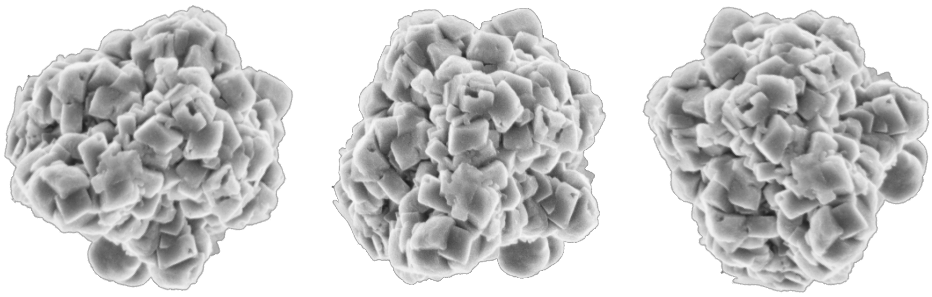
High Quality Matt Paint
68% pvc, 15% TiO_2 wt/wt

Paul Dietz

15th June 2020



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High Quality Matt/Web V1.0/June 2020

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FP PIGMENTS

Introduction

FP-460 Opacity Pigment™ was evaluated in a European High Quality matt paint containing enamel grade TiO_2 pigment as standard. A simple weight for weight ladder study was carried out replacing the TiO_2 in 5% increments from 5% to 20%.

Each performance of each paint was compared to the standard TiO_2 paint with the aim of finding the optimum TiO_2 replacement level for this formulation.

Evaluation

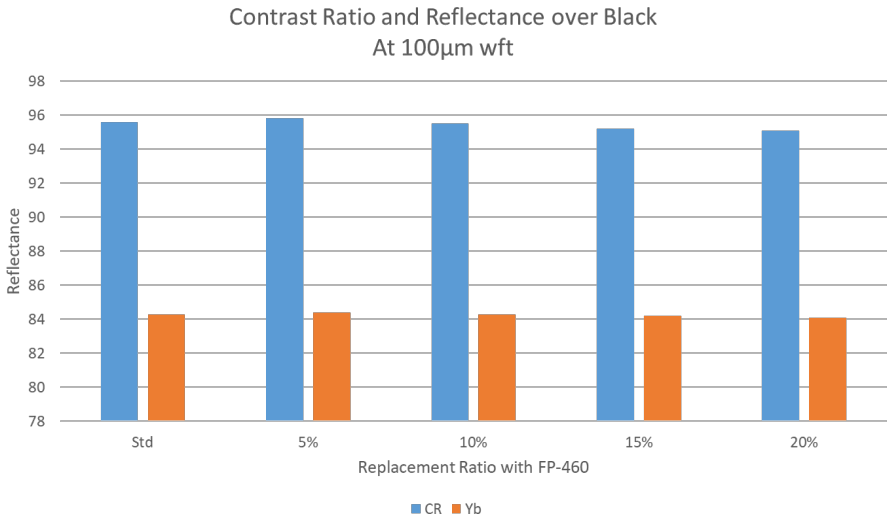
FP-460 Opacity Pigment™ was used as a partial replacement for an enamel grade TiO_2 grade, e.g. TIOXIDE® TR92, KRONOS® 2190, TiOna 595 and Ti-Pure® R902+. The typical formulation properties of the paint are given in the table below.

Property	Standard Formulation
Paint pvc	68%
Volume Solids	32%
TiO_2 Content Weight %	15%
Weight Solids	51%
Extender Types	Calcium Carbonate, Calcined Kaolin
Binder	Acrylic Copolymer

