



Etch Imitation System for Porcelain and Bone China (One-Fire-Decal-Method)

1 General Information

Etched decorations belong to the richest, most valuable precious metal designs to be found on tableware. However, etched decorations are not only work-intensive and expensive but they also require working with aggressive acids. Instead, producers work with etching imitation systems in which first a decal with a matt underlay and a bright relief on top is produced, applied onto the substrate to be decorated, and fired. Secondly, a liquid precious metal is applied by brush on top of the relief and the item is fired for a second time.

With this Technical Information, Heraeus Ceramic Colours introduces a one-fire-etch imitation system for decals. The new decoration system consists of carefully adjusted components: special underlay, special medium, relief, precious metal paste. The perfect harmony of these components allows the production of an imitation etching in one decal, which only needs to be transferred and fired once!

2 Firing Conditions

Substrate	Firing Conditions
Porcelain	800 - 820°C (1470-1508°F), 2 to 3 hours cold/cold
Bone China	800 - 820°C (1470-1508°F), 2 to 3 hours cold/cold

Worldwide there are many different glazes. The firing conditions differ from producer to producer. Pre-tests under own individual conditions are absolutely necessary.

3 Characteristics of the Products

The product composition and the production process determine the major product characteristics of the components of the decoration system. Testing each production lot guarantees a constant product quality.

With regard to the bright precious metal pastes of the system we regularly check the viscosity, the printing characteristics, the outline of printed test decorations as well as the precious metal colour shade and the brightness of the decoration after firing on a defined test substrate.



In case of the special underlay and the relief, we test eg. the grain sizes and the grain size distribution of each produced lot, the behaviour of the materials when pasted and the fired result in a test firing.

The statements concerning our products correspond to our current knowledge and experience. It is the obligation of the purchaser to examine the usefulness of the products in its intended use in each individual case. In order to prevent production losses the user has to test the preparations in connection with every other material being involved in the production process and has to be satisfied that the intended result can be consistently produced.

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3.1 Processing

Heraeus bright precious metal pastes are supplied ready to use. They can be processed without any thinning. The testing of each produced lot assures the consistent quality of our pastes.

The special underlay and the relief need to be pasted with the recommended pasting ratios and should be homogenized with a three-roll-mill.

3.2 Storage

Since bright precious metal products contain dissolved precious metals, there is practically no sedimentation. Nevertheless, bright precious metal products are subject to an ageing process. As a rule, the viscosity increases with the storage time. Therefore, we recommend storing bright precious metal pastes not longer than 6 months.

Bright precious metal pastes should be stored at room temperature (c. 20°C/68°F). Storage at approx. 7-14°C reduces the increase of viscosity during the storage.

3.3 Consumption

The average product consumption of bright precious metal preparations is approx. 0.15 to 0.20g / 100 cm², depending on the specific printing parameters (screen thickness, squeegee position, squeegee pressure).

4 Major Characteristics of Etch Imitation Decorations

Major characteristics of an imitation etch decoration are the brilliance of the metal film, the metal colour shade, the resistance of the decoration in dishwashing machines as well as the mechanical and chemical resistance.

These characteristics are determined by a number of factors. High quality products and the fine matching of the components (underlay, relief and precious metal preparation) are necessary to achieve a good fired result. Apart from the components the application, the glaze of the substrate and the firing conditions also play an important role. The variation of one factor, for example the firing conditions, can significantly affect the fired result.

We have tested the etch imitation system introduced in this technical information sheet on different porcelain and Bone China substrates. However, the diversity of different types of glaze and firing conditions worldwide does not allow simple general statements about the achievable decoration quality. All following descriptions can only be seen as approximate information achieved under our test conditions. The system needs to be tested under the user's own individual conditions.

4.1 Mechanical Resistance

Test decorations showed a good mechanical resistance. Tests under ones own individual conditions are essential.

4.2 Dishwasher Resistance

All details as to whether decorations are dishwasher resistant or durable are to be regarded as approximate values, as test results vary widely according to the type of dishwasher, washing programme, washing-up detergent, water quality and firing conditions. To avoid defective production, the user should test the colours in connection with materials involved in further processing and determine whether the desired dishwasher proof or resistant decorations are achieved.

Heraeus tests whether finished decorations are dishwasher resistant or durable, roughly following the test-washing programme of the Technical Standards Committee for Material Testing (Fachnormenausschuss Materialprüfung, FNM) in a Miele continuous dishwasher.

