Bright Precious Metal Preparations for Thermoplastic Screen Printing on Glass

1 General Information

Thermoplastic decoration materials - precious metal and decoration colours – will be printed with heated screens. They solidify after application.

That is why it is possible to realize complete surrounding prints of cylindrical glass and ceramic articles.

Thermoplastic bright gold and bright platinum pastes are used for the decoration of glass (e.g. beer glass decoration). However, preparations can also be used on ceramic articles (e.g. mugs).

Heraeus offers thermoplastic bright gold and bright platinum pastes with different precious metal contents.

2 Standard Firing Range

Substrate Type	Firing Range	
• Soda Lime Glass	560 - 620°C	(1040 - 1150°F)
• Borosilicat Glass	580 - 610°C	(1080 - 1130°F)
• Earthenware	600 - 650°C	(1112 - 1202°F)

The firing result depends on the firing temperature, on the total firing time, the soak time and not least on the glass type. To achieve an optimized firing result, we therefore recommend the user to check under his own individual conditions.

3 Properties Of The Preparations

The major characteristics of a Heraeus precious metal preparation are determined by its production recipe. From each lot produced, we take a sample and check defined characteristics.

In case of screen printing preparations, before firing, we check the physical properties (e. g. viscosity, thixotropy) and the application properties (e. g. printing properties), compared to a predefined standard. After firing under defined conditions, we check the optical properties (e.g. gloss level and colour). Controlling each single production lot assures the highest product quality and lot-to-lot stability.

3.1 Processing

We supply bright precious metal preparations for thermoplastic screen printing ready to use.

Screen printing pastes have a thixotropic nature in order to reach their printing properties. In some cases, the preparations reach their typical processing viscosity only under mechanical stress, that means by a certain print speed. Thixotropic pastes allow for printing fine lined decorations with a sharp outline.

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3.2 Storage

Also bright precious metal products are subject to an ageing process. As a rule, the viscosity increases with the storage time. Therefore, we recommend to use the bright gold preparations within 9 months and the bright platinum preparations within 6 months. They should be stored at room temperature (approx. 20°C / 70°F).

Storage at 7-14°C / 45-57°F reduces the increase of viscosity during the storage.

3.3 Consumption

The material consumption depends on the thickness of the applied precious metal layer. Under our conditions, the consumption is approx. 0.15 to 0.30 g /100 cm² .

4 Properties Of Finished Decorations

Besides their colour intensity and brilliance, the important properties of fully fired colour decorations are their resistance to mechanical and chemical attack .

The properties of finished decorations are influenced by a number of factors. The high quality of the colour used is an absolute prerequisite for the manufacturing high-quality decorations. The quality of a fired decoration, however, derives from the interplay of colour, application, substrate surface and the firing conditions. A variation in one factor – for instance, the firing conditions – has an influence in that it leads to altered properties of the fired decoration.

We processed the bright precious metal preparations under defined conditions. Then we determined the properties of the finished decorations. The following data indicate achievable quality features for the finished decorations manufactured with bright precious metal preparations. However, the user must always test the products under his own individual conditions.

4.1 Dishwasher Durability

All details as to whether decorations are dishwasher 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. Heraeus tests the dishwasher durability of glass decorations under defined test conditions in a Winterhalter Gastronom GS 29 with an automatic proportion of the detergent and the clear rinse (see technical information Nr. 9.11 „Behaviour of precious metal decorations in the dishwasher“).

Precious metal decorations on glass usually do not achieve the resistance of a similar decoration on ceramics. If a decor withstands 200 wash cycles under our conditions essentially without damage, we designate it as dishwasher durable.

Although, as mentioned above, many factors have an influence on the dishwasher durability, choosing the „right“ product is essential for a dishwasher durable decoration. In the product overview, the most reliable products are designated as “dishwasher durable”. The user must test the required properties under his own conditions.

4.2 Silver Containing Precious Metal Preparations

To achieve lemonish, light yellow and yellow gold decorations, silver is added to the formulation of precious metal preparations. Under certain unfavourable external circumstances, silver containing precious metal decorations can change their appearance in the course of time. Especially the contact to cardboard boxes, high humidity and high temperature support the reaction of silver to silver sulphide. Therefore, the user must individually check the suitability of a silver containing preparation.

Products with a higher silver content are labeled as “silver containing”. We recommend the hermetical packaging of items decorated with precious metal preparations we describe as “silver containing”, and to prevent direct contact with cardboard boxes. To exclude any risk, we recommend using yellow red gold preparations.

4.3 Precious Metal Colour On The Reverse Side Of Glass

Precious metal decorations on glass often show a red discoloration on the reverse side. The tendency to this kind of red discoloration is strongly related to the chemical formulation of the glass itself, but is also influenced by the

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precious metal product used and the kiln atmosphere during firing. Under our conditions, the mentioned products proved to be insensitive to this effect.

5 Application Recommendations

5.1 Conditions Required For Good Results

- Make sure that the surface of the object to be decorated is clean and dry. Dust, fingerprints and water condensation can affect the decoration while firing.
- Take care that the objects to be decorated are not taken from a cold store into a warm shop. A fine condensation film may occur, which is not visible to the naked eye. This results in firing disturbance (pinholes) in the fired precious metal decoration. Allow enough time so that they can adjust to the decoration room temperature.