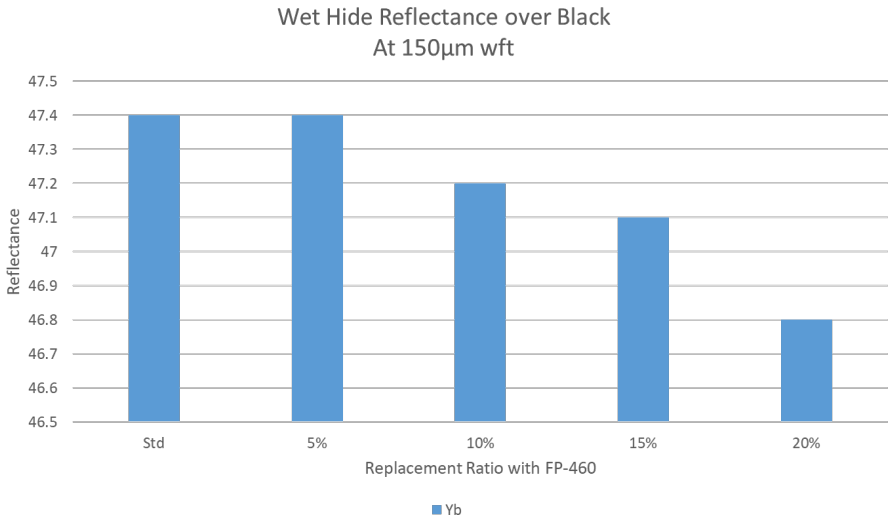
The paints were tested for contrast ratio and reflectance over black at 100µm wet film thickness, wet hide at 150µm, tinting strength with blue and black tinters, colour, gloss and scrub resistance.

Results

Contrast Ratio and Reflectance over Black at 150µm wet film thickness

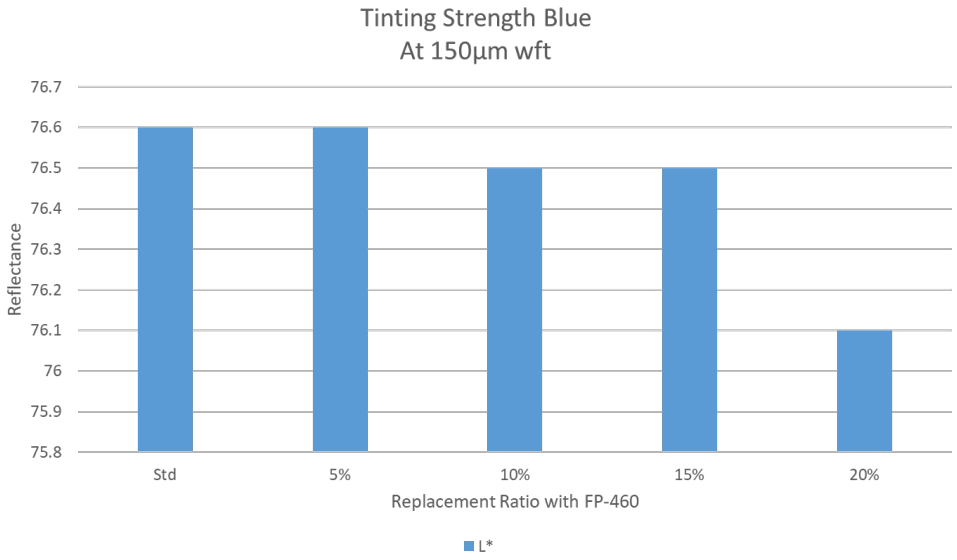


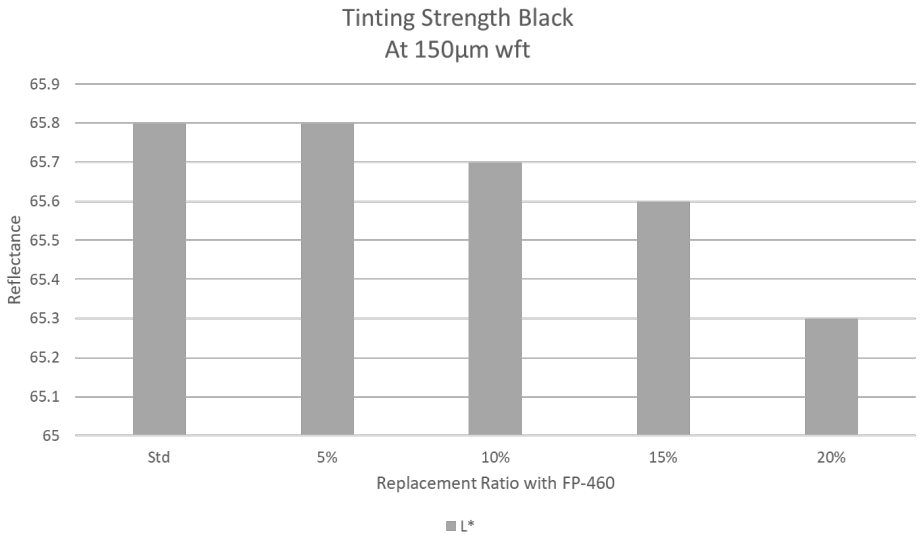
The chart above indicates that the optimum replacement level in this formulation for a contrast ratio and reflectance over black match would be in the range of 10 to 15%. At a 20% replacement level the reflectance over black is just at the level at which a visual difference might be discernible and therefore we would recommend a maximum replacement level of 15%.



