



Nanomaterial Risk Assessment Worksheet **DuPont™ Light Stabilizer for use as a polymer additive**

Outcome of Evaluation

DuPont has completed its evaluation of DuPont™ Light Stabilizer as is described in the documentation in the Nanomaterial Risk Assessment Worksheet and has approved moving forward to product announcement and subsequent commercial introduction.

Step 1. Describe Material and Its Application

Titanium is the ninth most common element in the earth's crust and is present naturally as the minerals rutile (TiO_2), ilmenite (FeTiO_3) and sphene (CaSiTiO_5) among others. DuPont extracts titanium from titanium minerals using chemistry and engineering and reforms the titanium into rutile titanium dioxide crystals (TiO_2 , titania).

The overwhelming majority of titanium dioxide produced and marketed globally today is pigmentary titanium dioxide used to impart whiteness into paints, plastics, and paper. Pigmentary titanium dioxide has a median particle size in the range of 250–350 nm. In commerce since 1912, over 11 billion pounds of titanium dioxide are produced and consumed each year. Approximately 2.5 billion pounds of pigmentary titanium dioxide are consumed in plastics each year.

DuPont, using innovative production technology, will produce a new family of products, DuPont™ Light Stabilizers, for use as a polymer additive. DuPont™ Light Stabilizer 210 is a surface-treated high-rutile phase titanium dioxide. DuPont's product has been optimized to absorb and scatter ultraviolet light so that it is effective as a UV stabilizer and UV screener for polymers. When used in polymer films and coatings they can protect substrates from the sun's damaging rays.

Powdered DuPont™ Light Stabilizer 210 will be delivered in plastic bags to plastics masterbatch/concentrate producers where it will be combined with other ingredients and intimately mixed with a molten polymer. Molten polymer encapsulates the particles. For more than half a century pigmentary titanium dioxide, carbon black and other fine and ultrafine powders have been processed to make masterbatch in this fashion. At polymer processing facilities the polymer pellets containing DuPont™ Light Stabilizer 210 are mixed with much larger amounts of virgin polymer resin pellets, the polymer is remelted and formed into sheets, films, parts, fibers, or coatings. The maximum addition level of DuPont™ Light Stabilizer 210 in the end polymer product is usually 3% or less.

Examples of applications envisioned for polymers stabilized with DuPont™ Light Stabilizers include sporting goods, outdoor furniture, fabrics, carpet fiber, toys – virtually any plastic product that will be exposed to sunlight. It also can be used in plastic films and sheeting to protect plants in greenhouses or packaged goods from UV light.

Use of light stabilizers can significantly extend the working lifetime of durable products, reducing materials and energy consumption for their replacement while reducing the volume of used plastics going to landfill.

DuPont™ Light Stabilizer 210, the first product, is approaching commercial availability. Earlier in the product development cycle DuPont selected this product as a test case in the development and evaluation of the Environmental Defense-DuPont Nano Risk Framework.

Step 2: Profile Lifecycles

Lifecycle Physical and Chemical Profile

DuPont™ Light Stabilizers have been well-characterized with respect to their physical and chemical properties and detailed data have been collected regarding their characteristics. DuPont™ Light Stabilizer 210 is a fine white powder with a distribution of particle sizes centered in the range of 130-140 nm on a weight basis. A portion of the distribution falls within the “nano” range, <100nm, and that portion is in the range of 10-20 weight percent. The product consists of dense polyhedral titanium dioxide crystals that can not be broken down to smaller size by ordinary mechanical action. The titanium dioxide surface is treated to shut down potential chemical interactions and to promote compatibility with end use systems. DuPont™ Light Stabilizers are stable refractory oxides and their composition will not substantially change throughout the material’s lifecycle. The Framework worksheet example contains more extensive “base set” physical and chemical properties.

Lifecycle Hazard Profile

According to Framework Step 2B, a series of toxicity studies has been performed to evaluate health hazards and environmental hazards associated with DuPont™ Light Stabilizers. Based on the toxicology studies enumerated in the Framework worksheet there doesn’t appear to be significant differences in the health effects of DuPont™ Light Stabilizer 210 and pigmentary titanium dioxide. Both have HMIS (Hazardous Materials Information System) health hazard rating of 1 (low). DuPont has set the inhalation AEL (acceptable exposure limit) for DuPont™ Light Stabilizer 210 at 2 mg/m³.

