

Not all Titanium Dioxide White Pigments Are Created Equal !

How to Choose the Best White Pigment for Your Geomembrane

1. Introduction

In recent years there has been increased utilization of white-surfaced HDPE geomembranes for large projects as the white surface means less heat build-up in the sun hence less wrinkles, less distortion and less long-term heat load (i.e. less thermal oxidation).

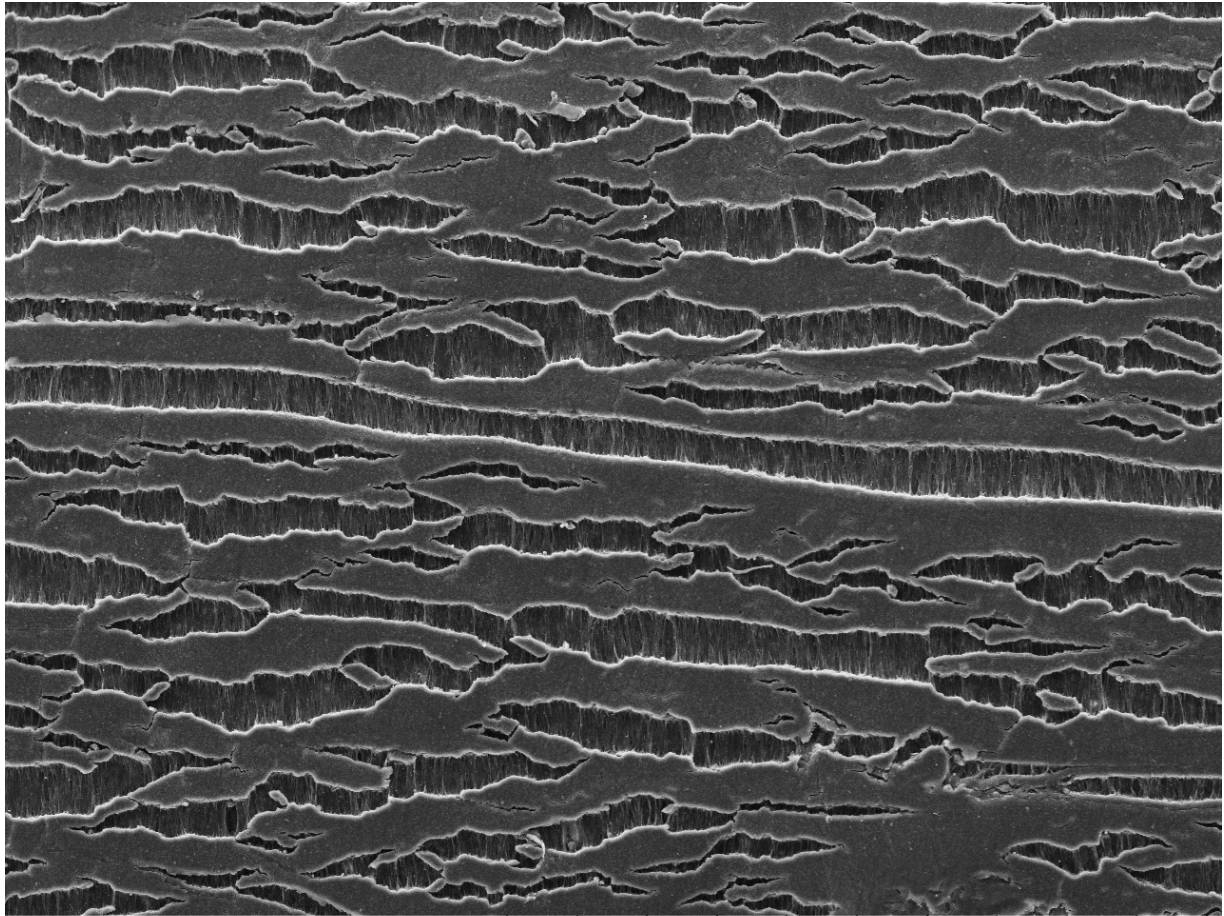
However it has been known by the HDPE liner manufacturers for some time that despite using higher loadings of stabilizers the white-surfaced geomembrane is more difficult to stabilize than black geomembranes.

Did you know?:

- Titanium dioxide is mined in two mineral forms *Anatase* and *Rutile*
- Rutile is used for pigment applications in plastics because it is more *photostable* than Anatase
- Anatase, for example, is used in white degradable shopping bags to make them fall apart quickly when left in the sun
- Even Rutile however is *photoactive* unless encapsulated with inorganic oxide (i.e. aluminium oxide and silicon dioxide) barrier layers to passivate the titanium dioxide
- For these reasons it is necessary for long-term exposed geosynthetics to use these special grades of coated rutile
- As with everything in life there are different levels of quality of coated rutile depending on price
- The most stable grades of titanium dioxide grades are the ‘Durable’ Coated Rutilites
- Using the wrong grade of titanium dioxide can lead to your geosynthetic polymer of coating breaking down quickly under UV light and chalking
- Coated rutile grade are also treated with an organic coating to improve compatible with the host polymer
- For HDPE applications the coated rutile should have a *hydrophobic* surface treatment
- For PVC or PVC-EIA applications the coated rutile should have a *hydrophilic* surface treatment

- Choosing the wrong grade of titanium dioxide for your geosynthetic product can lead to premature breakdown and quality complaints
- It is recommended to select the “*ultra-durable*” grade of titanium dioxide for maximum HDPE geosynthetic life

ExcelPlas has observed surface cracking of good-quality white on black HDPE geomembranes after some 5-7 years of exposed service (see micrographs of cracking below).