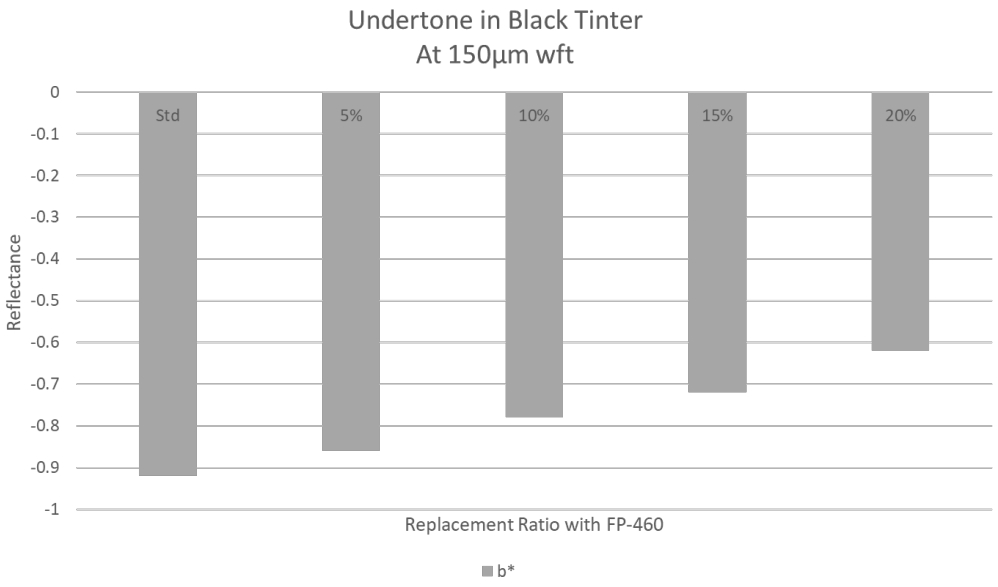
The wet hide performance begins to fall significantly after a 10% replacement. The 10% replacement, although measuring slightly down, is not seen as a visible difference. The 20% replacement is just at the level ±0.5 units at which the difference in wet hide becomes visibly discernible.

For tinting strength, the test results shown in the two charts below suggest a replacement of between 5 and 10% would be possible without the need to adjust Point of Sale software. Note: if POS base reformulation would be of interest, FP-Pigments have developed a reformulation protocol with Chromaflo to allow up to a 20% reduction in TiO_2 in matt pastel and mid-tone bases without the need to alter POS tinting software see out website page on POS reformulation





The black tint strength paints were also used to determine any effects on the undertone. The chart below shows that while undertone does become slightly browner, the effect would only be visually discernible at replacement levels at or above 20%, at which level opacity would no longer be acceptable in any case.



Colour and gloss results remained largely unaffected by the substitution with all measured figures being well within visually acceptable levels.

Colour and Gloss Results					
Property	**Std**	**5% FP-460**	**10% FP-460**	**15% FP-460**	**20% FP-460**
Colour CIE L*	95.3	95.3	95.3	95.3	95.3
Colour CIE b*	3.14	3.15	3.15	3.11	3.12
Gloss 20°	1.3	1.3	1.3	1.3	1.3
Gloss 60°	2.3	2.3	2.3	2.3	2.3
Gloss 85°	4.5	4.5	4.4	4.7	4.7

