KRONOS® specialities

KRONO*Clean* - TiO_2-Photocatalysts in Coatings

KRONO*Clean* 7000
TiO_2 photocatalyst for UV radiation and visible light

KRONO*Clean* 7050
TiO_2 photocatalyst for UV radiation

Both products are eminently suitable for accelerating the degradation of odours and organic contaminants, such as formaldehyde. They can additionally make a major contribution to reducing inorganic air pollutants, such as nitrogen oxides and sulphoxides, in the respective application.

The great efficiency of **KRONO*Clean* 7000** and **KRONO*Clean* 7050** is attributable to their porous, sponge-like structure (Fig. 1a) and the resultant large internal specific surface (BET = approx. 200 m²/g). In the form supplied, the products are agglomerates with a size of 1.0 to 2.0 µm. For comparison, Fig. 1b shows commercially available TiO_2 pigment, which has a particle size between 0.2 and 0.4 µm.

Conventional photocatalysts usually only make use of UV radiation, i.e. radiation up to a wavelength of approx. 400 nm. Consequently, they exploit less than 6% of the irradiated energy reaching the Earth. And yet the range of visible light alone, between 400 nm and 800 nm, accounts for approx. 52% of the energy supplied by the sun.

Thanks to special modification, **KRONO*Clean* 7000** is in a position to use not only ultraviolet radiation, but also part of the visible light spectrum with a wavelength > 400 nm.

KRONO*Clean* 7000 therefore greatly enlarges the effective range of TiO_2 photocatalysts. Pollutants can now also be degraded during the twilight hours, as well as on surfaces facing away from the sun, where conventional photocatalysts are in-effective (Fig. 3).

KRONOS photocatalysts for visible light are already being used successfully indoors.

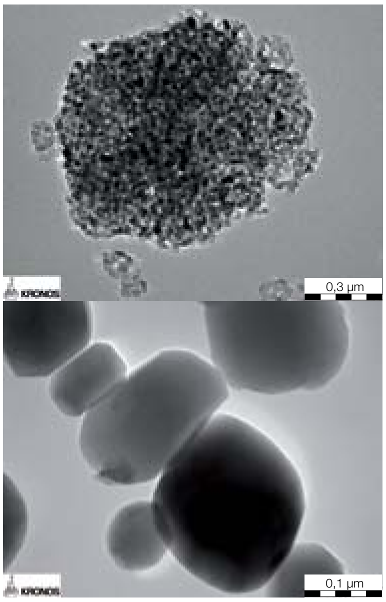

Fig. 1a and b: TEM photographs – photocatalyst (top), TiO_2-pigment (bottom)

