



January 7, 2014

Safety and Environmental Issues relating to Photocatalytic TiO₂

Photocatalytic TiO₂ (aka PCO or photocatalytic oxidation – the light activated reversal of photosynthesis) is a 45 year old technology that has been the subject of 9,000+ patents and 34,000+ scientific articles.

Widely studied for its potential to improve environmental remediation and infection control, there have been 30+ international conferences on the use of photocatalytic TiO₂ to treat air and water pollution. PCO products (self-cleaning glass, tile and aluminum cladding; smog reducing cement and paint; PCO air purifiers, etc.) generate nearly \$2 billion of commercial activity a year – mostly in Europe and Asia.

While photocatalytic TiO₂ is not new, it has been relatively unknown in the United States. When Americans first encounter PCO, the “sounds-too-good-to-be-true” nature of the technology is understandably greeted with sharp questions and healthy skepticism.

PURETi Group LLC is an American manufacturer of aqueous photocatalytic solutions – a 3rd generation, advanced form of PCO technology that is sprayed onto building materials – new or existing – as a watery mist that dries clear to form self-cleaning and air purifying surfaces. PURETi is simpler, stronger and more versatile and cost effective than all known competitors. One sustainable, completely transparent application of PURETi is warranted to work for 5+ years.

PURETi on the outside of buildings reverses pollution and ends grime build-up; saving water, time, energy and cost through reduced cleaning. PURETi on the inside of buildings improves IAQ, eliminates odors and enhances respiratory health.

PURETi is a NASA Dual Use Technology Partner, winner of 6 environmental awards and an HOK innovation partner. PURETi has been successfully applied to 2+ million square feet of buildings and building materials. All PURETi products have been registered safe by the National Sanitation Foundation.

PURETi is, at its heart, a health care company. Towards that end we put safety first, welcome all questions and take all concerns seriously.

We endeavor to be transparent, collaborative and scientifically rigorous in our approach. We are pleased to share the following scientific facts that we believe support our conviction that PURETi is safe for humans, safe for the environment and a great new tool for sustainability and health.



The Facts re: PURETi and TiO₂ Safety

1. **Titanium Dioxide or TiO₂ is the 9th most common mineral in the world** and the most studied of all nano materials because it is everywhere in everyday life. Also known as white pigment, TiO₂ is widely used in toothpaste, sunscreens, paint (there is 1.5 pounds of TiO₂ in every gallon of paint) and even Oreos (the white in the white creamy middle).

2. **PURETi manufactures water based solutions with nanoscale TiO₂ in suspension. PURETi is 98% - 99% water and 1%- 2% TiO₂ and PURETi is safe.**

a. **TiO₂ has been found to be safe.** The FDA classifies TiO₂ as GRAS (generally recognized as safe) and the European Science Commission has found TiO₂ to be safe in all forms – nano and macro and active and inactive. The vast preponderance of scientific evidence supports these conclusions.

b. **PURETi has been registered safe for surface applications with the National Sanitation Foundation (NSF).**

c. **PURETi VOC free, water based solutions have passed the California Aquatic Toxicity test.**

d. **PURETi is part of an FDA approved protocol** that transforms homes into hospital grade pure air environments to help prevent respiratory distress in children with cystic fibrosis.

e. **There are no respirable powders in PURETi.** The TiO₂ crystals in PURETi are all encapsulated in water in solution and durably bonded to surfaces after application.

f. **NIOSH has found the application of PURETi to be safe.** NIOSH – the National Institute of Occupational Safety and Health – conducted a real world evaluation of the application of PURETi and found our spray methods to be safe and TiO₂ exposure levels to be well below any threshold of concern.

g. **PURETi bonds durably and abrades safely.** Prof. Orlov of Stony Brook University; lead author for the UN's North American Committee on Nanotechnology, Safety and the Environment found PURETi to bond tightly to treated surfaces and only abrade with great force and in flakes larger than 100 nm – beyond any area of concern.

3. **PURETi is a water based (99% water) mineral film former that does not pose any respiratory risk – pre or post application.** PURETi is a heterogeneous surface treatment with nano crystals encapsulated in water that become part of durable, spot welded, polymeric like ceramic/mineral films when applied.