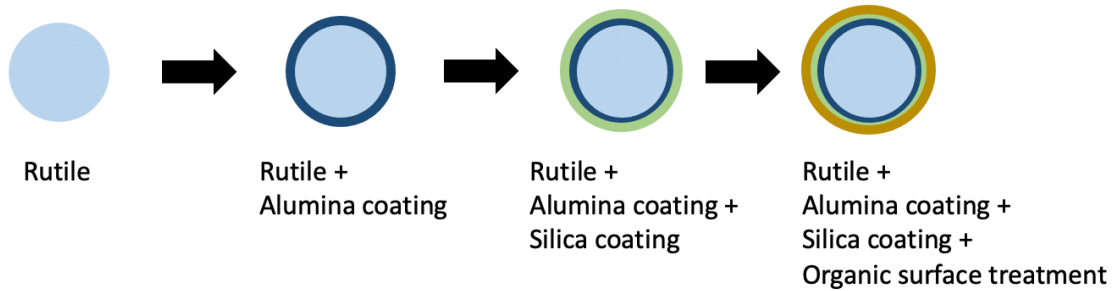
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HMUD8.3 x200 500 μ m

2. Hierarchical Surface Treatment of Titanium Dioxide

The types of encapsulation surface coating of titanium dioxide are shown in the graphic below.

Hierarchical Coating and Surface Treatment of Titanium Dioxide



Increasing durability in outdoor UV-exposed applications

Notes:

- Alumina surface coating is to passivate the titanium dioxide to reduce photoactivity
- Silica surface coating is to passivate the titanium dioxide to reduce photoactivity
- Organic stearic acid treatment to improve compatibility with polyolefins

3. Commercial Grades of Treated Titanium Dioxide

There exists many commercial grades of coated rutile as shown in the table below from one of the major suppliers DuPont. Note that the level and quality of the surface coatings and treatments vary significantly.

Table 1. Plastics Grades TiO₂ Physical Properties:

Property	Grade						
	R-101	R-102	R-103	R-104	R-105	R-350	R-960
TiO ₂ , wt%, min.	97	96	96	97	92	95	89
Alumina, wt%, max.	1.7	3.2	3.2	1.7	3.2	1.7	3.5
Silica, wt%, max.	N/A	N/A	N/A	N/A	3.5	3.0	6.5
Organic Treatment	hydrophilic	hydrophilic	hydrophilic	hydrophobic	hydrophobic	hydrophobic	N/A
Color CIE L*, min.	97.9	98.5	97.8	97.5	98.5	98.5	98.5
Specific Gravity	4.2	4.1	4.1	4.2	4.0	4.1	3.9

The R-105 and R-960 grades are recommended for long-term exposed polymer applications as they have the maximum levels of passivation. Due to its dual encapsulation with both alumina and silica as well as the hydrophobic treatment the R-105 is the optimum **durable** grade of titanium dioxide for white-surfaced HDPE geomembranes.

4. Optimum Grade of Treated Titanium Dioxide for HDPE

The inserts below have been extracted from the DuPont Technical Data Sheet for Ti-Pure™ R-105 (note in particular the yellow highlights).

Protection from Nature with Unsurpassed Durability

Ti-Pure™ R-105 is a rutile titanium dioxide (TiO₂) pigment, designed to extend the appearance and lifetime of outdoor plastic applications. **It is the preferred choice for ultra-durable performance.**

Features and Benefits

Manufactured via a proprietary chloride process, Ti-Pure™ R-105 features:

Ultra-durable performance to extend the lifetime of outdoor goods

High reflectivity that harnesses the power of light and maintains cool surfaces without deformation

Ti-Pure™

Exterior applications demand ultimate durability to protect against the ravages of nature's elements. It is a tough challenge to find the salient ingredient to lasting beauty and superior weatherability.

Rutile titanium dioxide can provide maximum protection for extended outdoor service life. However, not all grades of TiO₂ are created equal.

For durable polyolefin applications, Ti-Pure™ R-105 has the perfect combination of weatherability, optics, and processibility to meet the most exacting requirements.

Ti-Pure™ R-105 titanium dioxide has been specifically designed to achieve:

- **Maximum weather resistance**
- Bright, neutral whites
- Color formulation flexibility
- Superior processibility

Ti-Pure™ R-105 titanium dioxide was developed from over 50 years of experience in durable exterior applications providing exceptional performance.

Exceptional Durability

- UV energy is absorbed and dissipated by the fine sized particles of Ti-Pure™ R-105. Innovative silica encapsulation technology is used to impart a chemically inert coating on each TiO₂ particle to prevent microcracks, chalking, or other degradation of the plastic.
- Ti-Pure™ R-105 improves the efficiency of UV stabilizers.
- High gloss retention — polyolefin parts look and perform like new, longer.

Further Reading:

<https://rashimex.net/storage/PDF/Ti%20Pure%20Grade%20Selection%20for%20Plastic.pdf>