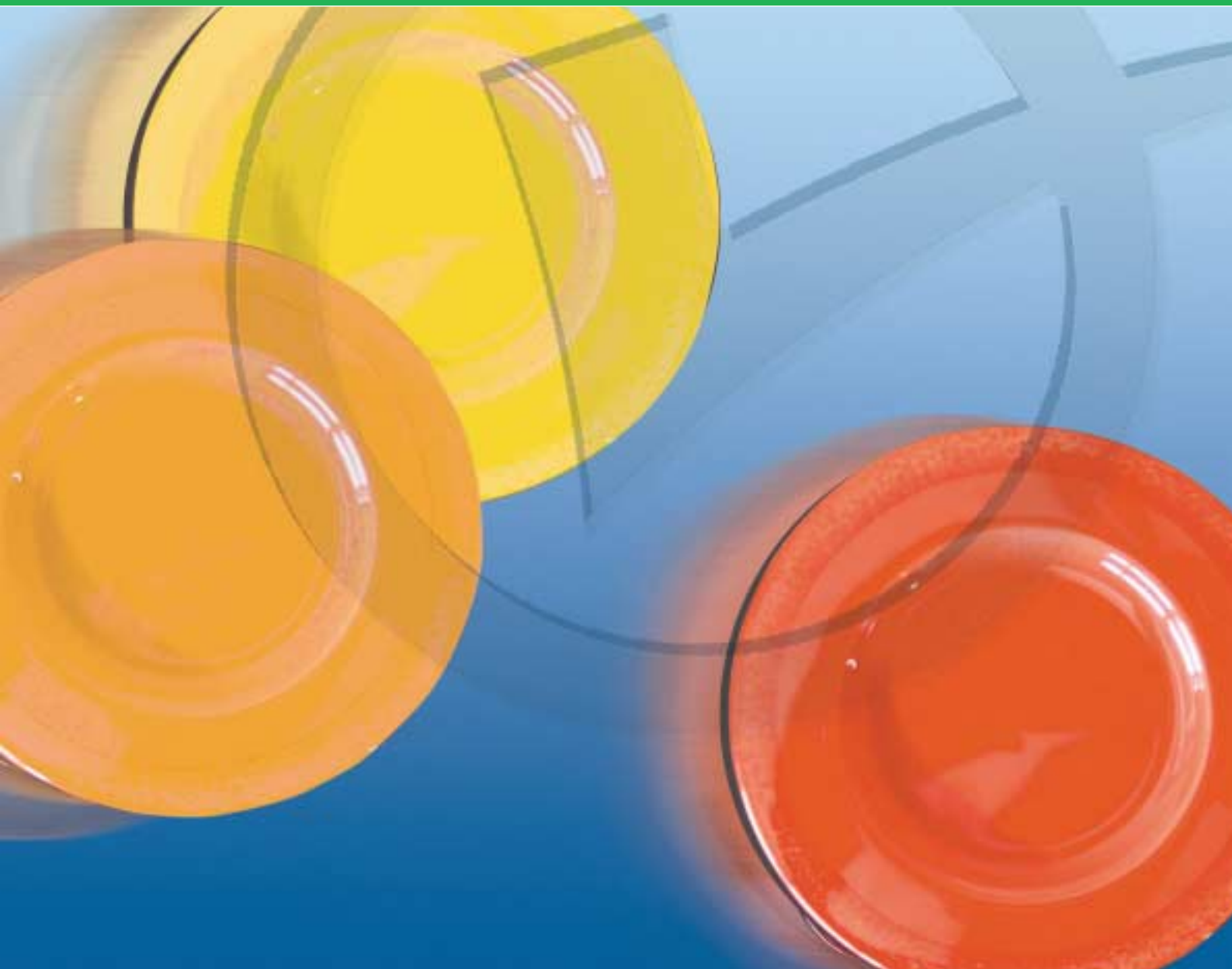


# Inclusion Pigments

colour your world

Performance Pigments and Colors

[www.ferro.com](http://www.ferro.com)



# Ferro touches your life every day

**Headquartered in Cleveland, 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 colours, glass decoration, precious metal preparations, speciality glasses, porcelain enamel coatings, auxiliary materials, and pigments. We pioneered the development of forehearth colour technology for colouring 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 the industry, from our international network of manufacturing plants and service centres. Our commitment to quality management has been recognized with the award of ISO 9000 accreditation to all of our global manufacturing and research facilities.

**Meeting the needs of the Colour 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 growing 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 colour 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 Partner to manufacturers around the world ...**

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

# Inclusion Pigments

## Top solutions for today's problems

Pigments and Special Products is a business unit of the Performance Pigments and Colors Division of Ferro. We develop, produce, and market our pigments, special glasses, glazes, and special coating materials.

In the ceramic industry, we are worldfamous for our innovative, high-quality colouring products.

Particularly our inclusion pigments create shining red, brilliant orange, and intense yellow colour shades in ceramic bodies and glazes, improving the traditional spectrum of colours available to the ceramic world in a unique way.

Our inclusion pigments are distinguished by their chemical and thermal stability. This ensures both a high level of production safety and excellent end-product profitability.

### **The inclusion principle – brilliant pigments are stabilized by encapsulation in chemically and thermally stable crystals**

The colours of yellow, orange, and red inclusion pigments are achieved using well-known, colour intensive cadmium-sulfoselenide compounds. These possess very limited chemical and thermal stability, and so we encapsulate them in practically inert, colourless zircon-silicate in a complex chemical synthesis process. As a result, our inclusion pigments compare chemically with pure zirconium silicate, yet demonstrate the optical properties of their embedded colour (see figure 1).



**Fig. 1:** As seen by microscope, the brilliant red cadmium in an inclusion pigment is completely enclosed in stable zircon crystals.

