Fraunhofer Allianz Photokatalyse

Biological efficiency measurements for photocatalysts

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Background

Photocatalytic coatings, such as titanium dioxide (TiO_2) are suitable for manifold applications:

- Self-cleaning surfaces
- Inactivation or even destruction of bacteria, algae and fungi
- Purification of air, reduction of misting on glass and mirrors.

Esp. in Asia, manifold products are available on the market. Nevertheless research is still going on to develop new coatings with further advantages. As an example, the important field of bio-corrosion, particularly with regard to the protection of cultural heritage objects, shall be mentioned.

Only a limited number of methods indicating the efficiency of the coatings is available. Mostly applied is the measurement of the contact angle of water as an indicator of hydrophobicity. Information on the degradation capacity of the coatings, especially for biological contaminations, is limited. Therefore, reproducible methods were developed quantitatively proving the efficiency of the coatings and products in a cost and labour effective manner. On the one hand such methods are useful in the developmental process of new products as the products are assessed rapidly. On the other hand they can be used to provide competitive advantage by documentation of the efficiency.

Methods applied for biological efficiency measurements

The antimicrobial activity of photocatalytic coatings is proved by using growing microbial cells. Depending on the application different organisms are important. Within the Fraunhofer Photocatalysis Network several methods were developed yielding each specific information. Each method can therefore be used for coatings or products with specific fields of application. Up to now, the following methods are available:

- Degradation of bacteria (*M. luteus, E. coli*) and fungi (*Aspergillus spp.*) - information specific for coatings with antimicrobial applications (e.g. wall tiles or door handles)
- Degradation of biological contaminations like algae or bird droppings - information of self-cleaning effects concerning outdoor applications (e.g. roof tiles or glass roofs of winter gardens).

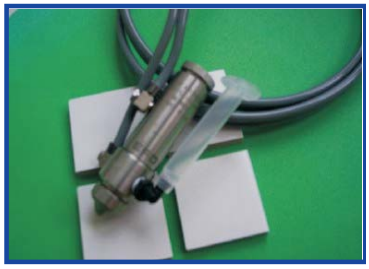


Figure 1: Preparation of samples for antimicrobial efficiency testing.

Figure 2: Preparation of samples for efficiency testing regarding degradation of algae.

Results

- We are able to demonstrate possible inhibitory effects on microorganisms, e.g. algae, due to the intrinsic properties of photocatalytic substances (Fig. 3).

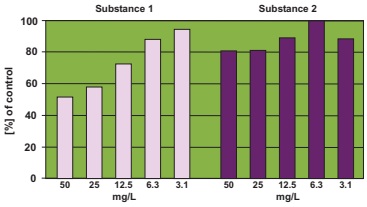


Figure 3: Inhibitory effect of two different TiO_2 substances on the algae *D. subspicatus*.

Several coatings on glass and ceramic tiles (novel and commercially available products) were tested.The experiments indicated differences between the coatings, e.g. in their efficiency against bacteria, fungi and algae:

- It is possible to differentiate between inactivation (inhibited cell division) and degradation of bacterial or fungal cells (Fig. 4 and 5).

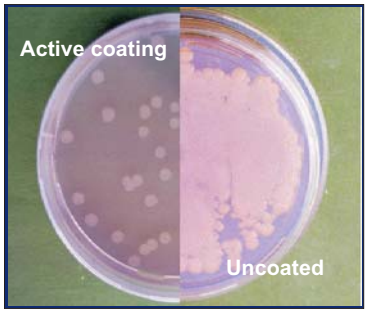
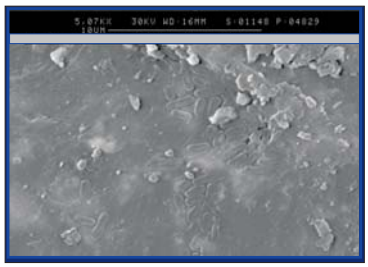


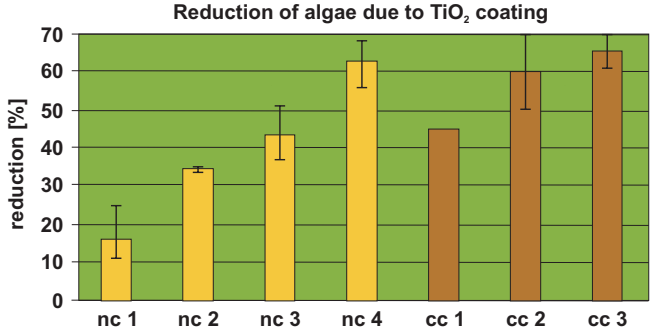
Figure 4: Reduction of cell growth of the bacteria *E. coli* caused by contact to a photocatalytically active surface.

Figure 5: SEM picture of cell structures of *E. coli* on a surface after photocatalytic inactivation. Complete degradation was not found even in tests in which inactivation of cells are measured.



- We are able to quantitatively determine the inhibitory effect of photo-catalytically active surface coatings on algae in a range which is sufficient for ecotoxicological testing.

Figure 6: Inhibitory effect of different TiO_2 coatings on the alga *D. subspicatus*.
The bar chart shows the mean reduction [%] of algae, incubated on coated glass compared to algae incubated on uncoated glass. The ranges specify the minimum and maximum values of reduction for each coating. nc = new coating, developed in the Fraunhofer Photcatalysis Network. cc = commercial coating



Conclusion

We are able to measure the *quality* and *quantity* of inhibitory effects of photocatalytically active substances and coatings on bacteria, fungi and algae. Consequently, we can assess the efficiency of substances and coatings regarding their type of application.
We are your partner in the development of efficient photocatalytically active construction material of glass, ceramic, stone, plastic, metal, paints and plaster. Regardless where your product will be applied (e.g. sanitary rooms or building protection), if your product aims at growth inhibition or degradation of microorganisms - we can prove and assess the desired effect.