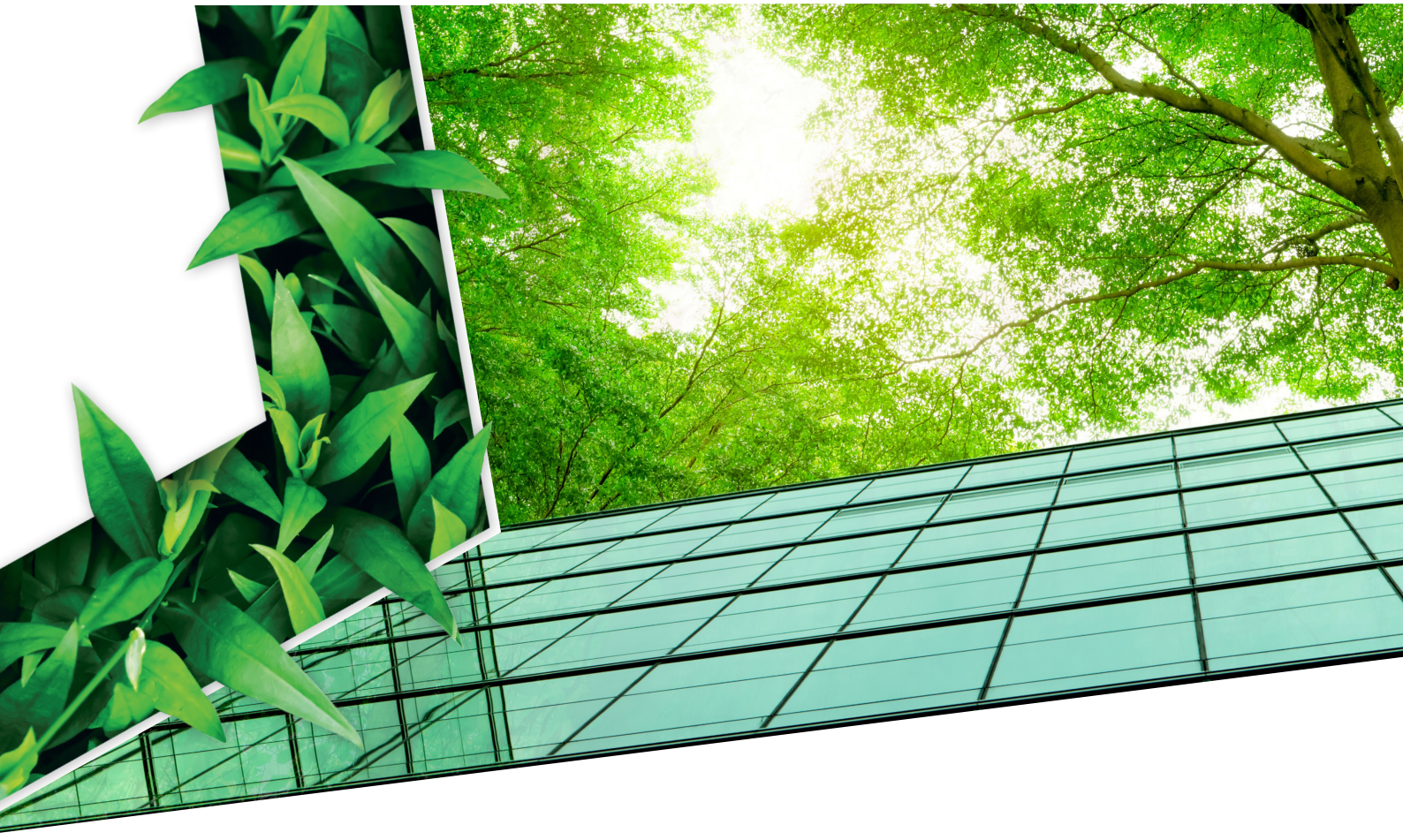
NANO TiO_2

CINKARNA

Different **dimension** of perfection

NANO titanium dioxide



AIR & WATER POLLUTION REDUCTION
HEALTH PROTECTION
SELF-CLEANING EFFECT
ANTIVIRAL / ANTIBACTERIAL EFFECT

PHOTOCATALYSIS

AIR and HEALTH QUALITY

Air pollution has negative impacts both on the human health and the natural environment. We still haven't done enough in this regard, which is why there are still more measures that need to be taken in order to protect our health and nature, specifically with regards to nitrogen oxides, VOCs and other organic pollutants,... Nitrogen oxides contribute to the formation of smog and acid rain, as well as affecting tropospheric ozone and are linked with a number of adverse effects on the respiratory system of all living beings. Whilst outdoor air pollution is important, we also need to consider the potential health effects of poor air quality indoors, which is created by a mixture of pollutants generated from inside the building and external pollutionmigrating indoors. We must not forget that we live in unpredictable times when presence of various kind of viruses and bacteria is unavoidable. Although, we can do much more regarding this issue and prevent the spread of infections by taking the advantage of the photocatalytic effect, which acts also as a disinfectant.