If a decoration withstands 500 washing cycles essentially without damage, we designate it as dishwasher durable. If it withstands 1000 washing cycles, we designate it as dishwasher resistant.

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In our tests, etching imitation decorations reached the level of dishwasher durability. Tests under ones own individual conditions are essential.

4.3 ASTM Resistance (ASTM C676-93)

We test decorations in a 0.3% sodium carbonate solution at a temperature of 98°C ($\pm 1^\circ\text{C}$). After 2 hours, the plate is taken out of the solution, rubbed with a piece of cloth and checked for attacks. This process is done totally three times. A decoration passes the ASTM test if it shows no attack after 3 x 2 hours in the test solution.

Test decorations passed 4 hours in the test solution. Tests under ones own individual conditions are essential.

4.4 Heavy Metal Release

We test the heavy metal release of a decoration according to DIN EN 1388-1-2. This means that the decoration surface to be examined is exposed to the attack of an acetic acid solution with a volume concentration of 4% in darkness for 24 hours at a temperature of $22 \pm 2^\circ\text{C}$. Subsequently, the mass concentrations of lead and cadmium in the extraction solution are determined.

The special underlay as well as the relief is produced without addition of lead. Etching imitation decorations are resistant according to DIN EN 1388-1-2. Tests under ones own individual conditions are essential.

5 Application Recommendations

Work in a well-ventilated room. Good printing conditions occur at a room temperature of 20 to 25°C and a relative humidity of c. 60 %.

Screens and squeegees have to be cleaned directly after use. We recommend our screen cleaner V 34. This special screen cleaner prevents blocking of the fine screen structure and prolongs its lifespan.

5.1 Production of an Imitation Etch Decal

Pasting of the special underlay with special medium in a ratio of

100 : 45 parts by weight (Bone China, underlay : special medium)

100 : 50 parts by weight (Porcelain, underlay : special medium).

The paste has to be homogenised with a three-roll mill.

Printing of the special underlay with a 130-34 – 150-31 polyester screen.

Drying over night at room temperature (c. 20°C/68°F).

Pasting of the special relief with special medium in a mixing ratio of 100 : 55 parts by weight (relief : special medium). Paste has to be homogenised with a three-roll mill.

Printing of the relief with a 230 to 300 mesh stainless steel or a 54-64 – 77-48 polyester screen.

Drying at room temperature (c. 20°C/68°F). We recommend drying over night.

Printing of the bright precious metal paste with a 120-34 polyester screen.

Drying. We recommend drying over night.

Printing of covercoat L 418 with a 32-120 polyester screen.

Drying at room temperature (c. 20°C/68°F). Finished etch imitation decals should be used within four weeks.

Important note! Do not print special underlay for reserve stocks! It is not possible to store decals printed with a special underlay in order to print the bright gold paste at a later date. Generally, fresh preparations should be used!

5.2 Transfer of the Decals onto the Object to be Decorated

The decals to be transferred have to be steeped in water (water temperature: 18 to 25°C/64 to 77°F). Decals can be released faster from the decal paper if the steep water is slightly warmed.

If the steep water is too cold, decals are released only with difficulty from the decal paper and - during transfer of the decal - cracking of the precious metal decoration can occur. If the steep water is too warm, the decals become too soft and accurate application is difficult. There is also a tendency for the covercoat film to shrink during drying.

The steep water should be changed regularly. If the steep water is too much polluted with glue residues, the glue quantity remaining on the decal will be too high. Glue residues below or on the transferred decal can lead to a spotted gold film or to pin holes.

After thorough steeping, the decals can be removed from the water and slid from the decal paper onto the object to be decorated. We recommend warming up the objects a little before decoration (25 - 30°C/77 - 86°F). This prevents the risk of cracking of the precious metal decoration, especially when decorating curved objects.

The transferred and adjusted decal has to be pressed carefully onto the object with a squeegee. The squeegee should be used from the centre to the edge of the decal to allow water residues, dextrin residues and air bubbles to escape.

Afterwards the surface of the decal should be cleaned with a damp sponge. Glue residues on the decal can lead to a bad firing result of the precious metal decoration (brown spots, "Pearl Strings").

The decorated ware should be dried for 16 to 24 hours at room temperature (20 to 22°C /68 to 72°F).

