (3) carbon process; (4) photomechanical process; (5) porous tile process; and (6) relief process: (a) colored glaze, (b) porcelain cameo, and (c) translucent types.

II. Description of Photoceramic Processes

(1) Substitution Process

The substitution process consists of making a silver positive similar to a lantern slide except that a collodion emulsion must be used instead of a gelatin emulsion. The silver image is changed by electrolysis to a combination of platinum, iridium, and gold, which oxidizes to produce a black image when it is fired, whereas the original silver would oxidize to produce a pale yellow color.

There are various modifications of this process, but the following procedure may be taken as representative. Obtain a collodion positive in the camera by the wet process.¹ Fix and wash the plate and bleach thoroughly in a 5% solution of mercuric chloride. Wash the plate again and place it in the substitution bath which is to replace the original image with a combination of platinum, iridian, and gold.

The bath composition is platonic chloride 2 gm., iridic chloride 1 gm., auric chloride 0.5 gm., and water 1000 cc. When the deepest shadows of the picture are toned through, wash for a few minutes to remove the free- toning solution. Cut around the margins of the film carefully, and immerse the plate in a 1% solution of sulfuric acid. The film presently will strip off. Wash cautiously and transfer to the final support of porcelain or other material and dry.

¹ Paul N. Hasluck, Book of Photography. Cassell and Co., Ltd., London, 1907.

The image side should be down. When dry, remove the collodion film by rubbing gently with a sponge moistened with ether and alcohol. Dry and dust the image with a flux; it is then ready to fire.

This process is fairly simple, except that skill is necessary to transfer the image to the ceramic piece. The materials are costly and therefore should not be wasted.

(2) Dusting-On Process

The two different methods used in the dusting-on process are (a) the ferric chloride method wherein light makes the film hygroscopic, and (b) the gum bichromate method wherein light makes the hygroscopic film lose this property.

(A) Ferric Chloride Method: The solution applied to a glass plate is ferric chloride (crystallized) 25 gm. tartaric acid 12 gm. and water 200 cc.

Dry this solution in a dark room and expose to light under a negative. On setting, the parts that were exposed to light will absorb moisture from the atmosphere and become sticky; the unexposed parts will remain dry. Dust on a suitable ceramic stain that will adhere to the sticky parts and form an image. Coat the image with collodion and allow to set. Soak the collodion-covered support in water until the collodion releases from the glass, carrying with it the ceramic stain which has formed the image. Wash thoroughly to remove the original ferric chloride solution, soak the film in a saturated solution of fused borax, and float into place on the ceramic piece. Dry, coat with a decalcomania varnish, and fire.

(B) Gum Bichromate Method: The solution applied to the glass plate is gum arabic 10 gm., white sugar 10 gm., ammonium bichromate 4 gm., and water 100 cc.

Dry the coated plate in the dark and expose to light under a positive, which should have about the same contrast as a lantern slide. Allow the exposed plate to set to absorb moisture from the atmosphere in the unexposed portions. Dust on a desired ceramic stain with a camel's hair brush several times until the image appears. Coat the plate with a collodion solution, and continue the process as in the foregoing ferric chloride method.

These processes are used generally for portrait work such as those used on tombstones. The ferric chloride method is more tedious because the solution is easily contaminated, causing it to lose its hygroscopicity.

(3) Carbon Process

Mix the carbon with gum arabic or albumen and apply as a coating on a suitable support. To make the film sensitive, soak in a solution of an alkaline bichromate, dry in the dark, and expose to light under a negative. The exposure to light makes this film insoluble, and the unexposed portions may be washed away by water. For ceramic purposes, substitute a suitable ceramic stain for the carbon, cover the film with a collodion solution, and process by the dusting-on method (section II (2)).

The carbon process, which is not commonly used, is best suited when a half-tone negative is used, that is, a negative, the image of which has been broken up into tiny dots, such as those adapted for book illustrations.

(4) Photomechanical Process

There are several photomechanical processes, but in general they are methods in which printing surfaces are produced from which impressions may be taken without the use of light in the production of each copy. Photolithography is one of these methods best suited for ceramic applications. In this method, sensitize the surface of the lithograph stone or zinc plate with a bichromate albumen solution. Dry this surface and expose under a half-tone negative. Wash the surface with water to remove the portion of the film that has not been exposed to light. Prepare the stone or zinc plate for printing, and use printing ink which contains the desired ceramic stain. The image is printed off on a suitable transfer paper, which is transferred to the ceramic piece by a method similar to that used in transferring decalcomania to dinnerware.

