

Ingenia Flexible Packaging Brief

TiO₂ – Titanium Dioxide – What makes a Masterbatch White?

Plastic films are typically clear when made from LDPE or LLDPE and translucent when made from HDPE. These films are pigmented white by using Titanium Dioxide since it imparts maximum opacity and whiteness over other minerals.

Titanium dioxide is a mineral which is found in the earth's crust. Titanium Dioxide occurs in three crystal forms – Rutile, Anatase and Brookite. For plastics, Rutile Titanium Dioxide is the crystal form of choice.

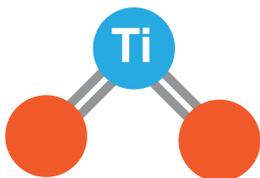
Titanium Dioxide can be manufactured by two processes – Sulfate and Chloride. In North America the Chloride process is primarily used. The chloride process yields a brighter product, with less by-products.





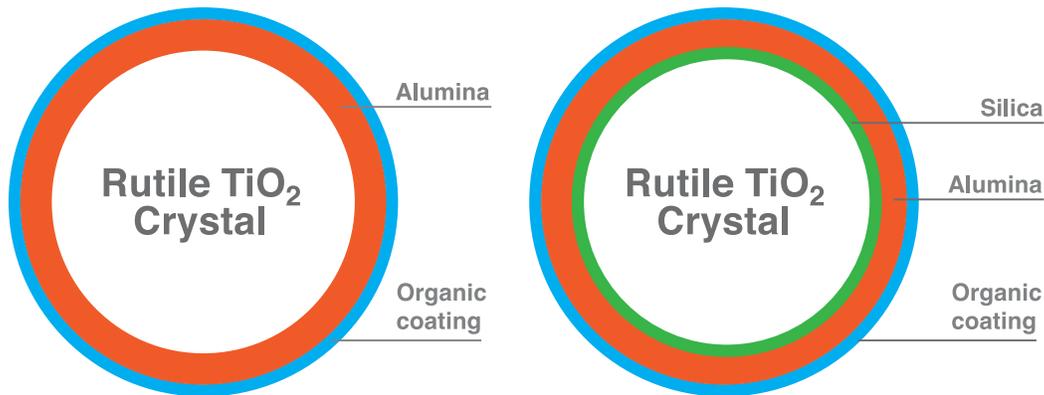
The opacity and whiteness of Titanium Dioxide are determined by the following factors:

- Particle size and Particle size distribution – Light scattering efficiency means better opacity, whiteness, brightness. Particle size is controlled to produce the final tint tone, smaller particle size results in a bluer tint, while larger particle size gives a yellow tint. Scattering efficiency of the base particle increases as you approach the optimal size, approximately half the wave length of visible light. A narrow and consistent distribution is essential to optimize properties.
- Refractive Index – Refractive Index determines how much the path of light is bent or refracted, when entering a material. To obtain maximum opacity the refractive index of the mineral has to be as dissimilar as possible to the refractive index of the host resin. For example, the refractive index of Rutile Titanium dioxide is 2.73 while the refractive index of Polyethylene is 1.5 -1.54. This results in an opaque white film.



Titanium Dioxide particles are hydrophilic - they disperse easily in water, but disperse poorly in an organic medium, e.g. polymers. Further, Titanium dioxide is a pro-degradant to the polyolefin that it is dispersed into. Therefore, the Titanium Dioxide particle is treated (coated) to minimize interaction that leads to diminished part properties.

Titanium Dioxide particles are treated to facilitate handling, dispersion and processability. Treatment with Alumina minimizes moisture pick up. Treatment with Silica enhances durability. Further, organic treatments are used to aid dispersion. The organic treatment has to be non-volatile, be uniform and optimized, so that it does not cause processability issues such as over lubrication and migration. Refer to figure below.



Schematic representations of standard Titanium dioxide (left) and Weatherable/Durable Titanium dioxide (right)

While standard Titanium Dioxide is used for packaging applications, weatherable or durable Titanium Dioxide is used for outdoor applications.

As Titanium Dioxide is a white powder it cannot be used in the free powder form but rather, is used in the form of a masterbatch or a compound. A masterbatch contains Titanium Dioxide at high concentrations, typically 50-80% and encapsulated/dispersed in a suitable polymeric resin. Masterbatches are let down for final use in a similar resin at a low percentage. Conversely, a compound contains lower levels of Titanium Dioxide at the actual usage levels in the final part in a suitable resin. Compounds are used directly, i.e. at 100% to create the final part.

The choice of the Titanium dioxide grade determines the efficacy of the masterbatch – dispersion, melt index, durability, undertone and opacity.

Use of Titanium Dioxide masterbatch provides the following benefits;

- Superior dispersion/distribution (maximize efficiency and performance of the Titanium dioxide).
- Accurate metering - leading to cost savings, superior products.
- Ease of handling - convert difficult to handle fine powder to pellets.
- Minimize interaction with other additives used in the films, such as slips and process aids.
- Minimize health hazards from free powder - hazards such as lung diseases, dust explosions, etc.

Titanium Dioxide masterbatches find use in blown film, cast film, blow moulding, injection moulding, extrusion coating and sheet extrusion



In Summary

The compounder/ masterbatch manufacturer has to ensure that the masterbatch is moisture free and that the Titanium Dioxide is uniformly dispersed within the carrier resin to provide a defect and gel free, uniformly opaque white film/sheet or molded part.

Ingenia has the manufacturing experience and technical knowledge to recommend the optimal white MB for your packaging applications. With a variety of stock and specialty White MB products, the solution is available at Ingenia.

Photography courtesy: Macro Engineering & Technology



www.ingeniapolymers.com