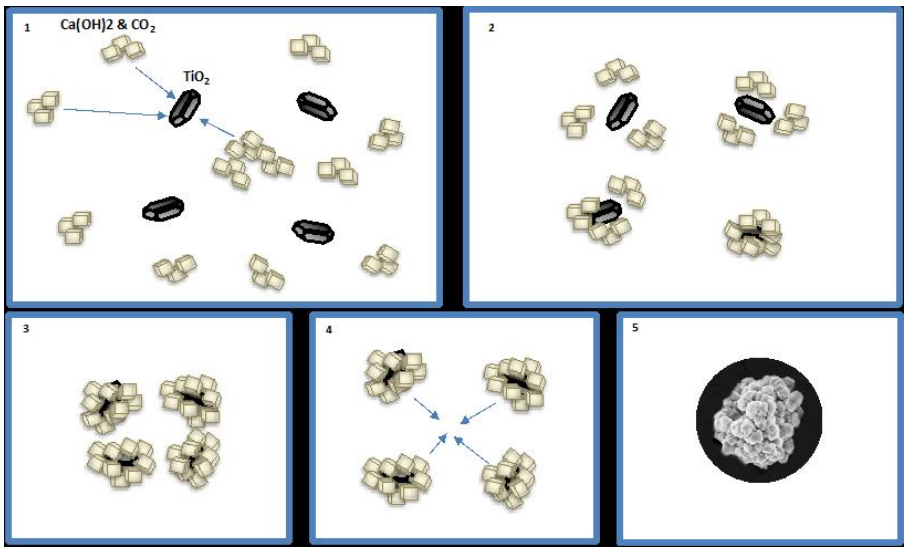
Conclusion

FP-460 Opacity Pigment™ has been shown to be a suitable partial replacement for titanium dioxide pigments in a typical European High Quality matt paint.

Appendices

What is FP-Opacity Pigment™?

Our products use commercially available TiO_2 pigments and a proprietary process that locks in an improved state of TiO_2 dispersion in a shell of high quality precipitated calcium carbonate.



These white pigment composites have an average particle size of 1 micron with a particle of FP-Opacity Pigment™ containing between 3 and 6 TiO_2 particles, each statistically space from each other by the optimum distance for scattering of 280nm.

The nature of the “special structure” of the calcium carbonate shell produced means that this product will maximise the light scattering and hence the whiteness and opacity by several mechanisms.

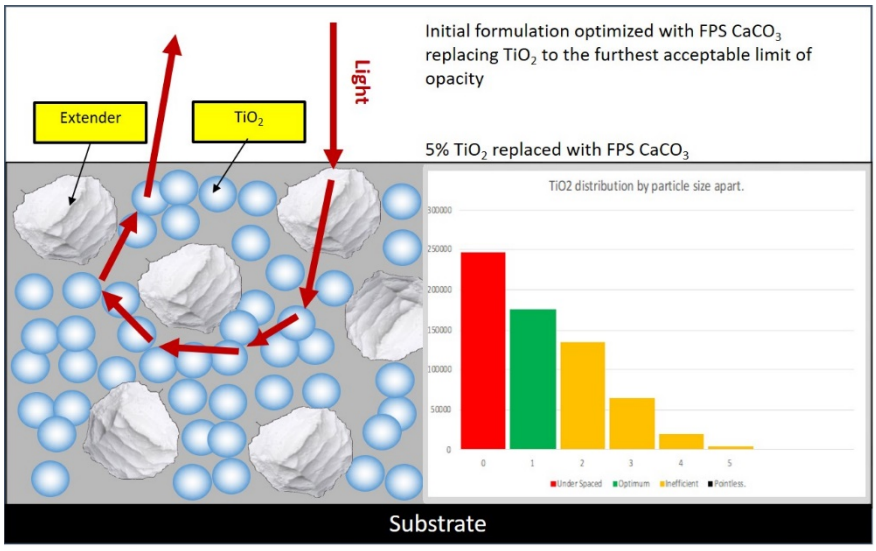
- Optimally spacing TiO_2 inside the FP-Opacity Pigment™ particle.
- Spacing loose TiO_2 around the particle.
- Air voids inside and at the surface of the particle.
- Diffraction from the rough surface of the particle.

As a white pigment, out FP-Opacity Pigments™ have an inherent light scattering functionality and a refractive index between 1.8 and 1.9, unlike extenders and fillers.

The FP-Opacity Pigments™ are used as simple, weight for weight, partial replacements for your existing TiO_2. Depending on the application and formulation type, FP-Opacity Pigments™ can normally replace between 5% and 30% of the TiO_2 without reducing your product quality or performance.

