

# HOW TiO<sub>2</sub> GRADES DRIVE VALUE & PERFORMANCE IN FLAT PAINTS

## Testing for Durability Reliable Methods and Pigment Contribution

The pigmentary TiO<sub>2</sub> market is expected to exceed 5 million tons in 2016, with approximately 60% of that volume servicing the paint and coatings markets. TiO<sub>2</sub> enjoys this strong position in the coatings industry for one reason – it is able to provide paints with white opacity that is needed to make both white and colored paints. TiO<sub>2</sub> provides this opacity by scattering light out of the paint film before it reaches the substrate. This can be contrasted to opacity through light absorption, when the paint film absorbs light before it interacts with the substrate. There is a severe visual limitation when using light absorption to provide opacity—with light absorption, only a black film is possible. White and colored films use light scattering for opacity.



### How it Works

TiO<sub>2</sub> is the premier light scattering pigment for a combination of reasons, all of which are related to the laws of physics that govern light scattering. The intensity of light scattered from a particle is determined by three factors.

**FIRST** is the wavelength of light that we wish to scatter. In the vast majority of paints, this is visible wavelengths, which span the range from 400 to 700 nm.

**NEXT** is the magnitude of difference in refractive indices between the particle and its surroundings (resin in the case of paints). TiO<sub>2</sub> has a uniquely high refractive index, giving it a strong advantage over other white powders.

**FINALLY**, the size of the particle determines the scattering per pound of material. Experienced producers of TiO<sub>2</sub> can produce these particles with a very narrow size range centered at 0.27 nanometers, the optimal size for scattering visible light (Figure 1).

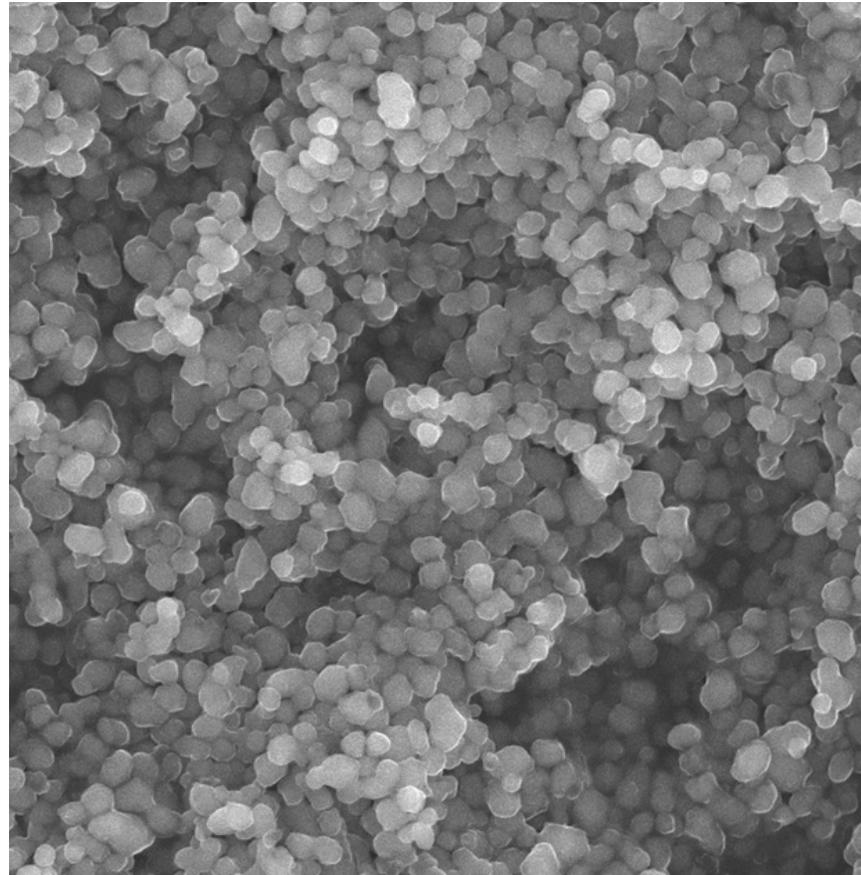


Figure 1. Tight TiO<sub>2</sub> particle size control to maximize light scattering performance.

