

Technical Information



# Container High Class Glass Decoration

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# Ferro: enhancing life through superior materials performance

Headquartered in Mayfield Heights, Ohio, USA, Ferro Corporation is a world leading producer of Performance Materials, with operations in 20 countries across Europe, Asia and the Americas.

We apply core technologies in organic and inorganic chemistry to develop leading market positions in a diverse range of industries.

Our mission is “to achieve market leadership through a customer-focused and highly creative organisation committed to delivering top quality products and outstanding services to customers worldwide”.

Our materials are used to add value to, and to improve the performance of products in a variety of end markets including building and renovation, home appliances, cookware, giftware and tableware, transportation, household furnishings, leisure, electronics and industrial products.

We are among the world’s leading suppliers of ceramic glazes and colors, glass decoration, speciality glasses and porcelain enamel coatings. We pioneered the development of forehearth color technology for coloring of glass.

Our global commitment to quality, reliability, innovation and personal customer care is founded on over 80 years of experience in serving the changing needs of industry, from our international network of manufacturing plants and service centres. Our commitment to quality management has been recognised with the award of ISO9001 accreditation to all of our global manufacturing and research facilities.

Meeting the needs of the Color World calls for great foresight, flexibility and innovation ...

- Our global presence is a strong competitive advantage. Technical, marketing and management personnel are in continuous contact with customers in every major region. Multinational customers can be assured of standard products and consistent quality wherever they have operations.
- We co-ordinate our R&D activities globally and use our international talent to ensure that product specifications and performance are designed to satisfy the specific requirements demanded by regional markets.
- Ferro views the world-wide concern for the environment as an opportunity to develop improved products and also to participate in chemical industry efforts to address public concern. Environmental concerns are a major driving force behind the evolution of our lead- and cadmium-free technology and our low VOC decoration systems.

- The markets we cover are extremely service-intensive. Ferro has established regional color matching, blending/pasting and technical support facilities, to provide the level of service demanded by our customers in all time zones.

Think of us as High Performance Partners to manufacturers around the world ...

... Helping to create and enhance many of the products you use and enjoy every day of your life.

# Technical Information

HGS01



## Organic inks for Container Glass Decoration

In this technical information leaflet Ferro presents the organic inks.

### Introduction

Ferro's organic inks are thermal cure organic screen print inks:

- single component inks (1 pack systems)
- vibrant color range
- no heavy metals
- low VOC
- higher mileage than ceramic inks
- cure at lower temperature than glass enamels

Organic inks are available in two forms:

#### HTP Series inks

- solid form, thermoplastic inks
- for both single and multi-color application
- formulated to give good adhesion to the glass
- additional colors can be immediately over-printed using high-speed decorating machines

#### RTP Series inks

- paste form, liquid at room temperature
- single print applications
- can also be used with HTP Series inks in multi-print applications as the final print

### Main market segments

Ferro's organic inks are used in the following market segments:

- Cosmetics and perfume containers
- Giftware and advertising specialties
- Tumblers and household containers; tableware
- One way bottles (Wine, Liquor, Vodka and other beverage bottles)
- Multi-trip returnable bottles
- Appliance and decorative flat glass

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## Legislation

Ferro's organic inks are heavy metal free and are therefore in compliance with the following legislations:

- Packaging and Packaging waste Directive 2004/12/EC
- CONEG Legislation
- TSCA
- Proposition 65

## Bisphenol A Migration

The base resin of our inks is an epoxy. Epoxy resins are manufactured from Bisphenol A. Following regular requests from our customers, Ferro has conducted a series of Bisphenol A migration tests with a number of organic inks at an independent scientific laboratory.

The glass slabs were prepared such that a typical spread of pigments (inorganic, organic) and cure conditions 180°C to 200°C were covered. Result of that study was that Bisphenol A migration could not be detected under any set of conditions. A detailed report is available upon request.

## Preparation of ink and substrate

### HTP Ink melting and handling

- Temperature control of the HTP organic ink is absolutely critical.
- A minimum amount of heat should always be used when melting and printing. Excess heat in pots or on screens will shorten the lifetime of the ink.
- Inks should be melted in a forced air oven. If one is not available, a convection oven can be used. Alternatively, the ink pot could be immersed in a hot water bath.
- Do not apply direct heat. Application of direct heat, such as from a microwave, hot plate or burner, will cause curing and hardening of the product.
- The ink block should be broken into small pieces to be melted. Smaller pieces will melt more quickly due to higher surface area.
- During melting and printing, ink temperature should be monitored regularly via thermocouple or infrared pyrometer (IR heat gun).
- Temperatures must be checked before, during and after printing; screen temperature can increase when the machine is stopped. If temperature is not checked, screens may be overheated and ink may cure.