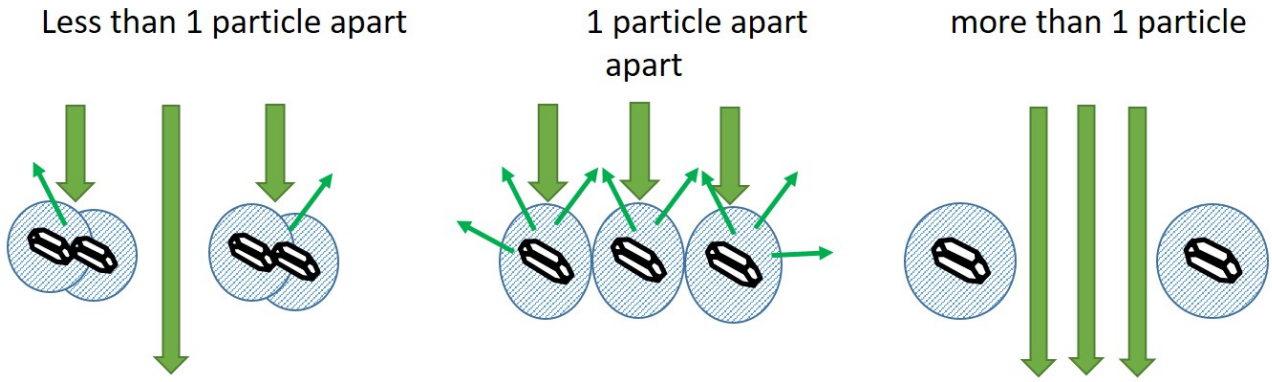
How FP-Opacity Pigments™ Work

In a coating there will usually be a continuous binder phase with TiO_2, extenders and other raw materials dispersed efficiently, yet randomly in that phase. The extenders have a similar refractive index to the binder and, as the TiO_2 cannot occupy the same volume as the extender, the presence of the extenders will create “windows” within the coating through which light can pass without significant scatter. Extenders are also typically much larger than TiO_2 and so TiO_2 is prevented from accessing a significant volume within the coating – this can be considered as TiO_2 crowding, the TiO_2 being forced into the spaces between the extenders and binder which coupled with the random nature of its dispersion leads to only about 30% of the TiO_2 particles having the optimum 280nm spacing.

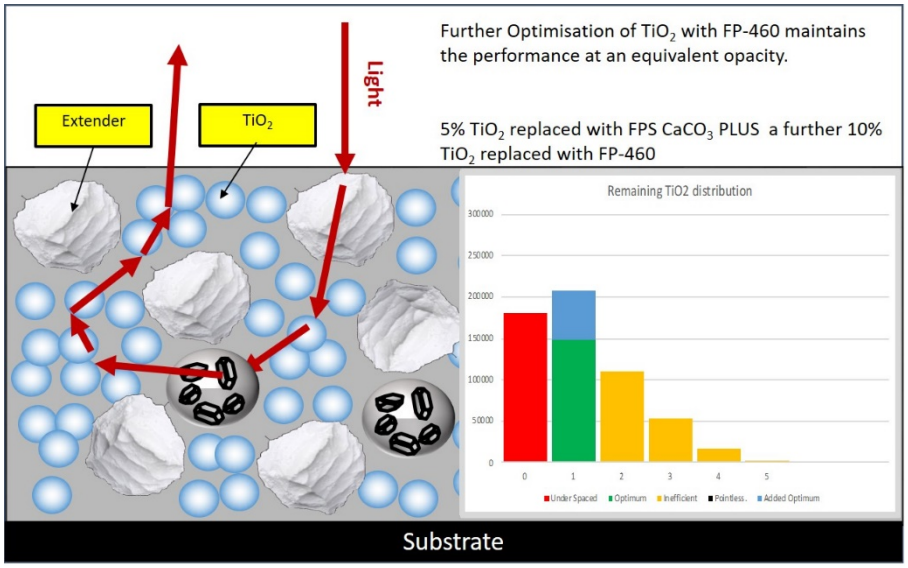


It is well documented that TiO_2 is inefficient if particles are too close together, or in lower concentrations, too far apart.

Inter-particle distance



By replacing a portion of the TiO_2 with FP-Opacity Pigment™ we increase the average distance between TiO_2 particles by a “dilution effect” (fewer particles occupying the same volume) while at the same time we introduce optimally spaced TiO_2 particles within the FP-Opacity Pigment™ structure. This effect can be clearly seen in the statistical model.



By utilising these performance changes, FP-Opacity Pigments™ can be used in coatings, plastics, inks and paper and board to replace between 5% and 30% of the TiO_2 without significantly reducing the opacity and mechanical properties.