5.3 Firing of the Decals

During the heating up phase the organic components burn off. This process is completed at approx. 400°C (750°F). The gold film is formed. A constant slow increase in temperature, enough oxygen and sufficient ventilation are decisive for the quality of the fired precious metal decoration.

The maximum firing temperature and the soak time have an important influence in the adhesive strength of the fired decoration. The substrate, as well as the form of the object determines the maximum firing temperature. As a rough rule of thumb: The higher the firing temperature the better the adhesive strength.

The rate of cooling has not as great an influence on the quality of the gold decoration as the firing temperature and the soak time. Nevertheless the firing process should not be stopped abruptly after the soak time. If the cooling rate of the decorated object is too high the glaze tends to crack.

6 Frequent Faults, their Causes and Ways of Avoiding them

Fault	Possible Cause	Remedy
Inhomogeneous surface	Layer of the printed special underlay is too thin.	We recommend printing the underlay with a 130-34 – 150-31 polyester screen.
Dull, matt fired precious metal layer on top of the underlay.	Print of the underlay is too thin.	We recommend printing the underlay with a 130-34 – 150-31 polyester screen.
Cracking of the decoration.	Underlay was pasted with too little medium.	We recommend a mixing ratio of 100 : 45 to 50 parts by weight (underlay : medium).
	Water residue and air bubbles could not escape.	Decal should be pressed carefully onto the object with a squeegee.
Firing disturbances, dark spots in the fired decoration.	Underlay was pasted with too much medium.	We recommend a mixing ratio of 100 : 45 to 50 parts by weight (underlay : medium).
	Decal was not cleaned after application.	Clean surface of the decal with a damp sponge.
Screen structure can be seen in the decoration.	Underlay was not dry enough before the print of the relief.	Drying over night at room temperature (20°C/68°F).
The relief chips off.	The relief was printed too thin.	We recommend printing the relief with a 230 to 300 mesh stainless steel screen.
	Wrong medium was used.	Use medium Nr. 238/3.
Pinholes in the relief. Partial chip offs.	The relief was pasted with too little special medium.	We recommend a mixing ratio of 100 : 55 parts by weight (relief : special medium).
No sharp outline. Brightness and brilliance missing.	The relief was pasted with too much medium.	We recommend a mixing ratio of 100 : 55 parts by weight (relief : special medium).
Screen meshes visible. Pinholes.	The relief was not dry enough when overprinted with the bright precious metal paste.	We recommend drying over night, before the metal paste will be applied.
Non-optimal fired metal film.	Precious metal deposit is too thin.	We recommend printing the precious metal paste with a 120-34 (305 mesh) polyester screen.
Matt and spotty fired metal film after firing.	Print of the precious metal paste is too thick.	We recommend printing the precious metal paste with a 120-34 (305 mesh) polyester screen.
	Decal was not cleaned after application.	Clean surface of the decal with a damp sponge.
Screen structure visible. Non-optimal fired precious metal film.	Precious metal layer had been still to humid when overprinted with covercoat.	We recommend drying over night at room temperature (20°C/68°F).
Cracks, firing disturbances	Surface of the decal paper is too rough.	We recommend the usage of a decal paper with a smooth surface.
Ugly precious metal film after firing, lack of adhesion, cracks.	Usage of an unsuitable precious metal paste.	See product recommendation in section 7.

The statements concerning our products correspond to our current knowledge and experience. It is the obligation of the purchaser to examine the usefulness of the products in its intended use in each individual case. In order to prevent production losses the user has to test the preparations in connection with every other material being involved in the production process and has to be satisfied that the intended result can be consistently produced.

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Fault	Possible Cause	Remedy
Cracks.	Firing temperature is too high and/or firing cycle is too long.	In our tests we achieved good fired results with firing temperatures of 800-820°C (1470-1508°F). A good fired result depends on the combination of the glaze of the article to be decorated, the firing temperature and the firing cycle. Therefore firing test under ones owns individual firing conditions are essential.
	Underlay and relief paste was too old when both were processed.	Please generally work with freshly pasted underlay and relief paste.
Bad adhesion, dull and matt precious metal decoration.	Firing temperature is too low and / or firing cycle is too short.	In our tests we achieved good fired results with firing temperatures of 800-820°C (1470-1508°F). A good fired result depends on the combination of the glaze of the article to be decorated, the firing temperature and the firing cycle. Therefore firing test under ones own individual firing conditions are essential.