5.2 Influencing Factors

A number of parameters can influence the decoration quality and need to be considered when choosing the precious metal product.

- Chemical composition of the glass
- Application of the precious metal decoration onto the glass
  Especially critical for the decoration is for example the rim of a drinking glass. Before applying a precious metal product to the rim of a drinking glass, we recommend making your own tests.
- Glass coating can impair the precious metal decoration
  Glasses are produced with inorganic and organic coatings, in order to minimize friction or damage of the glass surface during transport. Moreover, coatings are applied very unevenly. This can lead to quality loss with regard to brightness, colour shade and adhesion.
- Firing range (see recommendation under point 2).

5.3 Basic Information on Products, Screens And Squeegees

- Work in a well-ventilated room. Good printing conditions occur at a room temperature of 20 to 25°C / 68-77°F.
- For printing the thermoplastic bright gold- and bright platinum paste, a 425 - 500 mesh steel screen should be used.
- For a good printing result, it is important to have a well sharpened squeegee (hardness: 60-75° shore).

5.4 Screen Heating

- To print thermoplastic bright gold and bright platinum preparations, the surface of the screen must be heated up to a constant temperature of 65 to 75°C / 150-167°F.

Because of the risk of unwanted modifications of the preparations, thermoplastic precious metal preparations should not be heated up to more than 90°C / 194°F.

5.5 Printing Process

- Apply the thermoplastic precious metal preparation on the heated screen.

  The thermoplastic precious metal preparation can be applied as granulate on the heated screen (65 up to 75°C/ 150 up to 170°F). Depending on the applied quantity, the preparation melts within 5 to 10 minutes and becomes printable.

  As an alternative the precious metal preparation granulate can be pre-melted on a heated plate (65 up to 75°C/ 150 up to 170°F) or in a drying cabinet and applied in melted condition to the screen. For a quick refill of the paste during the printing process, anyway we recommend to pre-melt the preparation.

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Apply an appropriate quantity of the preparation onto the screen, so that the screen will be "flooded" with one squeegee motion. As a matter of principal the screen can be provided generously with preparation. A significant increase of viscosity during the printing process has not to be apprehended. Nevertheless the preparation should not be applied more than necessary on the screen for the complete printing process, because the preparation is subject to a certain ageing process.

5.6 Firing Of The Decoration

- During the first heating phase the organic components of the preparation burn off. This process is completed at approx. 400°C (750°F). The gold film is formed. A constant, slow temperature increase, enough oxygen and sufficient ventilation are decisive for the quality of the fired precious metal decoration.
- The firing profile considerably influences the mechanical and chemical properties of the fired decoration.
- The rate of cooling has no major influence on the quality of the gold decoration, unlike the firing temperature and soak time. However, the firing process should not be stopped too abruptly after the soak time. If the rate of cooling is too fast, there may be a danger of damaging the article (cracks and broken glass).

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6 Frequent Faults, Their Causes And Ways Of Avoiding Them

Fault	Possible Cause	Remedy
Streaks in the printed precious metal film	The squeegee is possibly scratched	Exchange or sharpen the squeegee
Squashed print	The squeegee is not sharp or it is worn out	Exchange or sharpen the squeegee
spots, firing disturbance	Objects were soiled by dust, finger marks or water drops before printing	clean the object before decorating
	problems in the kiln such as: • furnace atmosphere reduction • insufficient ventilation • too quick heat up in the critical phase between 200-400°C (390-750°F) • too many objects in the kiln	 • increase air addition • improveme ventilation • reduce the heating speed • reduce the number of objects in the kiln
Fired result is blotchy or matt	Screen used is too coarse; printed layer is too thick	we recommend a 425-500 mesh steel screen for printing the thermoplastic precious metal preparations
Blurred outline after precious metal has been fired (spreading or running)	too many objects in the kiln	reduce the number of objects in the kiln
Paste will not print properly	Screen temperature was too high. Product has been stored for too long.	Remove product from the screen (=> recycling). Cleaning the screen and print with fresh preparation. Be sure that the screen temperature is 65 -75°C (150° - 170°F).
Precious metal flakes off during firing	Printed layer was too thick.	Reduce thickness of applied film.
Fine pinholes	moisture on the objects before decoration leads to firing faults (pinholes)	give the ware enough time to acclimate to the temperature of the decoration shop and so a possible condensation film to evaporate
low mechanical resistance of the precious metal decoration	firing temperature was too low	increase firing temperature
	printed layer is too thin	Use 425-500 mesh steel screen to print thermoplastic precious metal preparations

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Fault	Possible Cause	Remedy
screen is clogged	Product is not sufficiently molten	Stop printing and allow the product to melt thoroughly. Check screen temperature. We recommend pre-melting thermoplastic precious metal preparations in a drying cabinet at 80°C / 175°F.
	Localized cooling of the screen	Check the screen's heating system.
red/very dark backside of the precious metal decoration	coating of the glass	Eventually, the organic coating of glass is to be removed by pre-firing
	Kiln atmosphere	Eventually adjust the firing profile

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