FERRO
Where innovation delivers performance™

Technical Information

Performance Colors & Glass

Lead Free Glass Enamel

RAL6017 Green	RAL5021Blue Green	RAL650-2 Cyan	RAL6024* Bright Green
RAL5017 Blue	RAL1021* Yellow	RAL1018* Yellow	RAL9016 White
RAL7047 Light Grey	RAL7044 Warm Grey	RAL7040 Cold Grey	RAL7046 Grey
RAL7011 Grey	RAl7015 Dark Grey	RAL7024 Dark Grey	RAL7016 Dark Grey
RAL5014 Bluish Grey	RAL5024 Bluish Grey	RAL9005 black	Etch 197588
RAL3009 Brown	RAL2004* Orange	RAL3020* Red	RAL9006** Metallic Grey
RAL9022 ** Metallic Grey	RAL140-M ** Champagne	RAL780-M** Champagne	RAL1036** Metallic Gold

Meet ROHS regulation (except * cadmium containing products);
Meet JC/T 2167-2013 China industrial standard on Glass Enamel;
Meet ASTMC1048 acid and alkali resistance as well as ink test requirement, except ** metallic colors
The color shades of above mentioned only represent an indication of the respective color shade which has been established under laboratory conditions. Actual results will depend on production conditions. We recommend to test the mentioned color shades under your production conditions and requirements.

Main Markets

• Domestic appliance glass –oven doors, control panels, refrigerator and freezer shelves, microwave doors…

• Architectural glass-spandrel panels, shower screens, advertising, internal glass doors and partitions…

• Glass furniture-tabletops, kitchen cabinets, wall cupboard doors, display cabinets…

Note: The above mentioned products cannot be used for side 1 decoration.

Chemical Composition

Colors in this system formulated to be lead-free and cadmium-free with controls in place to maintain upper limits of 100 ppm lead and 100 ppm cadmium. The supplementary cadmium colors are lead-free. Ferro maintains and manages the heavy metal limit through careful monitoring of raw materials combined with accurate processing and continuous precise quality control.

Expansion Coefficient (C.O.E.)

The C.O.E. of the enamels are about 80-95 x 10-7/℃（25-300℃）depending on factors such as flux and pigment type and content.

The expansion of all above mentioned glass enamels in designed to provide a good fit with the properties of float glass, but we still recommend performing preliminary test before launching production. If applied onto glass with low thermal expansion coefficients (<60x10-7k-1), the colors will tend to crack.

Recommended Firing

These colors are specially formulated by typical glass tempering cycles, with furnace temperatures set at 680-720℃ with a total cycle time 40 seconds per mm of glass thickness. The results in typical glass temperatures of 620-660℃.

Under typical glass tempering cycles – fast heating and high temperatures for a short time, dense and glossy color surfaces are obtained. An oxidizing atmosphere is necessary to achieve good properties of the fired layer.

Chemical Durability Rating

acid resistance	Level 4 or better for hydrochloric acid and Level 3 or better for citric acid
Alkali resistance	Weight loss less than 0.0028 g/cm2 (except the metallic colors)

Acid resistance: ASTM C 724 (10% citric acid and 3.7% HCl, 20±2℃,15min)

Alkali resistance: ASTM C 1203 (10% NaOH,95±3℃， 2h)

1. No attack apparent.
2. Appearance of iridescence or visible stain on the exposed surface when viewed at a 45° angle but not apparent at angles less than 30°.
3. A definite stain which does not blur reflected images and is visible at angles less than 30°.
4. Definite stain with a gross color change or strongly iridescent surface visible at angles less than 30° and which may blur reflected images.
5. Surface dull or matte with chalking possible.
6. Significant removal of enamel with pinhole evident.
7. Complete removal of enamel in exposed area.

Ink Test

According to ASTM C 1048, no residue ink be visible from the surface except the metallic enamels.

Test Procedure: Light scrape an area of 25mm x 75mm (1in X 3in) ten times with a single razor blade at an angle of 45℃ to the painted surface. Apply a line of India ink along the 75mm (3 in.) dimension and allow to sit for 15 min. Remove the ink from the surface with a fine abrasive paste and brush.

Methods of Use and Recommendations

The enamels are developed and controlled for the following application processes:

-Direct Screen Printing

-Roller Coating

Our pastes are supplied as a concentrate with a high viscosity; pasted should be let down with our recommended medium or thinner, to reach the printing viscosity required for the particular application process or conditions. For direct printing on flat glass, mesh size from 36 to 90 mesh per cm are widely used with our products.

Due to the required thin layers required for the decoration of etch imitation, we recommend etch application by screen printing. The best effects and surface quality are achieved using an90 mesh per cm screen. If coarser screens are used, noticeable differences in color shade can occur due to the increased layer thickness.

The viscosity of the enamel pastes is strongly influenced by the ambient temperature in the processing shop and therefore the paste temperature itself. Any change in paste viscosity will affect the applied thickness which in turn influences color opacity and color shade. To ensure prints of consistent quality, opacity and color shade, it is recommended to control the ambient temperature and humidity of the printing room and to maintain the printing parameters as constant as possible.

Regarding to float glass, the Sn-side causes a different color shade than the air side of the glass. The glass must be cleaned thoroughly to avoid of pinholes or other defects due to grease, dust or other foreign particles.

Standardize the screen frame, cloth, tension, emulsion, squeegee, printing parameters etc. which may affect the printing quality.

Keep the same thinning ratio and stirring process. We recommend stirring speed about 70-150rpm for 8-15mins. And during stirring, the agitator blade must be immersed totally in the paste to avoid the bubbles occurred.

Drying temperature is about 120-150℃. The glass is more thicker, the drying temperature is more higher or drying time is longer. We recommend to wear smooth gloves when touch the decorated dried surface. The drier glasses are better to be isolated from each other.

Please pay more attention to the film thickness and tempering parameters of etch products as it is more sensitive to the printing and firing conditions.

Metallic colors do not recommended to be decorated with the mesh finer than 150 mesh/inch.

Please use lower stirring spend and longer time mixing for better suspension.

The enamel must be fired correctly, otherwise it may not pass the chemical resistance and ink test. It is better to keep the same tempering parameter at the same tempering furnace for the same order to keep the consistent quality.

All the batches must be done warehouse-in inspection, please do contact us if any problem during the inspection. Please do not use the disputed products. We recommend prior test before all batch production especially when processed insulated, laminated, coated glass with the enameled glass.

Storage and Shelf Life

Cold pastes should be stored in cool and dry conditions, not below 5℃ or above 35℃. Partly used tins must be tightly sealed after use. If stored as recommended， the shelf life is 1year after production date.