PRETIOX

application of photocatalytic titanium dioxide in various areas

Clever choice

PRETIOX CG types are suitable for any photocatalytic application from air pollution treatment, photocatalytic surfaces, water treatment, to organic substances decomposition, various photocatalytic products.

PRECHEZA

PRETIOX

titanium dioxide photocatalysis

Although photocatalytic properties of TiO_2 have been well known for decades, direct utilisation of this phenomenon in commercial products emerged only recently. PRETIOX CG types are suitable for any photocatalytic application from air pollution treatment, organic substances decomposition, photocatalytic products or surfaces to cleaning troublesome water organic pollution.

Basic principles of titanium dioxide photocatalysis

TiO_2 photocatalysis is a reaction induced by UV light absorption and subsequent formation of electron-hole pair. This pair either recombines or reacts with water/oxygen and forms an OH radical. Such radicals are extremely reactive and oxidize almost any organic material in the vicinity of TiO_2 surface.

Titanium dioxide

Titanium dioxide acts as a very effective inorganic photocatalyst for removing some organic and inorganic pollutants (above all NO_x). When illuminated with UV light (below 380 nm), electron-hole pairs are generated in valence and conduction bands. The oxidative reaction in the presence of molecules of water or oxygen results in creating surface radicals. They attack molecules of pollutants and cause their degradation.

Illuminate concrete or a plaster mixture

For example, if we illuminate concrete or a plaster mixture pigmented with photoactive titanium dioxide with UV light, NO_x is oxidized to nitric acid. This acid reacts with present calcium carbonate to calcium nitrate which can be washed with water into soil and can be used by plants, while the liberated water and carbon dioxide remain in atmosphere. The amount of calcium carbonate in concrete is in significant surplus, so this reaction does not influence structural properties of materials.

The building industry

The building industry is a quickly growing industrial branch, which continues to innovate its technological processes and improve properties of building materials.

Using of photocatalytic TiO_2 in powder form in chosen matrixes of building materials is one of the possibilities. TiO_2 is described as the so called powder constituent of inert type (I) based on used terminology. Such a constituent may be added directly into cement, fresh concrete, silicate paste plaster materials and silicate paints. In case of cement or fresh concrete, the complicated photocatalytical process is realised only on the surface of set concrete. TiO_2 dosing is expressed in proportion to cement. Amounts up to 15% are possible without significant limitation of mechanical and physical properties of concrete. In case of TiO_2 application directly into cement it is necessary to work in accordance with the ČSN EN 197–1 standard, which mentions maximum dosages of other components in cement composition.

The EU 1999/30/ES Directive requiring a significant reduction of nitrogen oxide in all EU member countries not later than by January 2010 was the impulse for applying photocatalysts in building materials when other ways of reducing NO_x are not economically or technically feasible.

TiO_2-based photocatalysts can also be added to paste silicate-based plaster materials. They are applicable in the follow-up for outdoor and indoor usage on new or old bases it helps to degrade and on thermal insulation systems. It is a new generation of professional materials with excellent properties and easy processibility ensuring high adhesion to all kinds of building bases. Paste plaster materials are usually delivered with content of constituents actively suppressing moss and algae growth on finished surfaces. When photocatalytic TiO_2 is used in paint or plaster, it helps do degrade organic substances and, therefore, decrease attraction of such surfaces to biological contamination. This secures an increased degree of cleanness of the final surface and, in addition, the surrounding air compounds which could be harmful to the plaster surface are degraded. Application of photocatalytic TiO_2 in paste plaster materials significantly reduces maintenance costs by decreasing time between necessary cleaning. This type of plaster materials can be coloured only with stable inorganic pigments. When organic pigments are used for colouring materials with photocatalytic TiO_2, lightfastness is significantly compromised by the photocatalytic effect of the present titanium dioxide.

Nitrogen oxide removal path by photoactive effect of TiO_2 incorporated in plaster, concrete or paint surface.

An important role of photocatalytic surfaces on building materials is the removal of NO_X, especially in places where other measures are ineffective or economically not feasible like in inner cities crossroads with heavy traffic. Increased concentration of NO or NO_2 results from any combustion process. When those molecules touch photocatalytic surface irradiated by UV light they are oxidised to nitric acid which reacts with lime in construction material to calcium nitrate. The surface then renews by washing down this compound during rain.