Fig. 2: Colour of the photocatalysts

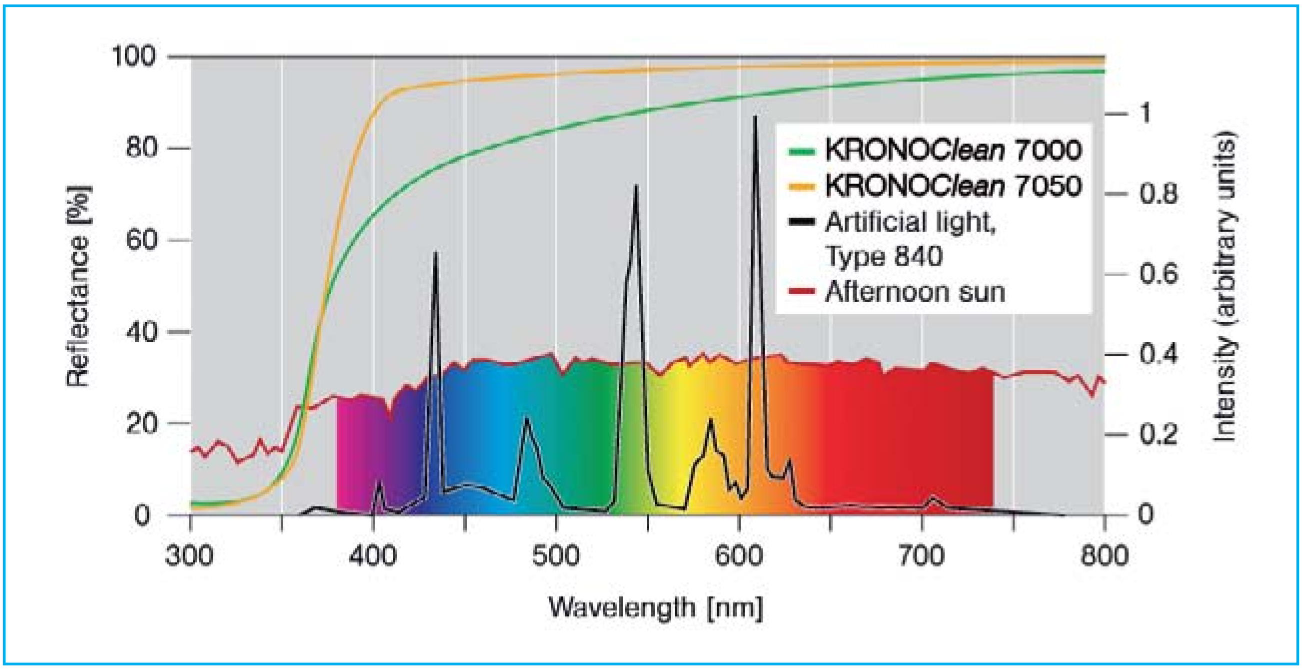

Fig. 3: Radiation spectra of artificial light and sunlight, and reflectance spectra of KRONOClean 7000, compared to conventional photocatalysts like KRONOClean 7050

Dispersion of photocatalysts

For processing reasons (e.g. dust, metering), photocatalysts are used with preference in the form of an aqueous preparation (slurry). The use of a suitable dispersant, the choice of the dispersing equipment and the dispersing time play a decisive role in this context.

Figure 4 shows the mean particle size and transparency as a function of the dispersing time. A 50% photocatalyst slurry with **KRONO*Clean* 7000** was dispersed in an attrition mill (SAZ beads, diameter 0.5 – 0.7 mm) for the experimental setup. The transparency increases with the dispersing time, whereas the particle size changes only marginally after a certain point in time.

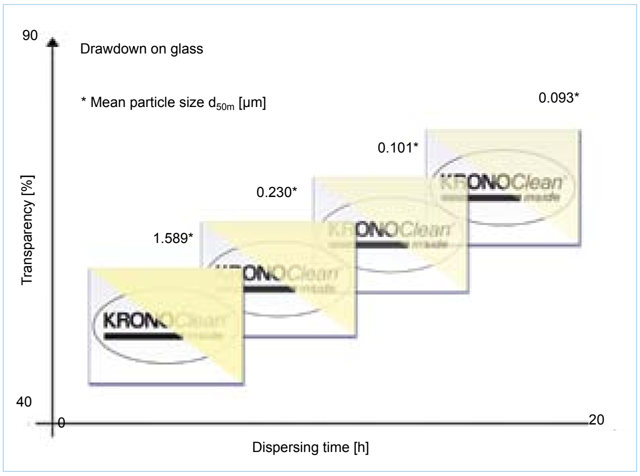

Fig. 4: Increase in transparency and decrease in mean particle size as a function of dispersing time

Applications using KRONO*Clean* 7000

Indoors – White emulsion paint with KRONOS 2190

Because of its photocatalytic activity in visible light, **KRONO*Clean* 7000** is particularly suitable for indoor use (e.g. interior emulsion paints). The effectiveness of these paints can be greatly influenced by varying the selected pigment volume concentration (PVC).

The higher the PVC, the greater the porosity – and thus the photocatalytic efficiency, as illustrated by the example of methanol degradation in Fig. 5a.