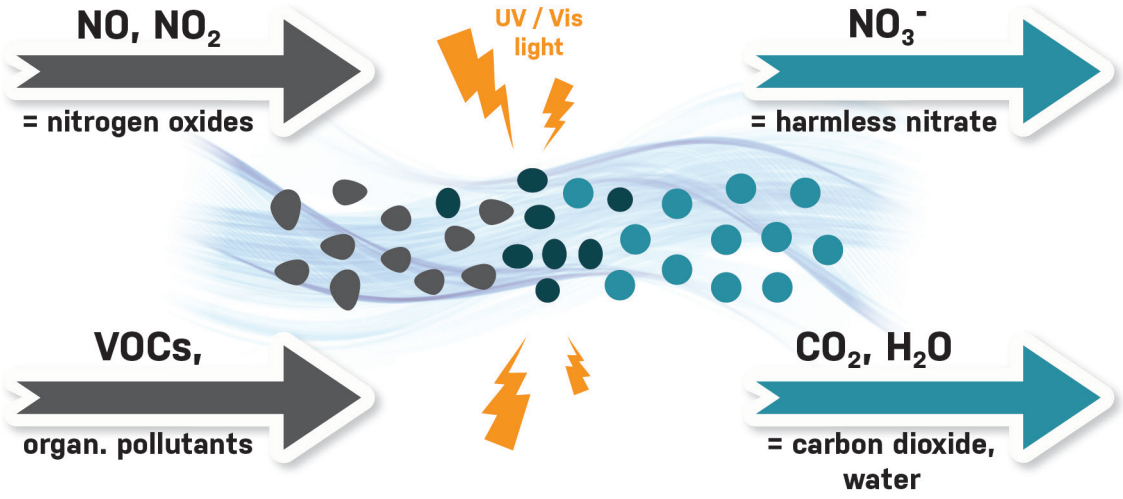
NANO TITANIUM DIOXIDE AS PHOTOCATALYTIC MATERIAL

Titanium dioxide is one of the most widely used inorganic materials in the world. The most common form is pigmentary titanium dioxide, but in recent years there has been a growing demand for ultrafine i.e. nano titanium dioxide.

Turning to smaller particles, i.e., creating nano-sized titanium dioxide particles offers new properties and advantages to final materials that they are incorporated in, for example, such as reducing pollution of the air outdoors and indoors by using a photocatalytic process to help protect our health and environment. The photocatalytic process reduces pollution - it decomposes harmful NOx, SOx, VOCs and other organic pollutants from the air and water, prevents the growth of micro-organisms, acts antiviral, antibacterial, neutralizes unpleasant odor, while at the same time providing a self-cleaning effect.

PHOTOCATALYSIS – HOW DOES IT WORK?

When light touches the surface, it promotes the photocatalytic action of the material to which nano TiO_2 particles were added. The photocatalytic reaction takes place on the particle's surface upon light absorption, thus rendering it oxidative and creating free radicals in the process. The radicals oxidize organic molecules and NOx on the surface of nano titanium dioxide into carbon dioxide, water and nitrates. Harmful nitrogen oxides and organic impurities disintegrate on the surface, while air motion, rain and evaporation help remove these substances and consequently clean the surface of the material.



ADVANTAGES

- Advantage for humans and the environment with regards to health and care
- Self-cleaning effect - aesthetic look
- Decomposition of harmful pollutants into harmless substances from the air and water
- Acting antiviral and antibacterial - preventing the spread of infections
- Preventing the growth of algae, mold and fungi
- Preserving the natural look of buildings and monuments
- Lower economic and social costs due to pollution and health risk
- Relatively low increase in the costs of final photocatalytic products
- It helps to comply with strict EU and national regulatory requirements with regards to the air pollution reduction

CHARACTERISTICS OF PHOTOCATALYTIC NANO TiO_2

- Particles are smaller than 100 nm
- Larger active surface means significantly more intense reactivity
- No more pigmentary properties, but transparent look
- Decomposition of pollutants with the help of photocatalysis process as a photocatalytic material
- Self-cleaning effect
- Photocatalysis acts even under small amount of light

PHOTOCATALYTIC APPLICATIONS OF NANO TiO_2

- Concretes, paving and asphalt surfaces for walking and driving
- Façades, roof tiles for buildings
- Indoor wall & ceiling surfaces/decorative paints
- Architecture & monument surfaces (historical statues and buildings)
- Other surfaces, such as windows, metal, ceramic tiles, textiles,...