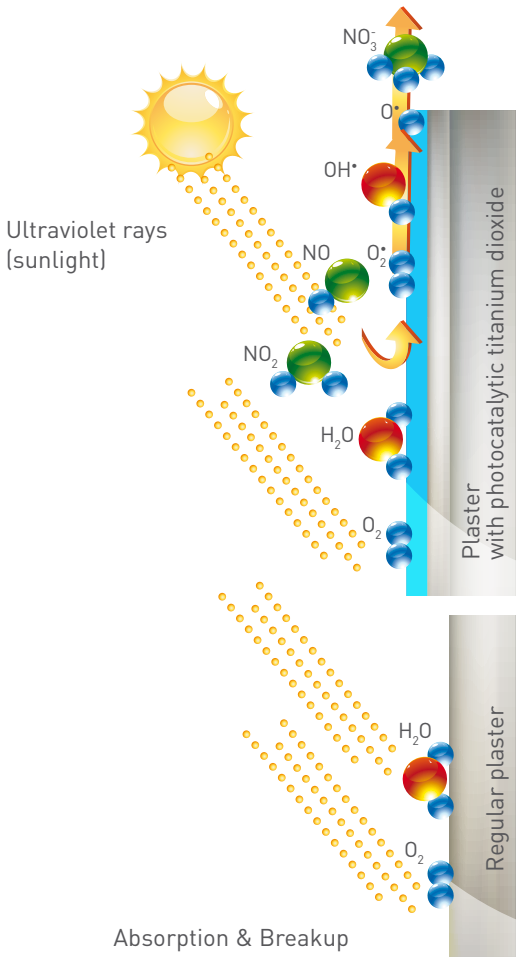
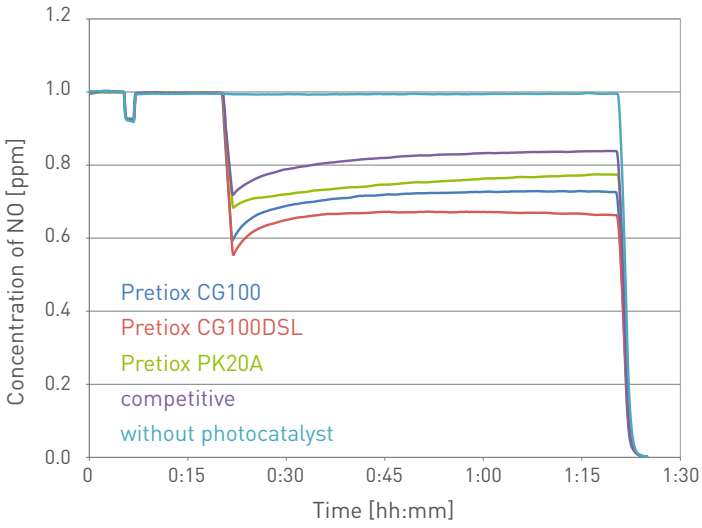


Figure: Nitrogen oxide removal path by photoactive effect of TiO_2 incorporated in plaster, concrete or paint surface.

Degradation of NO on the surface of concrete



Testing photoactivity of cements according to UNI 11259

cement	TiO_2	R(4)	R(26)	photoactive
with competitive equivalent	4% of competitive equivalent	32.13	51.18	yes
CEM I 42.5R	4% CG11	74.64	88.37	yes
CEM I 42.5R	4% CG100	45.61	69.01	yes
CEM I 42.5R	4% PK20A	54.09	91.41	yes

NO degradation on surface of various concrete blocks with and without photocatalytic TiO_2 as measured by ISO 22197-1:2007 method. Concrete pigmented by photocatalytic TiO_2 leads to NO concentration drop around 20-30% after irradiation by UV light.

Areas of application of special photocatalytic titanium dioxide PRETIOX

PRETIOX	CG11	CG100	CG300	PK20A	CG100DSL
Building industry					
Renovation of facades	■	■			■
Cement/concrete	■	■		■	■
Industry of paints					
Silicate paints	■	■		■	
Preparation catalysts			■		

■ recommended ■ suitable

Paints

Special grades of titanium dioxide with large surface area and high photocatalytic activity are suitable for application in functional paints. Photocatalytic TiO_2 added to indoor or outdoor paint causes efficient absorption and following decomposition of toxic gases (NO_x, formaldehyde, ammonia etc.) on the surface of paints. Besides degradation of toxic gases it is necessary to mention also the self-cleaning effect and removal of foul smell. Paints have high adhesiveness to application surface; moreover, outdoor paints have high resistance to abrasion and repulse water.

