Pavement Technology, Inc. **Real Science. Real Results.**

Achieve Up to 60% NOx Capture with Pollution-Reducing Photocatalytic Pavements

Pollution-removing and heat-reducing asphalt and concrete penetrants fortified with photocatalytic titanium dioxide (TiO_2), from Pavement Technology, Inc., reduce vehicular exhaust pollution and mitigate the effects of Urban Heat Islands (UHI). TiO_2-enhanced pavements create an air-purifying and solar-reflective top boundary that perpetually regenerates itself throughout the life (LCA) of the pavement, resisting oxidative weathering and traffic-related wear, while materially contributing to compliance with the Clean Air Act (CAA) and U.S. EPA's stringent National Ambient Air Quality Standard (NAAQS). Technical assistance is available from the manufacturer and its trained field representatives.

Ti-intro CME® Application

800-333-6309 • www.smogeatingroads.com

The Vehicular Pollution Challenge

According to the EPA's "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018" report, CO_2 emissions from mobile sources are the most significant contributor to harmful CO_2 Eq. greenhouse gas (GHG) emissions, such as nitrogen oxides (NOx) and sulfur oxides (SOx) formed during internal combustion processes. Vehicles introduce one of these dangerous toxins—nitrogen dioxide (NO_2)— into the environment, increasing ozone concentrations that form the nucleus of unhealthy photochemical smog.

The near-road microenvironment (ME) is a significant area of policy and practice concern for modern urban planners, regulators and sustainability managers. Emissions from cars and trucks are the major source of anthropogenic airborne toxins, which cause atopic disorders such as asthma and even deadly pulmonary and cardiovascular diseases.

As the ozone concentrates, the percentage of airborne nitrogen undergoing oxidization also increases, resulting in an increasingly higher percentage of NO_2 in the atmosphere. Research has identified a clear association between serious environmental, ecological and human health issues and the presence of photochemical smog, acid rain and NOx.

The ratio of NO_2 to NOx has been significantly increasing in our urban centers over the years due to a substantial increase in population and associated traffic.

Solar-Based NOx Capture

EPA technical data shows more than two-thirds of atmospheric NOx is emitted from mobile sources. Several approaches, including photocatalysis, have been studied as methods for counter-acting NOx emissions.

Photocatalysis is the acceleration of a photo-reaction (light absorbing) in the presence of a catalyst. A natural semiconductor material, such as TiO_2, activated by ultraviolet spectrum (UV) light creates hydroxyl radicals and superoxide through spontaneous oxidation-reduction reactions. These powerful oxidants aggressively decompose organic pollutants, such as NOx and volatile organic compounds (VOCs).

As a photocatalyst, TiO_2 is a multifaceted photo-responsive material[1] rapidly gaining increased scientific and commercial interest for near-roadway MEs due to its ability to advance a host of positive environmental and ecological benefits.

Up to 60% Pollution Capture – TiO_2-reactive surfaces capture and oxidize a variety of pollutants and contaminants, including those emitted by vehicles, such as NOx and VOCs, reducing ozone pollution and mitigating acid rain formation.

Reduced UHI – TiO_2-treated surfaces provide a solar-reflective top boundary that lessens pavement-related radiative forcing (RF) by reducing heat absorption and the convective re-release (pavement emissivity) from solar radiation. The result is a genuinely "cool pavement" that mitigates Urban Heat Island (UHI) effects and extends the life-cycle (LCA) of pavements by slowing down oxidation.[2]

Rapid Water Displacement – TiO_2-enhanced pavements are super-hydrophilic, enabling rapid surface water release. The result is a pavement that is self-cleaning, removing contaminants and preventing staining. The significantly enhanced hydrophilic properties are indicated for improved weather-related road safety by rapidly displacing rain and inhibiting ice formation.[3]

Product Stock

- A.R.A.-1 Ti® - Asphalt
- Litho1000Ti® - Concrete
- Ti-intro CME® - All Substrates

Markets

- Urban/Suburban Municipalities and Counties
- DOTs
- Airports

Compatible Substrates

Asphalt and Concrete surfaces of any age, including:

- Pavements
- Bridge Decks
- Tunnels
- Parapet Walls
- Parking Structures

PTI, with a half century of experience introducing nano-chemical technologies to pavements, has developed photocatalytic solutions that deeply penetrate pavement surfaces to deliver photocatalytic grade TiO_2 into depth at optimal load for sustained photo-oxidation of pollutants and UHI mitigation.

The product stock can be applied to almost any asphalt or concrete substrate using PTI's advanced application apparatus, and at a fraction of the cost of more archival means to clean air, reduce heat build and extend infrastructure life cycle.

