

# MIO in Coatings

## What is MIO?

Micaceous Iron Oxide (MIO) is iron oxide in a form that resembles mica, a highly structured, layered mineral (crystalline  $\text{Fe}_2\text{O}_3$ ). Minerals with this highly layered structure are termed lamellar. When MIO pigments are ground into smaller, finer particles, they tend to cleave along their layers, revealing flat, shiny surfaces that act like tiny mirrors. These tiny mirrors reflect UV light, protecting the resin from degradation and give the coating an attractive 'sparkle' finish. The lamellar shape also offers additional barrier protection. MIO pigment is also completely inert, non-toxic, and withstands temperatures to 1,000°C.

MIO coatings offer outstanding corrosion protection of steel and are used on iconic structures like the Eiffel Tower and Sydney Harbour Bridge.

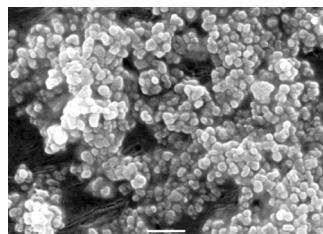
## How does MIO work?

Steel is chemically unstable – it rapidly rusts in the presence of oxygen, water and salts to form iron oxide (rust). Iron oxide is chemically stable, as it cannot oxidise any further. Furthermore, the lamellar shape of this particular form of iron oxide offers greatly enhanced barrier protection.

The lamellar nature and shiny surface appearance of MIO pigments also offer UV protection to the underlying resin system. Epoxy and enamel based coatings normally chalk on exposure to UV, however, in coatings pigmented with MIO, only the resin on the surface of the uppermost MIO particles are exposed to UV and will chalk. This chalky material readily weathers off, revealing clean, shiny surfaces.

Most pigments used in the coatings industry are roughly spherical in shape when viewed under the microscope. These pigments may contribute to opacity, colour, resistance to abrasion or other properties, or they may be mere fillers. The most common pigment in paints and coatings is titanium dioxide, due to its very high opacity (hiding power) and its spherical particles. The spherical shape aids the flow out and gloss level, allowing formulation of coatings of exceptional gloss.

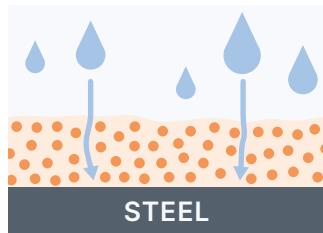
Lamellar pigments, such as micaceous iron oxides and glass flakes, are used specifically for their ability to greatly enhance the coating's barrier properties. The flakes themselves provide a 'tortuous path' for any molecule that may be detrimental to the substrate, as shown schematically on the right.



Titanium dioxide is spherical.



Micaceous Iron Oxide is lamellar (flat) and shiny.



Spherical pigments do not impart any barrier properties.



Lamellar pigment enhances barrier properties as they provide a tortuous path for liquids.

## What types of MIO coatings are available?

There are several resin types used in the formulation of MIO coatings. These include polyurethanes, epoxies, alkyd enamels and chlorinated rubbers.

### Polyurethane

Polyurethane MIO coatings have outstanding UV resistance and very good water resistance, and therefore are ideal topcoats for exterior and interior use. Polyurethanes exhibit:

- Excellent UV stability and resistance to chalking
- Excellent resistance to discolouration
- Very high abrasion resistance
- Very long-term durability
- Relatively easy to overcoat and maintain

WEATHERMAX® HBR MIO has been locally developed for high build roller or brush application. It is a high build recoatable polyurethane coating designed to be used over a wide range of suitably primed substrates such as mild steel, galvanised steel, concrete and aluminium. The micaceous iron oxide pigment particles interlock in the film to form a barrier against moisture ingress. WEATHERMAX® HBR MIO is available in Natural Grey and Mid Grey.

### Epoxy

Epoxy MIO coatings, due to the epoxy resin content, make excellent primers, intermediate coats and interior topcoats. Epoxies exhibit:

- Better adhesion to substrate
- Low water permeability

DUREBILD® STE MIO is a two pack surface tolerant MIO coating that is specifically developed for Australian and New Zealand. Bloom free cold cure hardener is available. It has been assessed and confirmed to meet specific APAS requirements. DUREBILD® STE MIO is available in Natural Grey and Mid Grey.

DUREMAX® GPE MIO is a general purpose MIO epoxy coating. Commonly used as an intermediate coat in very high corrosivity environment (C5) for added barrier protection. Available in Mid Grey.

FERREKO® No. 3 is a two-pack high MIO loading epoxy coating that has an extensive service history. It has been used as an intermediate coat in highly corrosive environments such as bridges and applied as a topcoat for public installations. FERREKO® No. 3 MIO is available in Natural Grey and Mid Grey.

FERREKO® No. 4 is a two-pack high-build high MIO loading epoxy designed with rapid overcoating properties for fast throughput. The high level of MIO pigment in the formulation offers excellent barrier protection and is ideal for use in environments where prevention of moisture ingress and abrasion resistance is needed. FERREKO® No. 4 MIO is available in Natural Grey.



West Gate Bridge, VIC  
DUREBILD® STE MIO and WEATHERMAX® HBR MIO

Story Bridge, QLD  
FERREKO® No. 6

Eastlink  
overpass, VIC  
FERREKO® No. 3

### Alkyd Enamel

Alkyd Enamel MIO coatings, being single pack, are convenient to use, and are particularly suitable for minor, miscellaneous steelwork. Although Alkyd enamels have relatively poor UV resistance and tend to chalk on exposure, the MIO pigment improves UV resistance.