This photomechanical process is suitable chiefly for large reproductions of the same image, and exceptionally skilled labor is necessary.

(5) Porous Tile Process

First cast a suitable plaque out of the following body: potash feldspar 60, flint 10, ball clay 15, and china clay 15%. Fire the tile to about cone 06. Make a sensitizing solution of potassium bichromate 8 gm., manganese sulfate 2 gm., cobalt sulfate 2 gm., dextrin 8 gm., and water 100 cc.

Dissolve these chemicals in water and filter. Dip the porous tile half immersed in the sensitizing solution for about 5 seconds. Set this plaque on a flat surface in the dark with the sensitized surface up, and dry in this position. Expose the plaque to light under a negative, and soak in distilled water for one hour. Remove and dry, with the exposed surface in contact with a flat surface, which permits any dissolved salts that might be left in the tile to deposit on the reverse side on evaporation. The dried plaque will have a brown image.

Fire the tile to cone 6 to vitrify the body, which leaves a bluish black image on the satin like surface of the plaque. This procedure may be applied to a bisque wall tile in the same manner, and the image may be calcined at cone 6, glazed, and refired at a lower temperature.

This process, which is comparatively simple and by which good results may be obtained, should be useful to amateur photographers, but it has no use outside the individual portrait field.

(6) Relief Process

Careful examination of a negative will always reveal some traces of surface modeling or relief. This relief is more noticeable when the gelatin coating on the film is relatively thick and when a pyrogallic acid developer is used. At best, however, the relief of the negative is slight and certainly not enough to make it worth while to cast or mold. If, however, a suitable compounded gelatin composition is attached to a glass plate, a high degree of relief will be obtained, and from this original, moldings or replicas may be cast in plaster.

The gelatin composition is gelatin 100 gm., sugar 25 gm., potassium bichromate 1 gm., and water 300 cc. Heat this solution until it melts, stir thoroughly, strain through muslin, and pour about 2 cc. of the liquid to 1 sq. in. of surface on a level glass plate. Dry this coated plate in a calcium chloride drier, and expose the dried plate under a negative for 1 hour under a 1000-watt lamp. Soak the exposed plate in distilled water to produce the relief, and, after a sufficient relief is obtained, make a plaster cast.

(A) *Colored Glaze*: Make a gelatin relief by the relief process, and cast and dry the plaster mold. A suitable pottery body is formed on this mold, having the same relief as the gelatin. Dry and bisque fire the piece formed. Apply a colored glaze, and gloss fire the piece. The original photograph will appear in the piece with an exceptional quality of depth and softness, owing to the fact that the fired glaze tends to spread out level, which permits the various depths of relief to produce a variable thickness of colored glaze. The high parts of the relief therefore will be the high lights of the picture, and the low parts will be the shadows.

(B) *Porcelain Cameo Type*²: Cast a plaster mold from the gelatin as in the colored glaze type. Pour a porcelain slip over the relief in the plaster mold which will produce a highly translucent porcelain when it is fired. Allow to cast for several minutes. Scrape off level, leaving the porcelain slip in the indentures of the mold. Make perfectly smooth, pour a colored porcelain slip on the leveled surface, and then drain off the slip which leaves a thin coating of colored porcelain. Back up these two coatings with a porcelain body and allow to set until the whole piece releases from the mold. Dry the piece and fire to complete vitrification. When it is removed from the kiln, the original photograph will appear in a bas-relief. The photographic likeness in this case is caused by the variable thickness of the first coating, allowing the colored layer underneath to show through with varied degrees of intensity.

(C) *Translucent Type*: Make a plaster cast from a gelatin relief, and from this cast, make a plaster mold having the same relief as the original gelatin. Form a porcelain piece on this mold by any method desired, and dry and fire to complete vitrification. When it is removed from the kiln, there is no interesting photographic likeness visible to the eye. There is only a relief, which is the reverse of that on the original gelatin, but when a light is placed back of the piece, a perfect photographic likeness of high quality is reproduced. This results from the variable thickness of porcelain, which allows a variable intensity of light to shine through this translucent porcelain piece.

²W. D. Ford, "Producing Colored Designs on Ceramic Ware," U. S. Pat. 2,147,770, Feb. 21, 1939; *Ceram. Abs.*, 18 [5] 120 (1939).

Such translucent application so far is limited and is applicable only to porcelain lamp shades and similar ware.

III. Use of Photography in Industrial Ceramic Decoration

(1) Decalcomania³

There is little photography used in decalcomania work, but the photomechanical process (section II (4)) is applicable, and a variation of the dusting-on process (section II (2)) could be used in small production.