## How it's Different

While other white powders scatter light, a much larger amount of them is needed per unit area to produce opacity than is needed for TiO<sub>2</sub>. This not only incurs added expense to purchase these powders, it also incurs added expense of the resin, since resin holds the particles together, and the more particles present per unit area, the thicker the paint film must be and the greater the resin requirement per unit area.

## How to Select the Right Pigment

### Consider the application

A variety of pigment grades are available to the paint formulator, each with a different balance of performance properties. Universal or multi-purpose grades are workhorses that are seen in many types of paints, but in some cases it is advantageous to use a TiO<sub>2</sub> grade that is specifically optimized for that specific paint application. This is true of the pigments used to make flat paints. These paints are formulated with high levels of large extender particles (diameters greater than 2 microns). The high concentration these particles (typically 10x the TiO<sub>2</sub> volume in a film) force the TiO<sub>2</sub> particles to crowd together. We see this in Figure 2, where the distance between pigment particles is seen to be greater in the absence of extender than in its presence (note

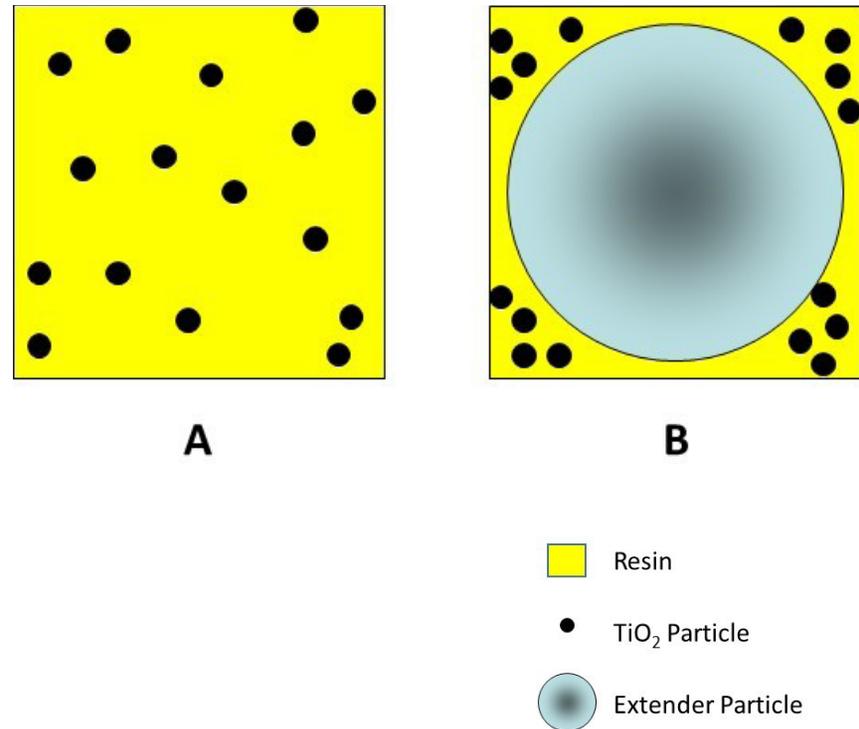


Figure 2. Crowding effect of large extender particles. TiO<sub>2</sub> - TiO<sub>2</sub> distances are longer in the absence of large extender particles.

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that in this illustration the concentrations of TiO<sub>2</sub> pigment particles are the same in both films).

### Prevent crowding

TiO<sub>2</sub> crowding is very undesirable because of the physics of light scattering. Particles scatter light best when they are far away from one another – at least 0.5 microns for TiO<sub>2</sub> pigment particles. Crowding forces the particles closer together than this ideal, and light scattering intensity suffers as a result. In Figure 3 we see that two particles that touch one another scatter light at only about 80% efficiency. When more than two particles touch one another, scattering is reduced even further. A particle that is completely surrounded by other touching particles scatters light at only 30% efficiency!