The maximum effect for outdoor application is achieved by using a mixture of rutile pigment and anatase nanoparticles – the rutile modification of TiO_2 protects deeper layers of paint against UV irradiation and highly photoactive anatase nanoparticles cause photocatalytic corrosion of the thin surface layer of top-coat. Inorganic-based substrate should be used, otherwise photocatalytic titanium dioxide would interact with organic components of paints. Photocatalytic functional paints were developed in a narrow cooperation with institutions involved in preparing paints, and their long-term efficiency was tested with very good results (rhodamine tests and quantitative dynamic tests). Photocatalytic titanium dioxide PRETIOX types CG preserve standard coating parameters and bring new quality to indoor and outdoor coating systems.

Fibres, fabric and paper

Incorporating photocatalytic TiO_2 to fibers, fabric or paper can bring new quality to new functional materials like curtains, wall paper, sunblinds and other material. It is expected and proved that materials which are properly impregnated with photocatalytic TiO_2 can serve as air cleaning means in areas like vehicle interiors, public places and other heavy polluted areas. Due to photocatalytic effect, the surface of treated material can stay clean for a longer period of time, especially, when some organic material is expected as pollutant.

Typical physical and chemical properties

PRETIOX	CG11	CG100	CG300	PK20A	CG100DSL
TiO_2 content [%]	> 99.0	> 97.5	> 87.5	> 87.5	49.5–52.5
Crystal modification	anatase	anatase	anatase	anatase	anatase
Specific surface area [m^2/g] BET (5 points)	10–13	70–110	250–350	70–110	70–110*
Delivery form	powder	powder	powder	powder	suspension

*Surface area of raw material

Health and environment

Packaging

PRETIOX CG is packed in standard paper bags from 10 to 25 kg net weight each or in big-bags from 300 to 1,000 kg net. PRETIOX CG is delivered on disposable wooden palettes (each palette up to 1 ton), palettes are covered with polyethylene foil. Special packaging and labeling can be delivered on request.

Safety, health and the environment

TiO_2 as a white pigment is ubiquitous in our society. Most of the surfaces and items that are white in colour contain TiO_2. Thus, we are surrounded by TiO_2 containing materials in our homes, workplaces and public areas. Since the introduction of TiO_2 as a commercial product in 1923, no health concerns have been associated with exposure among consumers or the general population. These facts are supported by the results from four large epidemiology studies involving more than 20.000 workers in the titanium dioxide manufacturing industry in North America and Europe which indicate no association with an increased risk of cancer or with any other adverse lung effects.

PRETIOX is stable under normal conditions and inert to most chemical substances. Titanium dioxide is not generally classified as hazardous to human health or to the environment and is also nonhazardous substance for transport. When handling of Pretiox CG, the powder can generate dust, and appropriate dust respirators should be used. PRECHEZA provides customers with Safety Data Sheet in accordance with EEC regulative.

There is concern regarding the use of nano TiO_2 such as photocatalytic TiO_2. There are numerous studies concerning health issues with various scientific relevance and significance. There is no proof that nano TiO_2 is associated with any increased health risk when used properly. According to our recent findings, TiO_2 even in its most photocatalytic forms is not phototoxic according to 3T3 NRU test (approved by EC/COLIPA).

* International Journal of Pharmaceutics 481 (2015) 91–96

PRECHEZA a.s.
nábřeží Dr. Edvarda Beneše 1170/24
750 02 Přerov | Czech Republic
Phone: +420 581 252 629
Fax: +420 581 253 830
E-mail: sales@precheza.cz

www.precheza.cz

preTiO2x

This leaflet is a general guide to the properties and fields of potential application of PRETIOX photocatalytic. Information on application is given in good faith and does not constitute any guarantee. For specific grade selection, see Product Speciications or contact Technical Service at PRECHEZA company. Material Safety Data Sheet and additional information about products and company is available on www.precheza.cz. Quality control of Pretiox CG is performed at all stages of production.
Samples are available on request. We recommend trial application tests.

design: COLOUR FUSION | photo: MICHAL FABIAN, INGIMAGE, SHUTTERSTOCK | 2016