(2) Intaglio Printing⁴

The photomechanical process is used extensively in intaglio work. Hand work, however, is used generally in conjunction with the process.

The procedure for the process is as follows: Coat the copper plate or mold with a solution of egg albumen and ammonium bichromate, dry, and expose to light under a negative; the exposed portions become insoluble in water. Wash off the unexposed portion, and remove the copper plate to an etching vat. The plate is thus etched where the film has been removed by water and remains untouched under the remaining insoluble material. Place the copper plate in a suitable printing machine. Apply an ink, containing a ceramic stain, over the entire plate and remove by a metal scraper, leaving the ink in the etched portions. Press impression paper against the plate, thus printing on the design of the original photograph. Cut this print from the paper, place in position on the plate while the print is still sticky, and rub down with soft soap or glycerin which serves as a lubricant. Allow the ware to stand for some time, wash off the paper, and fire the ware.

(3) Silk-Screen Printing⁵

Immerse a clear thin sheet of gelatin in a weak solution of potassium bichromate and water until it becomes quite limp. Float it in this condition on a silk screen already stretched on a frame which is also immersed in the solution. Lift both from the solution and dry in a warm place. Dry the gelatin-coated silk screen in the dark. Expose this screen under a photographic positive of the original design, wash in water until all of the soluble gelatin is removed which leaves the exposed or hardened gelatin attached to the screen and again dry the screen.

Press the ceramic piece against the silk screen, and squeegee or force the ink through the portions of the silk screen on to the ware where the gelatin film has been removed, thus producing the original design.

The process is used in the enamel, glass, and pottery industries.

(4) Colored Glaze Decoration

This is an application of the colored relief glaze type (section II. (6 A)).

Use a positive instead of a negative so that a relief may be produced on the mold that will not wear away easily. Form the relief in a suitable wax and shape to the form of the ware.⁶ Back up this wax with plaster, and make a block mold from the wax model. Make a plaster cast of the mold (by the usual method to produce working molds). Make the ware from these molds and bisque. Apply a colored glaze, and again fire the ware. The decorated piece thus comes from the gloss kiln.

This process is adaptable to the pottery, glass, and enamel industries.

³G. H. Stapleford, "Manufacture of Ceramic Decalcomania." *Bull. Amer. Ceram. Soc.*, **15** (11) 383-91 (1936).

⁴G. H. Stapleford, "Intaglio Printing in Dinnerware Industry," *ibid.*, **17** [11] 447-50 (1938).

⁵G. H. Stapleford, "Silk-Screen Printing and Its Application to Dinnerware Industry," *ibid.*, **16** [5] 188-95 (1937).

⁶W. D. Ford, "Transferring Photographic Designs on Ceramic Ware," U. S. Pat. 2,181,452, Nov. 28, 1939; *Ceram. Abs.*, **19** [2] 40 (1940).

IV. Future Development Work

The photographic work developed in ceramics has been entirely the adaptation of photographic processes used in other fields. A general investigation should be made of the metallic salts, which are photochemical in nature and which at the same time produce color in ceramic applications. If suitable metallic salts were found practical, many new applications could be developed which would be better suited to mass production methods than the processes now used. A design, for example, could be printed on a dinner plate, the surface of which has been sensitized by such a metallic salt. The light projected on the sensitized surface would cause the metallic salt to become insoluble in a suitable developing solution, thus producing an image that could be fired into the glazed surface of the plate.

An investigation should also be made of organic emulsions which can be volatilized easily without disturbing the ceramic colorant.

In view of the information which has been presented, it is hoped that there will be an increase in the commercial applications of photography in ceramics.

Acknowledgment

The author wishes to express his thanks to A. S. Watts and A. E. Baggs for their valuable suggestions and criticisms.

Ford Ceramic Arts, Incorporated
4591 North High Street
Columbus, Ohio

Additional References

1. P. C. Duchochois, *Industrial Photography*. Schovill & Adams Co., New York, N. Y., 1893.
2. E. J. Wall, *Dictionary of Photography*. American Photographic Publishing Co., Boston, Mass., 1931.
3. Louis Derr, *Photography for Students of Physics and Chemistry*. Macmillan Co., New York, N. Y., 1913.
4. *Cassell's Cyclopaedia of Photography*, Bernard E. Jones (ed.). Cassell and Co., Ltd., London, 1911.
5. Edward L. Wilson, *Wilson's Cyclopaedic Photography*. E. L. Wilson, New York, N. Y., 1894.