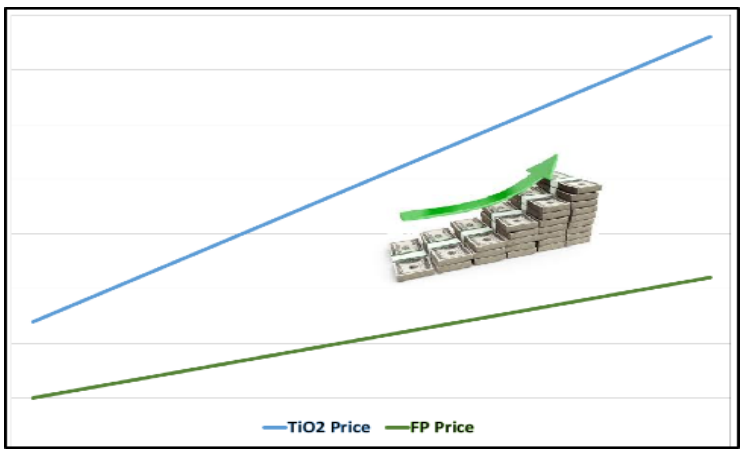
Why Use FP-Opacity Pigments™?

The main reason for using FP-Opacity Pigments™ can be given in three words – "Significant Cost Savings". For every kilogram of TiO_2 pigment replaced by FP-Opacity Pigment™ you will make a significant raw material cost saving while maintaining your product performance and quality. Since you are only replacing TiO_2 with FP-Opacity Pigment™ you can also keep the functionality and cost benefit of your current extender package.

Price Δ between TiO_2 and FP € per ton	Annual € savings, per 100 tons of TiO_2 replaced with FP	Annual € savings, per 500 tons of TiO_2 replaced with FP	Annual € savings, per 1000 tons of TiO_2 replaced with FP
€600	€60,000	€300,000	€600,000
€1000	€100,000	€500,000	€1,000,000
€1400	€140,000	€700,000	

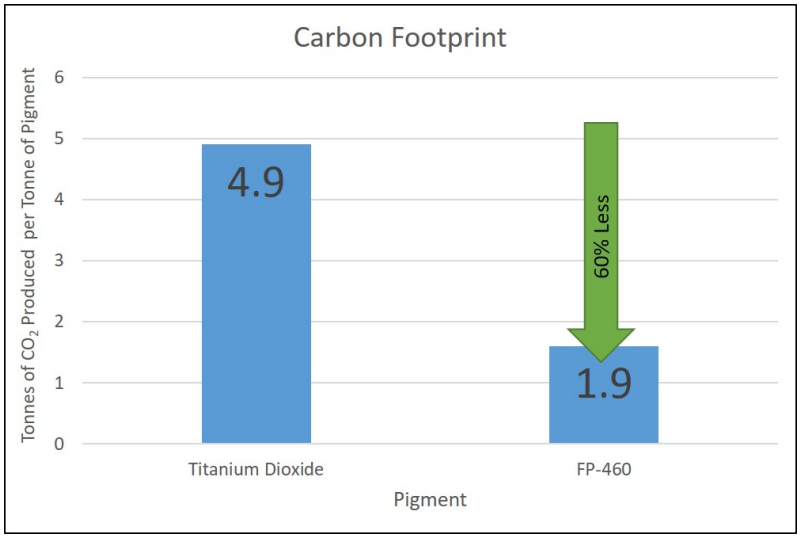
On average, FP-Opacity Pigments™ are 600 to 1000 Euro per tonne lower in price than normal TiO_2 pigment (and this can be even higher in some regions). SO, if your business can avoid using 100 tonnes of TiO_2 pigment by replacing it with FP-Opacity Pigment™ you could save up to €100,000 per year.

In addition, for the same whiteness and opacity produced, FP-Opacity Pigments™ utilise much less TiO_2 and so as TiO_2 prices vary with market conditions, the price of FP-Opacity Pigments™ is more immune to these commodity related price fluctuations.



The graph opposite shows how, as the price of TiO_2 increases, the cost of FP-Opacity Pigments™ rises at a significantly lower rate, helping to minimise the impact of raw material price increases.

Finally, cost savings aren't the only benefit of FP-Opacity Pigments™. For the same opacity product, weight for weight, FP-Opacity Pigments™ have a 60% lower carbon footprint than TiO_2.



The process used by FP-Pigments facilitates a reduction in CO_2 emissions by recycling CO_2 gas throughout our manufacturing route, thus reducing CO_2 losses to atmosphere. We also reduce water usage by having a closed water recirculation system, recycling and reusing process water. All of this as well as our ethical business practices which are regularly audited and qualified by Ecovadis who have awarded FP-Pigments their Silver Medal in both 2018 and 2020.