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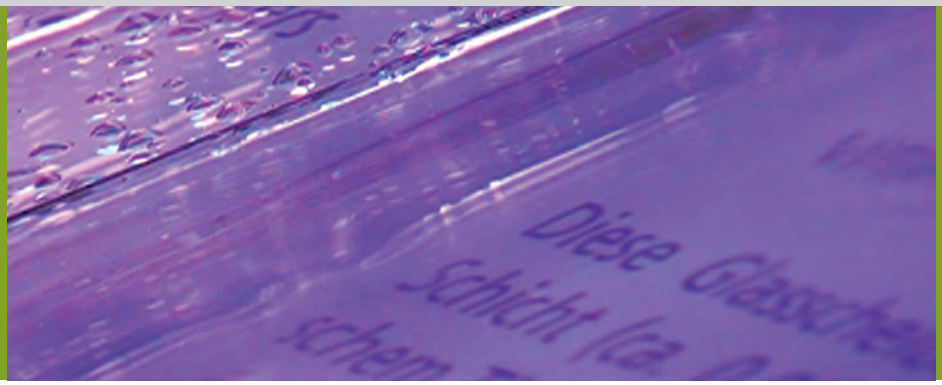

CRYSTALLINE TITANIUM DIOXIDE LAYERS

A MATERIAL FOR MANY APPLICATIONS

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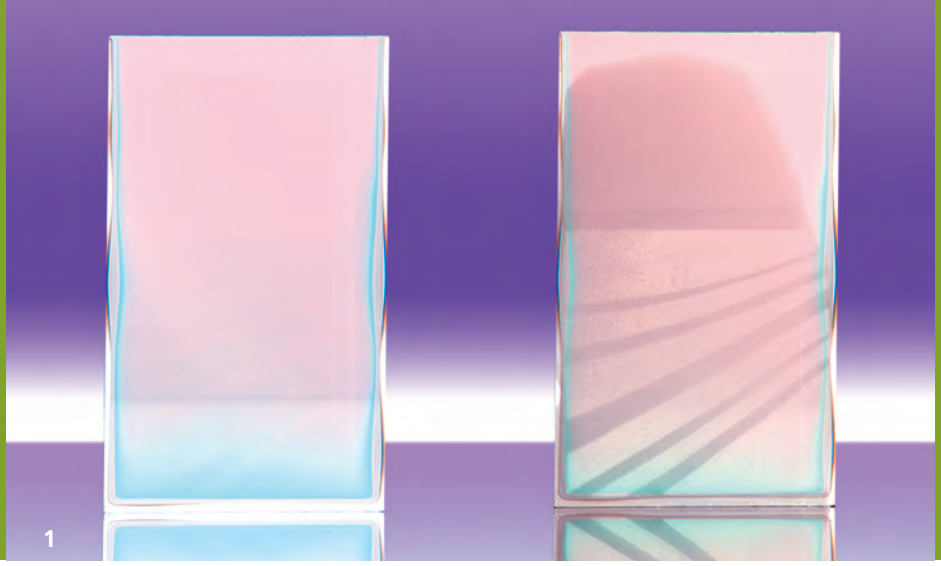
Titanium dioxide, a chemically stable and biologically inert material, is used in many different applications. In the field of medicine, titanium is the number one choice for implants and endoprostheses as well as high-end instruments. This is in large part due to the passivating oxide layer which forms on the surface under atmospheric conditions. This native oxide layer as such is bioinert, which means it is passive in contact with organic materials. Certain crystalline modifications are required if one wants to realize additional functional benefits with the material.

Crystalline titanium oxide layers can be activated by exposure to UV light or daylight. After activation, they exhibit superhydrophilic characteristics, which means perfect wettability with water. Hydrophilization is reached after only a short UV activation and lasts several hours. Therefore, activation promotes initial wetting and adhesion, for example for implants.

Crystalline titanium oxide layers also show photocatalytic properties. They can be used to decompose organic materials under photoactivation, for example to disintegrate biofilms in hygiene or environmental applications or in air and water purification.

Fraunhofer FEP applies titanium dioxide layers with the highest purity using vacuum coating processes such as pulsed magnetron sputtering or plasma-activated evaporation. These processes are used for the highly productive layer deposition on various substrates ranging from small to large – from flat substrates to 3D parts. The photoactivatable properties of these robust, mechanically stable titanium oxide layers can therefore be used in a wide variety of applications.



Applications

Photocatalysis

- **Self-cleaning and easy-to-clean surfaces** through the decomposition of organic contaminants adhering to surfaces by means of oxidation and reduction processes and through superhydrophilicity
- **Antibacterial surfaces**, for example for secure workbenches in laboratory facilities through the destruction of adhering microorganisms by means of decomposition reactions
- **Photocatalytic cleaning and reforming** of gases and liquids by oxidation and reduction processes
- **Photo-induced hydrophilic properties** reducing the water contact angle to less than 10°, leading to a cohesive water film on the surface
- **Anti-fog surfaces**, for example for mirrors, eyeglasses and glass panes by preventing droplet formation
- **Influencing initial adherence of cells** during the interaction between surface and physiological environment

Layer benefits

- Permanent effect because layer materials are not consumed
- Environmentally friendly, because no chemicals (such as binder materials) are released by the layer
- No antibiotics are needed for anti-bacterial effects
- Effect can be controlled through light exposure

Technology

At Fraunhofer FEP, we deposit titanium dioxide layers by reactive pulsed magnetron sputtering or plasma-activated evaporation. The process parameters can be varied to achieve the following application-specific coating characteristics:

- Hardness: 7 … 17 GPa
- Refractive index: n = 2.4 … 2.7 (@ 550 nm)
- Crystallinity: amorphous, anatase, rutile and mixed phases
- Good adhesion to a wide variety of materials
- Diffusion barrier against metal ions, oxygen and water vapor
- Electrical insulating

Benefits of our technology

- Stable vacuum coating processes with very high layer uniformity and purity
- Large-area coating with high productivity enables cost-effective production
- Crystalline layers can be synthesized at substrate temperatures of 130 … 250°C (in average 200°C lower compared to conventional methods), so they can be applied also to temperature-sensitive substrates as well
- Ability to coat 3-dimensional objects

Our offer

- Coating and material development for glass, metal, ceramic and plastic substrates
- Feasibility studies
- Process development, process and technology transfer to the customer

1 *Condensation of a masked activated TiO_2 layer*

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