Suggested starting points for ink melting and printing are as follows:

## Ink Temperature

Ink pot temperatures

- HTP ink: 70°C to 80°C
- RTP ink: 21°C to 40°C

Screen temperatures

- HTP ink print: 80°C to 90°C
- RTP ink: 25°C to 50°C

## Glass substrate preparation - Tableware

- Glass must be clean, dry and free from greases, oils, dust and other contaminants.
- If manually transferred, all glassware coming from the production line should be palletized and covered before transporting to the printing feed area.
- Glass must not be handled with bare hands. Handling without gloves may transfer oil, dirt or grease to the printing panel, which may result in poor printing.
- Make sure the loading table, guide rails etc. are oil and grease free.
- Ink transfer to cold glassware may be difficult. Recommended glass temperature is 30°C. Temperature should not exceed 40°C and not go below 27°C.

## Glass substrate preparation - Bottles

In addition to the above mentioned recommendations for glass tableware, we do emphasize the following parameters for the decoration of bottles:

### Hot end coating

Tin oxide, a hot end coating (HEC) is recommended. An application thickness of 20-40 CTU's (coating thickness unit) is recommended for use with Ferro's organic inks. If a hot end coating is not applied as recommended, adhesion of the organic inks may not be optimal and the decorated bottle may not meet performance requirements.

### Cold end coating

If a cold end coating (CEC) must be applied prior to decoration (post-annealing lehr), we recommend a very light application of stearate based cold end coatings. Cold end coatings based on polyethylene or oleic acid are known to cause adhesion problems with the cured print. Adhesion performance can be negatively affected when the cold end coatings are heavily applied.

Cold end coatings of any type may be applied to the printed ware if desired; no limitations exist for post-decoration cold end coating application.

Ferro recommends Arkema's Tegoglas T5 cold end coating. A 0.2% concentration of T5 in deionized water is recommended. If the cold end coating is not applied as recommended, adhesion of the ® organic inks may not be optimal and the decorated bottle may not meet performance requirements.

## Pretreatment

Ferro does not require the use of pretreatment with our organic inks to achieve optimal performance.

## Printing

Ferro's organic inks can be used on the existing printing machines and equipment already used with traditional inorganic glass enamels.

### Heatable stainless steel screen

- Mesh: 270 – 325 mesh
- for Metallic colors: ~160 mesh
- for Halftone printing and 360° surface printing (full wrap): 350 – 425 mesh

### Screen tension

- 15N/cm<sup>2</sup>

### Screen temperature:

- 80°C-90°C
- Temperature control during the printing process is important
- Attention: never increase the screen temperature in order to reduce the ink viscosity as the ink might polymerize!

### Screen sequence

Dependent on the design

- Small color areas at first color
- Large color print at last color

### Off contact

- 2 to 6 mm
- screen must not be in contact with the glass substrate

### Squeegee

- Durometer: 70-80 shore hardness, particularly for multi-color designs.
- Pressure: in order to avoid ink pick-off with multi-color designs, the minimum squeegee pressure required to transfer the ink to the glass is recommended.
- Heated squeegees are recommended. Information on suppliers of heatable squeegee holders is available upon request. If heated squeegees are not available, squeegees may be warmed by placing them into contact with the screen when the machine is stopped.

## Overprinting

Thanks to the outstanding opacity of our organic inks, it is not necessary to utilize a white base print. Intense colors can be achieved individually by side-by-side printing. Fine details such as letters and thin lines can still be overprinted.

## Thinning

Ferro's organic inks are ready-to-use and do not need any dilution. The pure ink is considered as touch-dry after print.

In certain circumstances, adding our Thinner 001 HTP/RTP might help to reduce the necessary screen temperature during the printing process. The addition of this thinner will affect the tackiness of the ink after print which means that the ink becomes sticky.

For more detailed information, please contact your regional technical service representative.

## Cleaning

Clean-up solvents typically used with ceramic enamels may not be effective. Solvents such as paint thinners, kerosene, mineral spirits, turpentine, or hydrocarbon based solvents are not recommended.

Clean-up solvents recommended for inks, depending on environmental regulations are:

- Acetone, MEK, alcohols
- DBE (di-basic ester) for hot screens

Cleaning of HTP ink on squeegees is usually done by putting them into a freezer and by peeling off the ink when frozen. Alternatively the dirty squeegee may be put into the oven at 70°C to 80°C. The hot ink can then be easily wiped off.