FERREKO® 810 is a popular single-pack MIO finish used extensively on tanks and other steel structures in dry and mild environments. FERREKO® 810 is available in Natural Grey and St Enoch Grey.

## Chlorinated Rubber

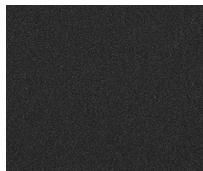
Chlorinated Rubber MIO coatings exhibit superior water barrier properties to single pack coatings. The chlorinated rubber resin forms an impermeable barrier to fresh and salt water and to water vapour, making chlorinated rubber MIO coatings particularly suitable for marine structures.

The relatively low heat resistance, and the higher solvent sensitivity compared with other MIO types, can limit the use of chlorinated rubber MIO coatings somewhat to areas not subject to slash or spillage of solvents. Due to the thermoplastic nature of chlorinated rubber coatings, on-site application is preferred.

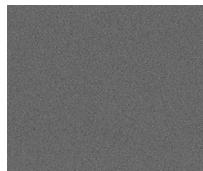
FERREKO® No 6 is a high build single-pack chlorinated rubber finish containing a high level of micaceous iron oxide. The micaceous iron oxide pigment particles interlock in the film to form a barrier against moisture ingress and improve resistance to degradation by UV light. FERREKO® No. 6 is available via made-to-order in Natural Grey and Mid Grey.

## What colour is MIO?

The natural colour of MIO pigment is a dark, charcoal grey. Some MIO coatings also contain aluminium flake (another lamellar pigment) to lighten the colour.



Dulux MIO  
Natural Grey



Dulux MIO  
Mid Grey



Dulux MIO  
St Enoch Grey

## What to consider when using MIO coatings

MIO coatings were designed for protection of steel and not as a decorative finish. Nevertheless, MIO coatings are widely used specifically for their sparkly finish and industrial look. If the MIO coating is required as a decorative finish, the following points must be noted:

### Colour variation between batches

The major pigment in the paint is actually natural micaceous iron oxide. This naturally occurring mineral is mined from a number of sources, and therefore colour variation can occur between batches depending on the exact source of the MIO. Variations in colour consistency may be minimised by using the same batch of paint.

### Perceived colour variation on a sample

MIO has a strong "flip" typical of metallic finishes – that is, the colour varies depending on the viewing angle. The colour can appear very light in one angle, but much darker at another angle. Therefore, trying to match an MIO (or any metallic finish) with a solid colour is difficult, as it all depends on which angle you view the sample.

### Colour variation when viewed in situ

Brush, roller and spray all have very different appearance, because each application method results in the MIO particles being deposited on the surface very differently. Differences in spray equipment (conventional versus airless spray), spray tip size, fan size, spray distance and other spray technique variations can all result in significant differences in colour, texture and sheen level. The direction of spray is particularly important; applying the paint over two panels, in the same direction, then turning one panel 180 degrees will result in apparent colour variation between the two panels due to 'flip'. Also, spray overlapping can be obvious.



## Texture variation

Application by roller or brush generally results in a vastly different finish from that of spray application, as the MIO pigment particles are highly irregular in shape, and therefore inhibit the natural flow-out of the wet paint. When brushing, the brush hairs drag and align the MIO particles linearly in the direction of the brush-stroke, whereas spray application disperses the MIO particles randomly and uniformly. MIO paints exhibit higher brush-marking, roller-marking and stipple than other types of paint.

## Variation in touch up appearance

Touch-ups are usually difficult to blend in with any type of paint, but with MIO coatings, this problem is compounded by the coarseness of the MIO pigment. Touch-up appearance can be lessened, however, by using the same application method as that used originally (eg. spray touch up for spray areas, or a roller with the same nap as that used for the rolled areas).

## Possible variation in appearance between start of job and end

As MIO pigment is heavy, it settles to the bottom of the container. Therefore, thorough mixing before application, and frequent mixing during application are essential to ensure a consistent finish and prevent variation across a job.

## Colour variation on UV exposure

This is only a problem with epoxy and alkyd enamel MIO coatings; the colour appears to lighten (and become more "sparkly") with exposure to UV (sunlight) due to surface erosion of the resin, exposing the MIO pigment to direct sun. Whilst this phenomenon can be seen as a virtue from a design point of view, it can also present aesthetic problems in broad areas that are partly shaded (such as under eaves) or receive variable amounts of sunlight. The north face will fade the most, whilst the south side and shaded areas will remain darker. Further erosion is mitigated however, by the protection of the exposed MIO particle.

## Marring or marking on contact

In areas where people are likely to come in contact with the coating system (such as walls, columns, handrails, etc.), coarse flat MIO finishes will mark very easily, rather like emery paper does when used. And just like emery paper, flat MIO finishes cannot be cleaned. Therefore, flat MIO coatings are unsuitable in easily accessible areas. The only way to reduce marring is to specify a smooth, semi-gloss MIO finish such as WEATHERMAX® HBR MIO or METALSHIELD® QD Topcoat MIO.

If marring is of concern, you need to specify an appropriate MIO coating with a gloss to semi-gloss finish, or, perhaps choose a metallic coating that looks like an MIO.

## Conclusion

MIO coatings offer excellent corrosion protection and long-term durability. The use of the MIO coating with the right resin system must be carefully considered in relation to the environment and expected service life, particularly in areas subject to wear and tear or exposed to UV light. Your Protective Coatings Specification Consultant will be able to advise you on the best specification for your particular project.