As a further example of the relationship between porosity or PVC and photocatalytic activity, Fig. 5b shows the degradation of the yellowing caused by cigarette smoke.

For this purpose, the coatings were contaminated with cigarette smoke in a defined gas space and exposed behind glass for a period of two days. The efficiency of a coating containing a photocatalyst can also be significantly influenced by varying the photocatalyst content.

Emulsion paints without photocatalyst and containing 2% and 3% **KRONO*Clean* 7000** were prepared to illustrate this effect. An aqueous methylene blue solution was used as the model substance. The reduction in discolouration in percent was determined after exposure to UV radiation (Intensity 5.5 W/m²) over a period of 30 hours (Fig. 6).

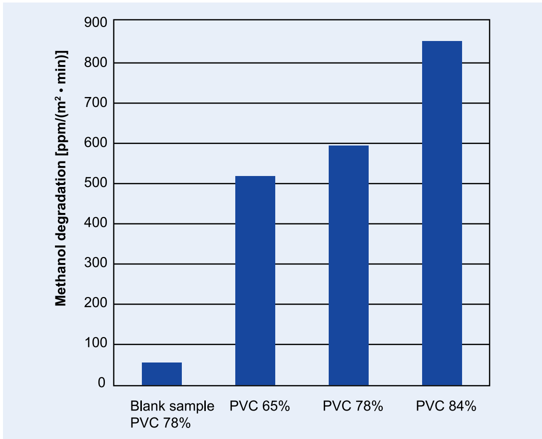

Fig. 5a: Methanol degradation as a function of the PVC of interior emulsion paints

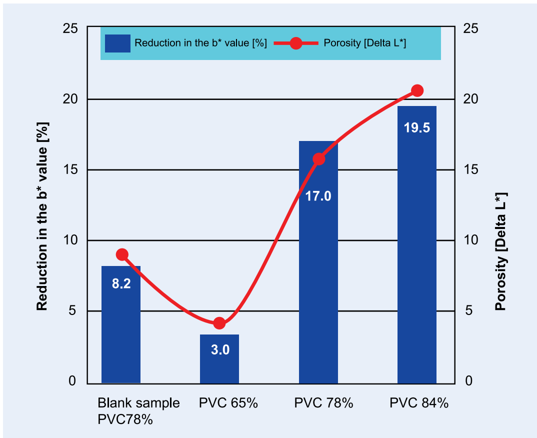

Fig. 5b: Nicotine degradation as a function of the PVC of interior emulsion paints

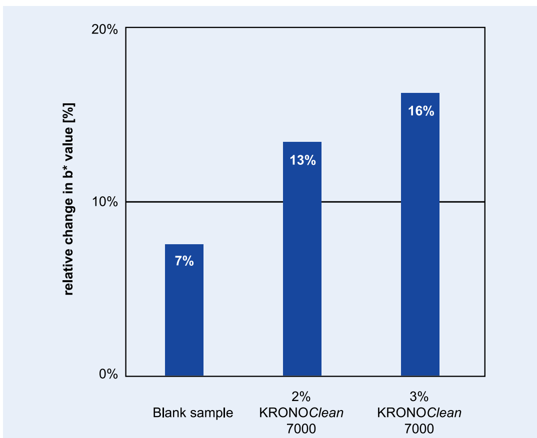

Fig. 6: Degradation of methylene blue by exposure to UV radiation

KRONOS®
specialities

Application using KRONO*Clean* 7000

Outdoors – White hybrid architectural paint with KRONOS 2360

The consequence of using photocatalysts is that not only organic pollutants are degraded, but also all other organic compounds, such as the polymeric constituents of paints. For this reason, mineral binders should be used in paints for outdoor applications (e.g. architectural paints) wherever possible. In this case, a good compromise can be found in so-called hybrid binders, because they have a relatively high content of inorganic constituents.

Hybrid architectural paints containing a photocatalyst display a lesser degree of soiling, compared to paints containing no photocatalyst.