OUR NANO TiO_2 PRODUCTS FOR PHOTOCATALYTIC APPLICATIONS

PRODUCT	USE	APPLICATION
CCA 100 BS	Outdoor application	Self-cleaning effect, decomposition of organic pollutants, water cleaning, air cleaning, DeNOx, protection from mold, algae and fungi, antiviral and antibacterial effect, neutralizing unpleasant odor,...
CCR 200 N	With improved performance in outdoor and indoor applications	Self-cleaning effect, decomposition of organic pollutants, water cleaning, air cleaning, DeNOx, protection from mold, algae and fungi, antiviral and antibacterial effect, neutralizing unpleasant odor,...

DID YOU KNOW?

The surface of one photocatalytic active roof covering a family house and its driveway has the ability to remove the amount of NOx created by two passenger cars in one year of average use.

OUR SPECIFIC APPROACH TO MANUFACTURING

The elementary principle of our nano TiO_2 is the sulphate synthesis process, which is upgraded for the synthesis of final nano product. In Cinkarna Celje we decided to be strategically oriented towards the production of nano TiO_2 only in the form of a water suspension. We have already developed the synthesis methods for anatase and rutile nano particles that we obtain in the form of a suspension without any intermediate powder phase.

Advantages of our manufacturing process enable us to efficiently adapt to the customer's specific needs and provide them with high-quality products. The most important advantage and the difference in the manufacturing process is that we produce materials in the form of stable water suspensions.

Numerous manufacturers of nano TiO_2 material produce it by making a powder first and then grinding it into nano particles. In this case, they produce the powder form of nano TiO_2 materials, which is afterwards suspended in water. In our production, all process phases take place in an aqueous medium which guarantees better stability and dispersibility for our products without the presence of dry powdery material. In this way, we prevent the possible negative impacts that nanopowder causes if it comes into direct contact with people and the environment.

CCA 100 BS	CCR 200 N

Both materials are stabilized aqueous suspensions of nano titanium dioxide (TiO_2) with an excellent photocatalytical activity. Our particle design technology is the basis for premium product performance in a wide range of applications

Designed and optimized for photocatalyst use:

- Nano TiO_2 without pigmentary properties
- Highly stabilized, neutral pH, white aqueous suspension
- Recommended for applications with a neutral or basic pH range
- High photocatalytic activity

CCA 100 BS	CCR 200 N
• Degradation of organic and inorganic molecules under UV light • Anatase crystal structure	• Degradation of organic and inorganic molecules under UV and visible light • Rutile crystal structure • Crystal lattice doped with N

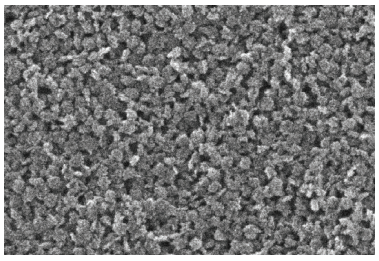
Main applications are:

- Photocatalyst used for self-cleaning effect on various building materials, glass, ceramics, textiles, etc
- Air and water purification (degradation of NOx, SOx, VOCs, other organic molecules, etc)
- Removing unpleasant odors (smell, tobacco,...)
- Preventing mold, fungi and algae
- Degradation of viruses and bacteria

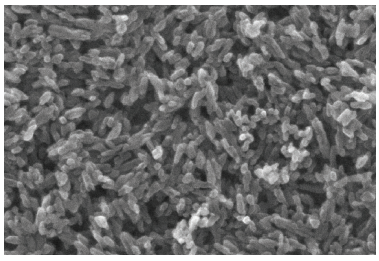
CCA 100 BS	CCR 200 N
• Outdoor applications	• Indoor and outdoor applications

	CCA 100 BS		CCR 200 N
TiO_2 content	20 - 22 %	**TiO_2 content**	20 - 22 %
Density	~ 1.2 g/cm³	**Density**	~ 1.2 g/cm³
pH	7 - 9	**pH**	6 - 8
Crystallite size (Scherrer)	~ 10 nm	**Crystallite size (Scherrer)**	~ 30 nm
Specific Conductivity	< 1 mS/cm	**Specific Conductivity**	< 1 mS/cm
Specific surface area	> 250 m²/g	**Specific surface area**	> 60 m²/g
Typical photocatalytic activity ISO 22197-1*	**UV** 30.2 mg NO/m²h	**Typical photocatalytic activity ISO 22197-1***	**UV** 22.4 mg NO/m²h **Vis** 17.2 mg NO/m²h

* Measurements were performed by Institut für Technische Chemie (Hannover, Germany). A value more than 5.0 mg NO/m²h can be regarded as very good degradation efficiency.