Our resolution to the problem of TiO<sub>2</sub> particle crowding is to deposit a thick layer of porous material onto the TiO<sub>2</sub> surface. This layer acts as a physical barrier to keep the TiO<sub>2</sub> core of the pigment particles from touching one another, even in highly crowded systems. This can be seen in Figure 4, which is an electron micrograph of TS-6300, a pigment that has been optimized for performance in highly crowded paints. This grade uses roughly 16 weight percent of porous oxides to provide this barrier layer (a porous coating is preferred over a dense coating because it requires less material per unit volume, and so therefore minimizes the dilution of the TiO<sub>2</sub> by the coatings).

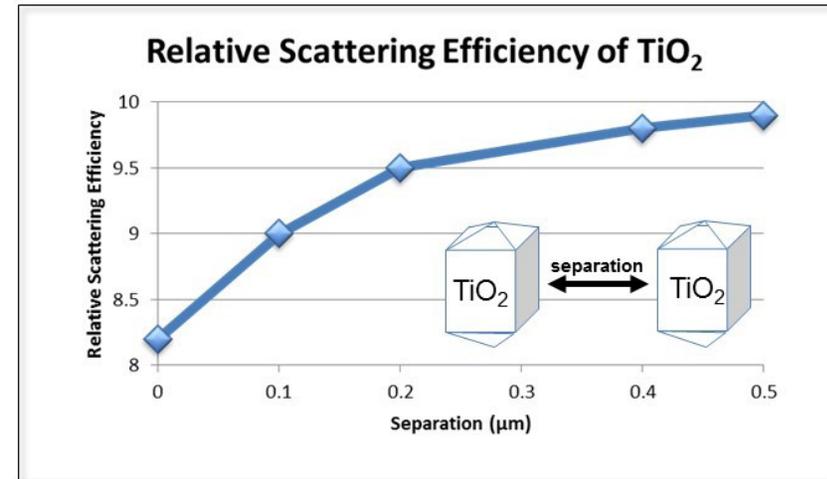


Figure 3. Impact of TiO<sub>2</sub> particle separation distance on scattering efficiency.

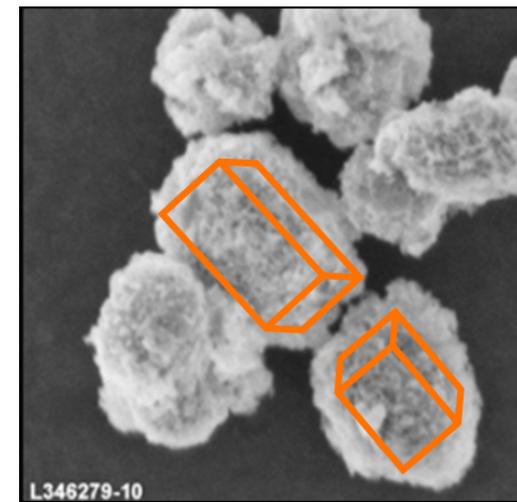


Figure 4. Highly treated TS-6300 particles. Gold outlines represent the size of the encapsulated TiO<sub>2</sub> particles.

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## Compare hiding power

The success of this strategy can be seen in light scattering performance. Figure 5 compares the hiding ability and tint strength of TS-6300 to three universal grades in highly crowded paint systems. TS-6300 clearly gives the highest hide and brightest colored paint. The skilled formulator can make use of these advantages in one of two ways. First, a better performing paint can be at the same TiO<sub>2</sub> level (and cost).

Alternatively, TiO<sub>2</sub> pigment can be partially removed from the formulation, returning the paint to its original performance while taking cost out of it. These two options are demonstrated for an architectural paint in Figure 6. Note that some reformulation was necessary to accommodate the different surface structure of TS-6300, and that simply replacing a universal grade with TS-6300, without any reformulation, does not always lead to improved opacity performance.