Figure 7 shows the relative brightness as a function of the duration of outdoor exposure. The paint containing 5% **KRONO*Clean* 7000** shows the lowest degree of soiling after almost two years of outdoor exposure.

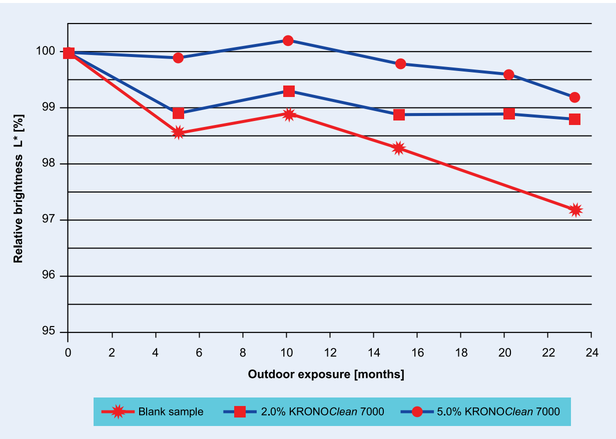

Fig. 7: Soiling tendency of hybrid architectural paints containing a photocatalyst

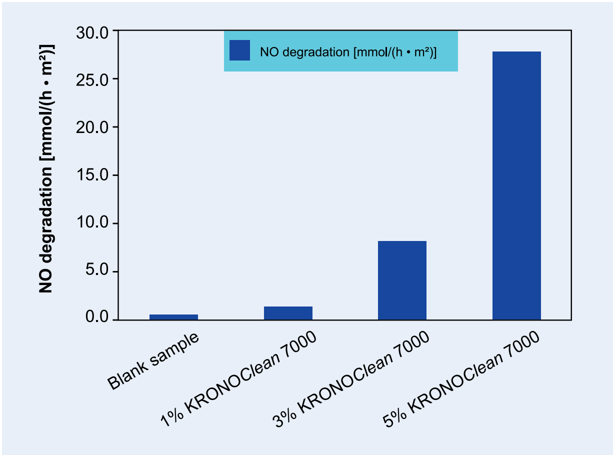

Fig. 8: NO degradation as a function of the photocatalyst concen-tration in hybrid architectural paints

Architectural paints containing a photocatalyst can moreover make a substantial contribution to improving air quality, since they can mineralise toxic NO_x compounds, for example.

The effectiveness of hybrid architectural paints containing different quantities of photocatalyst was tested according to ISO 22197-1:2007. As can be seen in Fig. 8, use of 5% **KRONO*Clean* 7000** results in an exceptionally high degradation rate.

If architectural paints are to be able to develop their optimum activity, the photocatalyst they contain has to be activated. This presupposes pre-activation of the coating.

Figure 9 shows the photocatalytic activity of the coatings as a function of the exposure time (Xe-WOM). The longer the coatings are pre-activated, the higher is their photocatalytic efficiency, as illustrated by the example of isopropanol degradation. Activation is also greatly influenced by the photocatalyst concentration

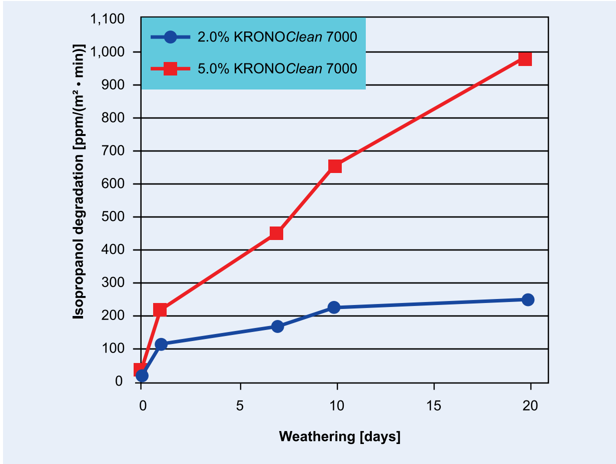

Fig. 9: Isopropanol degradation of the hybrid architectural paint as a function of exposure duration and photocatalyst concentration

Examples of practical applications

Architectural coatings

Silicate paints offer an ideal matrix for the incorporation of photocatalysts. Figure 10 shows silicate paints after 2 years of outdoor exposure. The paint containing **KRONO*Clean* 7050** displays a far less pronounced soiling tendency than the paint without photocatalyst.