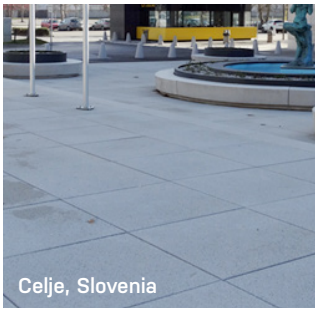
SEM image of the CCA 100 BS



SEM image of the CCR 200 N

Applications with our photocatalytic nano TiO_2 materials

Maribor, Slovenia



Celje, Slovenia

Barcelona, Spain

Self-cleaning, Praha, CZ

Antibacterial towels, Poland

APPLICATIONS OF PHOTOCATALYTIC NANO TiO_2

Photocatalytic (universal) coatings

Transparent coatings with nano TiO_2 particles included – such coatings are applied (sprayed or coated) on various surfaces, such as wooden surfaces, wall and floor surfaces, in indoor and outdoor spaces, facades, plastic and metal surfaces, textiles, ceramics, ventilation filters,.... Nano TiO_2 particles included in coatings in contact with light act photocatalytic.

Photocatalytic end-poducts

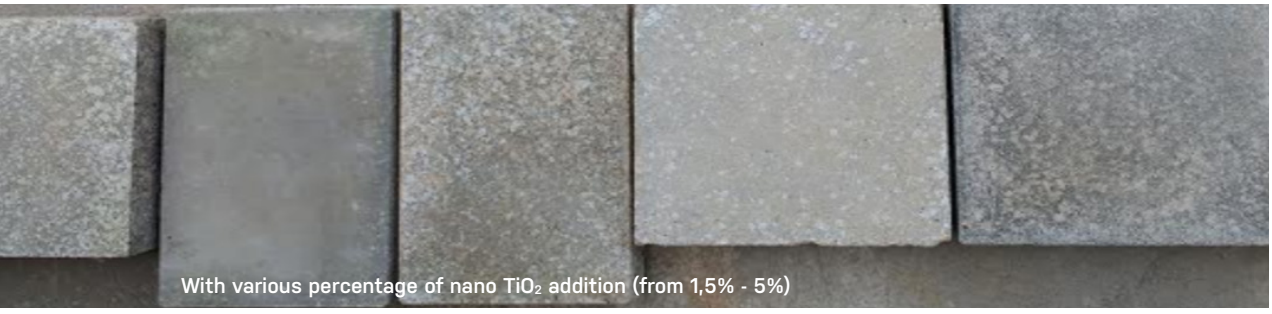
In this case, nano TiO_2 is incorporated directly into end-products, such as roof tiles, pavers, concretes,... Active particles of nano TiO_2 are installed in the last (outer) several mm thick layer of the end-product - where the nano TiO_2 particles can be activated by light. Deeper in the end-product itself particles do not have any function as light cannot activated them. This applications are more durable and resistant compared to photocatalytic coatings applications.

SUSTAINABLE CONTRIBUTION TO SOCIETY AND ENVIRONMENT

- ***Aesthetics and environmental de-pollution***
  facades, floors, walls, roofs, roads, sidewalks, parking lots, monuments...
- ***Lower costs of cleaning and maintaining urban transport infrastructure***
  railway stations, squares, sidewalks, bridges, tunnels, road markings...
- ***Antiviral/antibacterial effect***
  hospitals, homes for the elderly, schools, kindergartens, work organizations, animal farms,...
- ***Prevention of algae and mold formation***
  by the coasts sea/water level, beaches, fountains, urban water tabs,...

MAIN DIFFERENCES BETWEEN PIGMET AND NANO TiO_2

	pigment TiO_2	nano TiO_2
Particle size	200 - 300 nm	30 - 100 nm
Visual effect	non - transparent	transparent
Visual look	powder	water suspension (Cinkarna)
Purpose of use	• Higher coverability and opacity • Light and weather protection • Exceptional lightening power • Extending shelf life of materials and products	• Light resistance/UV absorber: - extending the shelf life of materials • Photcatalytic effect: - air purification (indoor/outdoor) - water purification - self-cleanng and antimicrobial effect
Sustainable aspect	• Less heating (reflection of light) • Less energy consumption (cooling and room lightning) • Less consumption of materials • Less waste • Less negative impact on environment • Lower costs	• Pollution reduction • Improvement of various medical states • Higher quality of living conditions • Less negative impact on environment Less energy consumption • Lower consumption of material • Lower costs


With various percentage of nano TiO_2 addition (from 1,5% - 5%)


Without addition of nano TiO_2

Concrete samples were immersed in the sea for 1 year at the tide line, where aglae presence is the highest.

www.cinkarna.si

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