## Curing

HTP and RTP inks are formulated to cure completely when the temperature of the glass reaches 200°C. Time and temperature can vary depending on factory conditions.

For complete curing and best performance, organic inks and the substrate must reach a temperature of about 200°C. In forced air ovens and Lehrs a recommended starting point cure cycle is 20 minutes at 200°C. The actual time necessary to cure the coating is dependent on the heat transfer rate of the oven or Lehr and the size, shape and thickness of the glass. Best results are obtained when the heat is applied as quickly as possible.

Heat tapes can be used to check the glass temperature and adjust the Lehr accordingly. Glass temperature must reach 191°C to 204°C and remain there for at least 15 to 20 minutes. Temperature tapes are recommended as an easy way to determine peak bottle temperature reached.

An oven tracking system, such as a DataPaq Q1860A data logger unit, is highly recommended. A unit of this type should be used to check Lehr temperatures, record temperature profiles and to determine the appropriate cure profile.

When curing the organic inks in a traditional glass Lehr, a typical profile may only require heat in the first few zones. The latter zones may not be needed. Typically the curing of organic inks will only require the operation and heating of 2 to 4 zones. Slow heat-up profiles that are often used for ceramic enamels to ensure good medium burn-out are not needed with organics because there is nothing to burn out. Slow profiles may give poor results by delaying full cure and allowing the prints to flow.

The application of too much heat can cause organic inks to decompose or yellow. This will be most evident in white or lighter colors. This can be corrected by reducing temperature, increasing the volume of glass, or speeding up the belt.

## Test parameters

To ensure decorated ware meets quality specifications, there are several QC tests that can be performed by the decorator. Tests recommended are as follows:

### Cross Hatch Adhesion test

If the inks have been properly applied and cured, test result should be "Pass". (Equivalent to "4B" per the ASTM guideline)

### Solvent rub test

If the inks have been properly applied and cured, test result should be greater than or equal to 50 acetone/MEK double rubs.

### Pencil Hardness

If the inks have been properly applied and cured, test result should be greater than or equal to 4H.

### 24 hour soaking test in ethanol, G1 and cold water

If the inks have been properly applied and cured, test result should be "Pass".

*Note: These quality control tests are provided as a guide for determining adequate cure of the inks. Cure performance does not necessarily imply suitability for a given application. Suitability of the ink performance must be determined by the decorator and the customer.*

## Consumption

Compared to glass enamels the same design decorated with an organic ink will cover approx. more area per kg.

The ink deposit varies according to the application and design.

As our organic inks are opaque there is no need of a white underlayer. This reduces the amount of white color enormous.

For an approximate calculation following values can be helpful: using 270 and 325 mesh size the consumption should be approx. 0.03 to 0.02 g/cm<sup>2</sup>.

## Storage

**RTP (Room temperature printing) liquid inks** Product must be stored in cool and dry conditions. The storage temperatures should not be below 10°C and not exceed 22°C. Shelf life will decrease with increasing storage temperature. Settling may occur if stored for long periods of time. Prior to use, products must be stirred thoroughly. Partly used containers must be tightly sealed after use. If stored as recommended, a minimum shelf life of six months after the production date is guaranteed.

**HTP (High temperature printing) hot melt or thermoplastic inks** Product must be stored in cool and dry conditions. Storage temperature should not exceed 22°C. Storing in refrigerated conditions is recommended and will increase shelf life. Recommended storage is in a refrigerator or freezer, with storage temperature not to drop below -7°C. Inks that have been melted for use should be used completely. Melted inks cannot be stored for later use. If stored as recommended, a minimum shelf life of six months after the production date is guaranteed.

## Range of products

- RTP inks:** A full range of vibrant opaque colors covering the Pantone spectrum are available in liquid paste form (no transparent colors available). A very large number of color matches do already have existing commercial references. Please contact your regional technical service representative at Ferro for more information!
- HTP inks:** A full range of vibrant opaque colors covering the Pantone spectrum are available in thermoplastic form. A very large number of color matches do already have existing commercial references. Please contact your regional technical service representative at Ferro for more information!
- Kristal inks:** Transparent HTP inks – standard color palette:

SAP code	Product name
1411271	GSOR DE 91-3001 KRIS Green 1 HTP
1411270	GSOR DE 91-3002 KRIS Green 2 HTP
1411274	GSOR DE 92-3001 KRIS Blue 1 HTP
1411273	GSOR DE 93-3001 KRIS Yellow 1 HTP
1411272	GSOR DE 97-3001 KRIS Red 1 HTP
1411275	GSOR DE 97-3002 KRIS Red 2 HTP
1411276	GSOR DE 98-3001 KRIS Violet 1 HTP

All color prints are provided as an indication of the shade only.