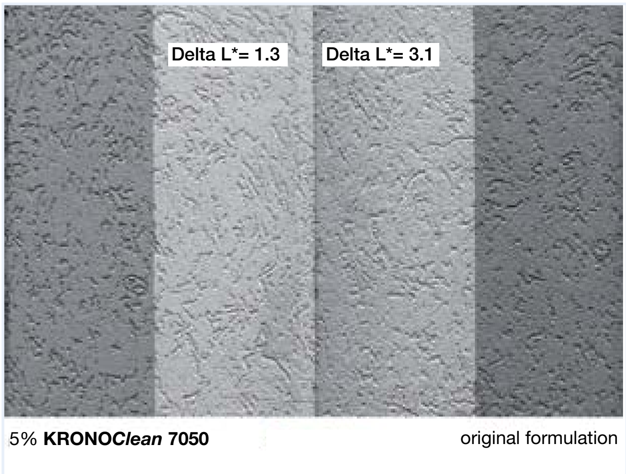

Fig. 10: Self-cleaning effect of silicate paints

Degradation of oil on paving stones

In addition to use in coatings, **KRONO*Clean* 7000** is also particularly suitable for applications in cement-based systems.

Figure 11 illustrates the effect of **KRONOClean 7000** in concrete, taking the photocatalytic degradation of used oil on paving stones as an example.

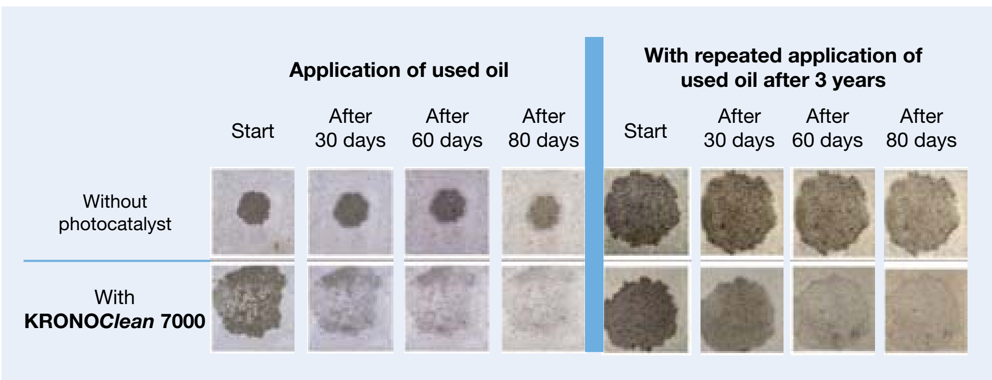

Fig. 11: Use of KRONOClean 7000 in paving stones

KRONOS®

specialities

KRONO*Clean* TiO_2- photocatalysts

◆ = strongly recommended

KRONOS grades not strongly recommended in these tables may nevertheless be highly efficient in specific cases.

Ask our Application Technology Center.

KRONO*Clean*	7000	7050
Emulsion paints, interior	◆	
Facade colors	◆	◆
Plasters, interior	◆	
Plasters, exterior	◆	◆
Fair-faced concrete	◆	◆
Paving stones	◆	◆
Roofing tiles	◆	◆
Fibres	◆	
Paper	◆	
Water treatment	◆	◆
Air purification (filters)	◆	◆
Polymer dispersion-based silicate paints, silicate paints	◆	◆
Silicone paints	◆	◆