Based on the aquatic toxicity studies performed there don’t appear to be significant differences in the environmental effects of DuPont™ Light Stabilizer 210 and pigmentary titanium dioxide. Aquatic toxicity testing for fish and invertebrates showed DuPont™ Light Stabilizer 210 demonstrated low hazard while testing results with algae showed medium concern, thought to be due largely to the light blocking ability of titanium dioxide.

Regarding environmental fate, titanium dioxide is naturally occurring and ubiquitous in the environment in various forms. In soil or sludge samples, there are no established methods for differentiating naturally occurring titanium dioxide from titanium dioxide contained in DuPont™ Light Stabilizer. There are no accepted methods for bioaccumulation potential screens for nanomaterials. These are areas where further methods development is required.

DuPont™ Light Stabilizer 210 is stable and compatible with other materials in the environment. It is not explosive, flammable, catalytically reactive or corrosive.

Lifecycle Exposure Profile

Exposure potential to DuPont workers is expected to be low under normal operating conditions. Engineering controls and personal protective equipment including safety glasses and gloves are used. Half-mask dual cartridge respirators with P100 filters are to be used if the acceptable exposure limit is exceeded. Protective coveralls are made available to workers. Personnel monitoring and area monitoring for respirable particles have been undertaken during production and handling of DuPont™ Light Stabilizer 210, including during product powder packaging tests when exposure potential is considered to be greatest. Based on the monitoring data, DuPont's industrial hygiene experts determined that exposure in all areas was below the acceptable exposure limit (AEL) of 2 mg/m³. Also, monitoring of pilot compounding/extrusion areas, where DuPont™ Light Stabilizer 210 is incorporated into polymers, gave similarly low respirable dust exposure results.

DuPont has incorporated DuPont™ Light Stabilizer 210 into polymers in processing equipment similar to that expected to be used in customer's polymer processing areas. Procedures and recommendations for safe handling have been developed. With use of proper procedures and personal protective equipment, exposure is expected to be low. Product use, storage and handling bulletins will be provided to customers and on-site consultation is available. Recommended procedures, personal protective equipment, and engineering controls are provided in the bulletin.

Once incorporated into polymer DuPont™ Light Stabilizer 210 is encapsulated by the polymer and exposure potential to workers and consumers is further reduced.

Exposure to DuPont™ Light Stabilizer 210 used in light stabilizing applications is expected to be minimal throughout its product lifecycle because:

- (1) Potential worker exposure is well-managed in industrial settings.
- (2) Due to the low production, use of engineering controls, and inherently low volatility and low solubility, releases to the environment are expected to be below levels of human health or ecological concern, from manufacturing through waste disposal.
- (3) The ultimate sink is a polymer matrix (end product) where it is expected to be retained unless incinerated. Environmental releases from incineration of polymer are not expected to be significant due to the low concentrations in the materials going to the incinerator and due to incinerator emissions controls.

Step 3: Evaluate Risks

DuPont performed a risk evaluation by synthesizing the information collected in Step 2.

The Risk Assessment analysis concludes that there don't appear to be significant differences in the health effects of DuPont™ Light Stabilizer 210 and pigmentary titanium dioxide, both showing low hazard. Further, the exposure throughout its lifecycle

is well-managed and minimal. The combination of a product with low inherent hazard and minimal exposure results in the conclusion that there are no substantive risk issues associated with manufacture, processing, use or disposal of DuPont™ Light Stabilizer.

Step 4. Assess Risk Management

Because the Risk Assessment results indicate that there is low inherent hazard and minimal exposure, only a few additional data needs and actions were recommended. Examples include: 1) scheduling of personnel and area monitoring of respirable dust during non-routine equipment procedures, sampling, and spill cleanup, and 2) developing and documenting recycling procedures. We also agreed to conduct an additional pulmonary instillation test and product specific extraction tests to reaffirm findings. We are considering the need to perform toxicity tests for sediment dwelling organisms. Details can be found in the full document.

Step 5. Decide, Document and Act

A cross-functional decision-making review team was assembled to critically review the compiled DuPont™ Light Stabilizer framework worksheet information, discuss the information with the product stewardship team, analyze the options, and to deliberate on any additional data needs or actions. The review team accepted the recommendation made in Step 4 for additional data needs and actions and approved moving forward to product announcement and subsequent commercial introduction.

Step 6. Review and Update

DuPont has scheduled reviews of DuPont™ Light Stabilizer 210 first in 3Q2009 and subsequently every 4 years thereafter. Additional “as-needed” risk reviews will be triggered by events such as applications in new market segments, significant changes in hazard or exposure information, or production volume beyond that anticipated in the current document.

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