- Metallic effect inks:** available in HTP such as:

SAP code	Product name
1411280	GSOR DE 93-28642 Met. Gold HTP
1411279	GSOR DE 93-28962 Met. Gold HTP
1411278	GSOR DE 93-28643 Met. Gold HTP
1411277	GSOR DE 93-28961 Met. Gold HTP
1411282	GSOR DE 94-20877 Met. Silver HTP
1411281	GSOR DE 94-28001 Met. Silver HTP
1411284	GSOR DE 97-28903 Met. Red HTP
1411283	GSOR DE 97-28943 Met. Copper HTP
1411286	GSOR DE 98-28903 Met. Violet HTP
1411285	GSOR DE 99-2001 MET. WHITE HTP

All color prints are provided as an indication of the shade only.

The mentioned references are randomly selected color shades, please contact your respective Ferro Technical Service to get more information on further available colors.

Social effect inks: Limited range of organic inks available upon request, such as:

SAP code	Product name
1411606	GSOR DE 93-20803 Neon Yellow HTP
1411604	GSOR DE 91-20802 Neon Green HTP
1411603	GSOR DE 97-20190 Neon Pink HTP
1411819	GSOR DE 97-20804 Neon Orange HTP
1411605	GSOR DE 97-20212 Thermo Mag HTP

All color prints are provided as an indication of the shade only. The mentioned references are randomly selected color shades, please contact your respective Ferro Technical Service to get more information on further available colors.

For more information on our full range of organic inks, please contact your regional technical service representative at Ferro.



## Technical Information Summary - Organic Inks

	HTP	HTP Kristal	RTP
<b>Appearance:</b>			
Ink at Room Temperature	Solid	Solid	Liquid Paste
Opacity	Opaque	Transparent	Opaque
Gloss	High gloss / Frost available	High gloss	High gloss / matt
Calors Available	Full range	7 colors	Full range

### Chemical / Physical Data:

Resin Base in System	Epoxy	Epoxy	Epoxy
Solids	>98%	>98%	>98%
Flash Point	> 93°C	> 93°C	> 93°C
Density	1,20 to 1,44 g/cm <sup>3</sup>	1,20 to 1,44 g/cm <sup>3</sup>	1,20 to 1,44 g/cm <sup>3</sup>
Thinning	Products ready to use / thinning possible with Thinner 001 HTP/RTP	Products ready to use / thinning possible with Thinner 001 HTP/RTP	Products ready to use / thinning possible with Thinner 001 HTP/RTP
Consumption, 270 mesh	Approximately 0.03 g/cm <sup>2</sup>	Approximately 0.03 g/cm <sup>2</sup>	Approximately 0.03 g/cm <sup>2</sup>
Drying	Dry to the touch after printing	Dry to the touch after printing	Remains wet after printing
Shelf life	6 months	6 months	6 months
Storage	<22° C, best if refrigerated, not below -7° C	<22° C, best if refrigerated, not below -7° C	between 10°C and 35°C

### General Performance:

Scuff Resistance	Outstanding	Outstanding	Outstanding
Pencil Hardness	>4H	>4H	>4H
MEK / Acetone double rubs	>50	>50	>50
Boiling Water, 30 min	Pass	Pass	Pass
24h Soak in Water /Ethanol/	Pass	Pass	Pass
Dishwasher Resistance (Household)	minimum 500 cycles	minimum 500 cycles	minimum 500 cycles
Dishwasher Resistance (Professional)	minimum 900 cycles	minimum 900 cycles	minimum 900 cycles
Overprintability	Can be overprinted under specific conditions. Side by side printing recommended	Not recommended	Not possible. Can be used as a last print on HTP or waterborne coatings

### Application and Usage:

Application Method	Hot screen printing	Hot screen printing	Screen printing
Screen Mesh	stainless steel 270-325 mesh for metallic: 160 mesh for halftone and 360° print: 350-425 mesh	stainless steel 400 mesh	stainless steel or polyester 270-325 mesh for metallic: 160 mesh
Squeegee Durameter	70-80 shore	70-80 shore	70-80 shore
Glass Temperature	Between 27°C and 40° C	Between 27°C and 40° C	Between 27°C and 40° C
Cleaning	Acetone, MEK, DBE	Acetone, MEK, DBE	Acetone, MEK, DBE
Curing Temperature	200°C glass temperature	200°C glass temperature	200°C glass temperature
Curing Time	20 min	20 min	20 min

## FAQ's

### **Q. Do I need any special equipment to use these products?**

No. Ferro's organic RTP and HTP Series inks are designed for use with existing manual and automatic screen-print decorating machines and lehrs currently used in the glass industry, and are especially suitable for high speed decoration lines. Although more careful control of operating conditions and temperature must be employed compared to printing with glass enamels, no special equipment is needed.