### **Low cadmium content**

One of the advantages of our cadmium inclusion pigments is that only a very small amount of cadmium is required to achieve the desired colour. As little as 0.1 weight-% cadmium is sufficient to create strong colours. This is about one twentieth of the amount required to achieve the same colour in conventional cadmium glazes.

### **1000 times less cadmium released**

The cadmium solubility of inclusion pigment glazes is very low. ISO 6713-approved tests for cadmium release show that the cadmium released by inclusion pigment glazes can be a thousand times or more less than that of conventional free-cadmium glazes.

## Inclusion pigments for glaze application

Pigment	Colour	Firing stability	Sieve residue on 45 µm
230 416	Lemon Yellow	up to 1350 °C	<2 %
230 508	Mango Orange	up to 1350 °C	<2 %
230 616	Carrot Orange	up to 1350 °C	<2 %
230 634	Mandarin	up to 1350 °C	<2 %
270 496	Fire Engine Red	up to 1350 °C	<2 %
270 497	Bordeaux Red	up to 1350 °C	<2 %
270 527	Fire Red	up to 1350 °C	<2 %

## Inclusion pigments for stoneware and tableware

Pigment	Colour	Firing stability	Sieve residue on 45 µm
239 416	Lime Yellow	up to 1350 °C	<2 %
239 616	Pumpkin Orange	up to 1350 °C	<2 %
279 496	Crayon Red	up to 1350 °C	<2 %
279 497	Claret Red	up to 1350 °C	<2 %

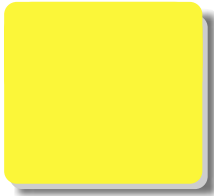
## InstantColor®: Dispersible inclusion pigments

Pigment	Colour	Firing stability	Sieve residue on 32 µm	Application
230 942	Brilliant Orange	up to 1350 °C	<5 %	Earthenware glazes
230 952	Intense Yellow	up to 1350 °C	<5 %	Earthenware glazes
230 954	Intense Orange	up to 1350 °C	<5 %	Earthenware glazes
239 942	Brilliant Orange	up to 1350 °C	<5 %	Stoneware and Tableware
270 944	Intense Red	up to 1350 °C	<5 %	Earthenware glazes
270 950	Intense Red	up to 1350 °C	<5 %	Earthenware glazes
279 944	Intense Red	up to 1350 °C	<5 %	Stoneware and Tableware

## Glaze/body composition in weight-% (standard values)

Oxide	A Fast-firing, transparent
SiO <sub>2</sub>	60
B <sub>2</sub> O <sub>3</sub>	2
Al <sub>2</sub> O <sub>3</sub>	9
CaO	12
ZnO	10
MgO	2
Na <sub>2</sub> O	1
K <sub>2</sub> O	4

## Inclusion pigments for glaze application



230 416  
Lemon Yellow  
239 416  
Lime Yellow



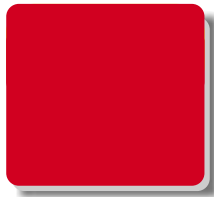
230 508  
Mango-Orange



230 616  
Carrot Orange  
239 616  
Pumpkin Orange



230 634  
Mandarin



270 496  
Fire Engine Red  
279 496  
Crayon Red



270 497  
Bordeaux Red  
279 497  
Claret Red

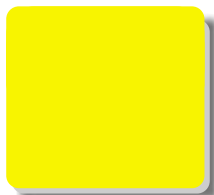


270 527  
Fire Red

## Dispersible inclusion pigments



230 942  
Brilliant Orange  
239 942  
Brilliant Orange



230 952  
Intense Yellow



230 954  
Intense Orange



270 944  
Intense Red  
279 944  
Intense Red



270 950  
Intense Red

While every attempt has been made to reproduce colours exactly, the colour samples printed in this brochure may differ slightly from fired ceramic products. All stains were applied with 5 % in glaze A.

## Application hints

With the help of our inclusion pigments, our customers can obtain bright yellow, orange, and red glazes and bodies for applications in the tableware, art ceramic, tile, and sanitary industries. Each inclusion pigment has been optimized for its specific application, both to assist in customer selection and to meet our quality requirements.

When colouring earthenware glazes we recommend that our customers use those inclusion pigments with a "0" as third digit of the product number. For applications in the stoneware and tableware industry we recommend those with a "9" as the third digit, as these pigments have been optimized for these particular applications. Quality and release control testing have also of course been specifically designed for each application. Detailed test conditions for our products are specified in the corresponding data sheets, which we will gladly send you upon request.

For optimal results using our inclusion pigments, please read the following application hints, as these will lead to increased quality of your products.

- Inclusion pigments are intermiscible, as well as miscible with other zircon and brown stains. To increase the red value in brown shades, you can add inclusion pigments to successfully match your desired colour.
- Glaze systems containing lead, lime, zinc, boron, or zircon improve the colour development of inclusion pigments.
- Alkali-rich glazes reduce the colour intensity.
- To avoid mechanical destruction of inclusion pigments during glaze preparation, we recommend adding the stain when only 5 % of the total milling time remains.
- Using inclusion pigments in the InstantColor® range will give you the most striking and intense shades available, along with all the advantages of stir-in (dispersible) stains.
- For the production of fashionable, natural-coloured earthenware and rustic designs, we recommend our very economical inclusion pigment 270 527.
- In the stoneware and tableware application, the remarkable stability of our inclusion pigments is especially evident in pastel shades.
- Inclusion pigments improve the refiring stability of shades that contain zircon-iron-red, particularly in case of partial exchange.
- Inclusion pigments demonstrate good firing stability even under reducing firing conditions.



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### Safety & Handling

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



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