The value of using a specialized grade for flat architectural coatings is clear. In the absence of the porous outer layer on the TiO<sub>2</sub> surface, pigment particles touch one another in these crowded paint systems and lose scattering strength—and opacity. By coating the TiO<sub>2</sub> particles with a specially engineered porous layer, we can greatly decrease this loss of scattering strength and improve the performance of the paint.

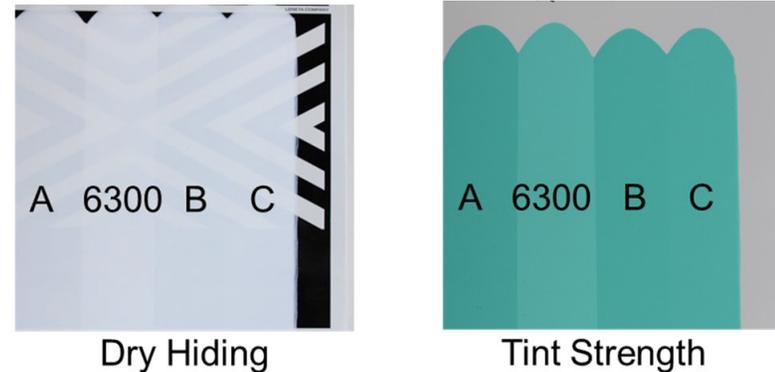


Figure 5. Light scattering advantage of TS-6300 as seen in white and tinted paints.

## TS-6300 Performance vs. “Universal” TiO<sub>2</sub> Grades

A study in Vinyl Acetate Acrylic (PVA) 63% PVC Flat Paint

When compared to R-902+ , TS-6300 provides:

- Significantly higher Dry Hiding Power, Tint Strength and Brightness at same paint TiO<sub>2</sub> content
- OR
- Equal Dry Hiding Power, Tint Strength and Brightness at **25% lower** TiO<sub>2</sub> content

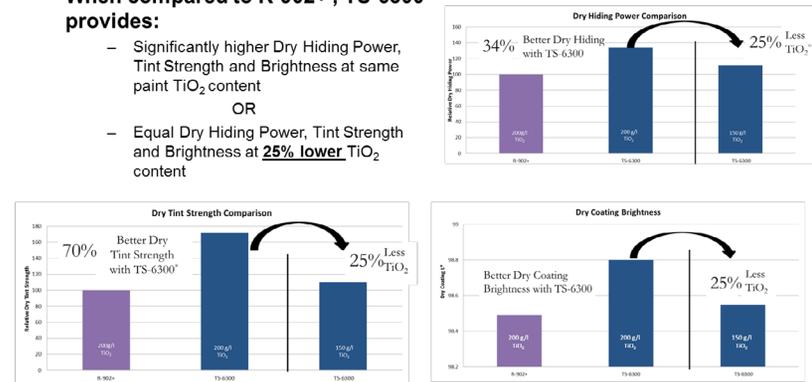


Figure 6. Options to take advantage of the improved light scattering performance of TS-6300

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### About Chemours Titanium Technologies

Chemours Titanium Technologies is the world's largest manufacturer of titanium dioxide products. We are dedicated to providing value for our customers, who subsequently supply the world with coatings, plastics, laminate and paper products. We deliver industry-leading innovation that addresses the growing worldwide demand for high quality titanium dioxide by working to create brighter, more efficient pigments. Even beyond the products we deliver, we also strive to be a partner that enables the development of sustainable solutions to customer challenges, further enhancing their business performance.

In addition to being known as a leader in safety and ethics within the TiO<sub>2</sub> industry for over 80 years, the Ti-Pure™ brand is known for technological innovation. Since the invention and implementation of the chloride manufacturing process in the 1950's, consistent advancement in Ti-Pure™ TiO<sub>2</sub> pigment design has expanded its quality and utility across the numerous applications in which it is a component. Fostering innovation to improve the quality of our customers' experience as well as our products has always been a critical component of our success, and will continue to do so as we build upon our 80+ years of expertise.

For more products and information, visit

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