### **Q. Do the inks contain heavy metals or BPA?**

Ferro's organic inks are heavy metal free and are therefore in compliance with the following legislations:

- Packaging Directive 2004/12/EC
- CONEG Legislation
- TSCA
- Proposition 65

Ferro has conducted a series of Bisphenol A migration tests with a number of organic inks at an independent scientific laboratory. Bisphenol A migration could not be detected under any set of conditions. A detailed report is available upon request; please contact your local Ferro representative for more information.

### **Q. Do I need any special pretreatment on the glass to use the inks?**

No, pretreatments are not necessary.

### **Q. What is the best way to melt the HTP inks?**

We recommend melting them in a forced air oven, a convection oven, or in a pot immersed in a hot water bath at a temperature of 70°C to 80°C. Application of direct heat, such as from a hot plate, burner, or a microwave will cause curing and hardening of the product.

To minimize the time spent melting, the ink block should be broken into small pieces to be melted. Smaller pieces will melt more quickly due to a higher surface area.

### **Q. How long may I keep the ink molten? At what temperature can I keep it at?**

The ink can be kept molten at approximately 70°C to 80°C for about 1 shift, or approximately 8 hours. To prevent curing in pots or screens, we recommend keeping molten only enough material that is needed to print within the next 4 hours.

### **Q. Temperature control is very important, how can I check the temperature?**

During melting and printing, temperature should be monitored regularly via thermocouple or infrared pyrometer (IR heat gun).

### **Q. What is the maximum screen temperature that I should be using?**

You should not exceed a maximum of about 90°C. Excess heat will cause the ink to begin curing.

### **Q. How do I tell if the ink has been overheated?**

Ink that has been overheated will have begun to cure, making it unusable. If the ink begins to cure, the viscosity will begin to rise and ink transfer to the ware will become more difficult.

### **Q. If I have overheated the ink, what can I do to continue using it?**

Ink that has been overheated will have begun to cure, making it unusable. Overheated ink should be scrapped.

### **Q. Does the type of squeegee used matter? What type should I use?**

For the HTP inks we recommend urethane squeegees of approximately 80 durometer Shore hardness. We recommend 65 to 70 durometer hardness for the RTP inks.

### **Q. What is recommended for thinning the inks?**

Ferro's organic inks are ready-to-use and do not need any dilution.

In certain circumstances, adding our Thinner 001 HTP/RTP might help to reduce the necessary screen temperature during the printing process. The addition of this thinner will affect the tackiness of the ink after printing, which means that the ink becomes sticky.

### **Q. The ink is not transferring well to the glass, what should I do?**

Ink transfer to cold glassware may be difficult. Recommended glass temperature is 35°C. Temperature should not exceed 40°C and not go below 27°C.

### **Q. I do not have a temperature data recorder, how can I optimize my cure cycle/lehr?**

We recommend using temperature tapes on the glass ware to determine the maximum temperature that is achieved.

### **Q. How can I check to see if the inks are cured?**

Cure performance should be measured using quality tests such as those outlined in the Ferro test procedures (please refer to pages 3 in this brochure, section "Curing"!).

**Q. The ink has changed color or has turned yellow after curing. What caused this?**

A color change or yellowing of the ink indicates that either the temperature of the Lehr was too high, or the amount of curing time was too long. In forced air ovens and Lehrs a recommended starting point cure cycle is 20 minutes at 200°C.

**Q. After curing it appears that the ink print has “sagged”. What caused this?**

Sagging prints can occur if the heat in the first zone(s) of the Lehr is increased too slowly. Sagging can also occur when the ink has been excessively diluted.

**Q. Why must I store the HTP inks in a refrigerator?**

All HTP inks should be stored in a refrigerator or freezer to get consistent behavior. This will ensure maximum shelf life and product stability. The polymerization occurs even at room temperature, but the reaction is very slow. This reaction will be virtually arrested when stored as recommended. Please refer to page 4 in this brochure, section “Storage”!

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## Safety&Handling

Please refer our Material Safety Data Sheet for safe handling and use of our products, prior to use.



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