The Facts re: PURETi and the Environment

Life Cycle Analysis

Life Cycle Analysis (LCA) has been done and PURETi has been found to be environmentally beneficial in a broad and sustainable way. Prof. Marwa Hassan of LSU, in her peer reviewed 2009 paper on the LCA of Smog Reducing Concrete, found smog reducing concrete, despite the high carbon content of concrete, to be an environmentally beneficial product.

Prof. Hassan has studied PURETi's heterogeneous, water based surface treatment approach to creating photocatalytic surfaces for over 5 years. Her LSU team has found spray applied PURETi to be 2-4 times better at reducing NO_x than photocatalytic concrete produced with embedded TiO₂ nano powders.

Prof. Hassan stated further that the environmental gains created by PURETi (water and energy savings from reduced maintenance, NO_x reduction, methane and VOC oxidation, and heat island mitigation through increased solar reflectance) far outweigh the carbon cost of the trace amounts of CO₂ produced in the photocatalytic process.

Pollution Reversal

PURETi has been found to significantly reduce NO_x (an indirect GHG and the key ingredient in acid rain and smog) in repeated studies with major American universities (SBU, LSU, WSU and U. of TX), state departments of transportation (LDOT and MODOT) and independent international test labs (the UK's Queens International Photocatalyst Test Centre and Italy's Ferrara University). **One lane mile of PURETi treated road will remove 1 ton of NO_x per year per Prof. Hassan of LSU.**

In June 2013, a report from Indiana University raised concerns that PCO posed a risk to the environment by its potential to convert ammonia to NO_x. PURETi believes this report is an initial and isolated lab study that runs counter to all previous research in the field and we have raised several basic questions with the study and its design:

- Weak catalyst - the catalyst studied was a weak catalyst. Weak catalysts can create incomplete oxidation. PURETi is the strongest catalyst on the market.
- Weak Light - the light deployed in the study was very low. PCO needs light to work. The Indiana study was compromised by its lighting choices.
- Insufficient Time – PCO requires time to work. The Indiana study took a short snapshot time that was misleading.

PURETi's science adviser is Prof. Alex Orlov of Stony Brook University; UN lead author on Nanotechnology and the Environment and Chair of the American Chemical Society's committee on photocatalysis. In addition to the points raised above re: the questionable methodology deployed in the Indiana study, Professor Orlov also noted the ironic point that ammonia is poisonous to humans and that NO_x, while a greenhouse gas, is not a poison and poses a lower order of risk to humans.



CONCLUSION

PURETi is dedicated to producing the safest, simplest, most sustainable, credentialed and cost effective photocatalytic solutions in the world. We believe we currently do and we believe further that photocatalysis – the light activated acceleration of the natural process of organic degradation – holds tremendous power to be a healing force for man and planet.

PURETi works with universities, national labs and independent testing organizations on a daily basis to insure that our products are safe, effective and environmentally beneficial. This has been our practice since day one over ten years ago and this will continue to be our standard and our commitment as we move forward.

PURETi has been proven safe. PURETi has been proven environmentally beneficial. PURETi continues to test. The studies that PURETi is involved with now or will soon undertake are to document precisely how beneficial the application of PURETi is to:

- Road and building surfaces to reduce NOx to prevent smog and improve air quality – studies are ongoing at LSU and WSU and will soon be underway in Barcelona
- White roofs to prevent grime build up to maintain solar reflectance and save energy – studies are being planned with LBNL and Occidental College
- Solar panels to reduce de-rating due to soiling to increase electrical output – studies are being run with several solar firms and test labs
- School and office interior windows, window covering and light fixtures to improve IAQ – studies are being run in London and will soon be run in the US
- Building facades and windows to reduce maintenance and save water, energy and cost – case studies are being developed in all markets
- Residential and healthcare interiors to prevent disease related to respiratory distress – studies are underway with the Asthma and Allergy Prevention Company

Our mission is to put the power of photocatalysis to the broadest possible end use to benefit people, animals and the environment and to do this in the safest and most sustainable manner possible.