7 Products

We offer the etch imitation system as a product set. All components of the decoration set have been tested intensely in our application lab to find components that interact perfectly with each other. And this perfect interaction is essential for the printing of a good decal and an optimised fired result of the etch imitation decoration.

Even though the components are matched with each other, it is essential to run firing tests with a printed decal under ones own individual firing conditions. Glaze, firing temperature, firing cycle and the conditions in the kiln strongly influence the fired result and therefore need to be checked from case to case. If need be the firing conditions might require an adjustment. Our application technicians are at your disposal and can help you with advice. An etch imitation product set consists of the following products: precious metal paste, special underlay, special relief, special medium and a well-suited covercoat.

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8 Etch Imitation for Porcelain (One-Fire-Decal-Method)

Precious Metal Preparations

Colour	Product	Precious Metal Content	Remarks
lemon yellow	GGP 2614/EI	12%	-
lemon yellow	GGP 2615/EI	10 %	-
yellow	GGP 2453/EI	12%	-
white	GPP 4605/EI		-

Special Underlay and Relief

Number of Colour	Name of Colour	Firing Temperature approx.	Appearance after firing	Requirements				Remarks
				contains silver	lead free (< 300 ppm)	cadmium free (< 200 ppm)	resistant DIN EN 1388-1-2	
H 55080	White	800-820°C	matt		●	●	●	Special matt underlay for the single fire etch-imitation-system for porcelain
H 55090	White	800-820°C	Bright		●	●	●	Bright relief for the single fire etch-imitation-system for porcelain

Auxiliary Materials

Screen Printing Medium	Viscosity ¹⁾	Solids Content approx.	Thinner	Material Compatibility						Remarks
				Porcelain	Bone China	Vitreous China	Earthenware	Glass	Enamel	
Nr. 238/3	76-83 / 3 mm	42%	V 167		●	●	●	●	●	Special medium for the single-fire-etch-imitation-system for pasting off the special underlay and bright relief

1) flow time in seconds measured in a DIN cup, temperature: c. 20°C/68°F

Covercoat	Block resistance	Viscosity ¹⁾	Thinner	Solids Content approx.	Material Compatibility						Remarks
					Porcelain	Bone China	Vitreous China	Earthenware	Glass	Enamel	
L 418	not block resistant	62-67 / 8 mm	V 41	46%	●	●	●	●	●	●	Film stable covercoat for multiple use, higher expansion than L 406, long shelf life of the decals, excellently suitable for extremely thick layers in single printing process

All covercoats are also available in thixotropic form

1) flow time in seconds measured in a DIN cup, temperature: 20°C/68°F

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9 Etch Imitation for Bone China (One-Fire-Decal-Method)

Precious Metal Preparations

Colour	Product	Precious Metal Content	Remarks
yellow	GPP 2453/EI	12%	-
white	GPP 4452/EI		-

Special Underlay and Relief

Number of Colour	Name of Colour	Firing Temperature approx.	Appearance after firing	contains silver				Remarks
				lead free (< 300 ppm)	cadmium free (< 200 ppm)	resistant DIN EN 1388-1-2		
H 55060	white	800-820°C	matt	●	●	●	Special matt underlay for the single-fire-etch-imitation-system for Bone China	
H 55070	white	800-820°C	bright	●	●	●	Bright relief for the single-fire-etch-imitation-system for Bone China	

Auxiliary Materials

Screen Printing Medium	Viscosity ¹⁾	Solids Content approx.	Thinner							Remarks
				Porcelain	Bone China	Vitreous China	Earthenware	Glass	Enamel	
Nr. 238/3	76-83 / 3 mm	42%	V 167		●	●	●	●	●	Special medium for the single-fire-etch-imitation-system for pasting off the special underlay and bright relief

1) flow time in seconds measured in a DIN cup, temperature: c. 20°C/68°F

Covercoat	Block resistance	Viscosity ¹⁾	Thinner	Solids Content approx.							Remarks
					Porcelain	Bone China	Vitreous China	Earthenware	Glass	Enamel	
L 418	not block resistant	62-67 / 8 mm	V 41	46%	●	●	●	●	●	●	Film stable covercoat for multiple use, higher expansion than L 406, long shelf life of the decals, excellently suitable for extremely thick layers in single printing process

All covercoats are also available in thixotropic form

1) flow time in seconds measured in a DIN cup, temperature: 20°C/68°F

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