For more information contact Michael Durante, MDurante@pavetechinc.com

Manufacturer and National Distributor

D&D Emulsions, Inc., Mansfield, OH
Pavement Technology, Inc., Westlake, OH

1 *Polymers, Light and the Science of TiO_2, DuPont™ Ti-Pure® Titanium Dioxide, Dow DuPont, www.dow-dupont.com.*

2 *Gopalakrishnan K, et al., Climate Change, Energy, Sustainability, and Pavements, Springer, 2014.*

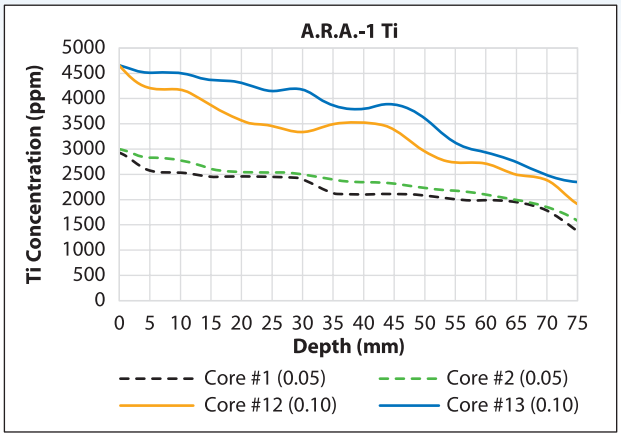
3 *Arainpour F and Farzaneh M, On Hydrophobic and Icephobic Properties of TiO_2-Doped Silicon Rubber Coatings, Department of Applied Sciences, Universite du Quebec, International Journal of Theoretical and Applied Nanotechnology, 2012.*

Specifications/Testing[4 5]

Depth of Penetration

Pavements treated with A.R.A.-1 Ti maltene-based asphalt rejuvenator showed delivery of high concentrations of photocatalytic grade TiO_2 both at the surface and well below wearing-course depth.

TiO_2 Penetration Orlando International Airport



Source: Texas A&M Transportation Institute (TTI)

NOx Reduction Efficiency

Results showed that the pavements impregnated with A.R.A.-1 Ti maltene-based asphalt rejuvenator and Litho1000^{Ti} concrete sealer/hardener had NOx reductions ranging from 42 to near 60 percent.

NOx Reduction – Orlando International Airport and Charlotte County (FL)

Site	NO Reduction Efficiency (%)				
0.06–0.08 gsy > TiO_2	Control Sample	A.R.A.-1 Ti Sample A	A.R.A.-1 Ti Sample B	Litho1000^{Ti} Sample A	Litho1000^{Ti} Sample B
Orlando International	NEGL	45%	43%	53%	57%
Charlotte Co. (FL)	NEGL			42%	46%
		Ti-intro CME Concrete Sample A	Ti-intro CME Concrete Sample B	Ti-intro CME Asphalt Sample A	Ti-intro CME Asphalt Sample B
Charlotte Co. (FL)	NEGL	48%	47%	49%	50%

Source: Texas A&M Transportation Institute (TTI)

Solar Reflective Index

Results showed that the pavements impregnated with A.R.A.-1 Ti maltene-based asphalt rejuvenator, Litho1000^{Ti} concrete sealer/hardener and Ti-intro CME pollution-reducing penetrant had SR value improvements ranging from 55 to 85 percent, placing all treated surface courses well above USGBC LEED for UHI mitigation.[6]

Solar Reflectance

(a) Orlando International Airport (b) Charlotte County (FL)

Compound/ Substrate	Solar Reflectance Index Value (SRI)					
Application Rate (a)	Control Sample	Control Sample	0.10 gsy	0.10 gsy	0.08 gsy	0.08 gsy
A.R.A.-1 Ti/ Asphalt	9	8	40	39		
Litho1000^{Ti}/ Concrete	24	24			38	38
Application Rate (b)	Control Sample	0.03 gsy	0.06 gsy			
Ti-intro CME/ Asphalt	11	30	34			
Ti-intro CME/ Concrete	20	37	42			
Litho1000^{Ti}/ Concrete	25	41	46			

Source: Texas A&M Transportation Institute (TTI)

Super Hydrophilic Surfaces

Results showed that the pavements impregnated with A.R.A.-1 Ti maltene-based asphalt rejuvenator improved water displacement by as much as 40 percent, creating an antimicrobial surface and a much safer roadway.

Water Contact Angle (WCA) – FDOT Test Bartow (FL)

Site	Water Contact Angle°				
A.R.A.-1 Ti	Control Sample	TiO_2 1 Visible Light	TiO_2 1 UV Light	TiO_2 2 Visible Light	TiO_2 2 UV Light
FDOT Test	81°	82°	51°	81°	50°

Source: Texas A&M Transportation Institute (TTI)

4 Zollinger DG and Joshaghani A, Laboratory Investigation of the Effect of TiO_2 Topical Treatments on Concrete and Asphalt Samples, Texas A&M Transportation Institute, May 2019.

5 Zollinger DG and Joshaghani A, Solar Reflectance Analysis of TiO_2 Penetrant Treatments on Concrete and Asphalt Samples, Texas A&M Transportation Institute, August 2019.

6 U.S. Green Building Council USGBC), LEED V4 Heat Island Reduction (HIR) via Solar Reflectance Index (SRI) > 50% 29, www.usgbc.org.

Patents: US 9,493,378 B2 and US 8,899,871 B2

Made and Sourced in America

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