TiO_2 coatings

Titanium oxide or titania (TiO2), in the form of nanocrystalline thin films and coatings, has within recent years found a wide range of potential applications due to its interesting physical and chemical properties.

Introduction

TiO_2 forming the anatase crystal structure is known for its photocatalytic property upon UV light exposure and it is therefore capable of forming OH radicals and super oxides on the surface. Due to these properties TiO_2 is suitable for applications in self-cleaning and antibacterial coatings for industrial products.

The Tribology Centre is able to deposit TiO_2 thin film coatings either as rutile TiO_2 or anatase TiO_2 or a mixture hereof. The coating can be deposited on basically all types of substrate materials such as stainless steel, glass, copper, aluminium, silicon and different polymer-based substrates (e.g. PC, PMMA, etc.). In the case of polymer substrates, it might be necessary to deposit a barrier layer between the photocatalytic coating and the under-lying organic substrate to avoid degradation hereof. Substrate size is limited to a dimension corresponding to a cylinder with Ø400 mm and height 400 mm.

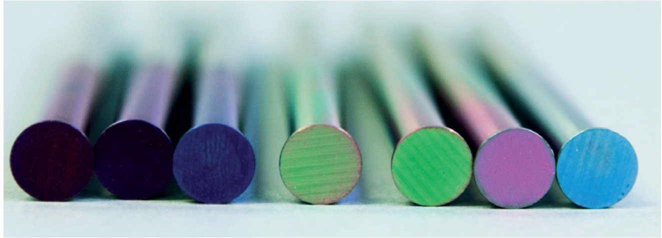

Figure 1:
The image shows TiO_2 coatings with different thicknesses on steel substrates. The different colours are due to interference effects caused by the different coating thicknesses.

Applications

Photocatalytic PVD TiO_2 coatings are well suited as protective coatings in applications where additional benefits can be obtained through self-cleaning, anti-bacterial effects upon UV light exposure either from the sun or through exposure to artificial UV light. This could for instance be in connection with medical applications where surfaces are UV-sterilized, outdoor lamps, signs, water or air cleaning units, cleaning units based on ozone (O_3) or other clean-tech applications.

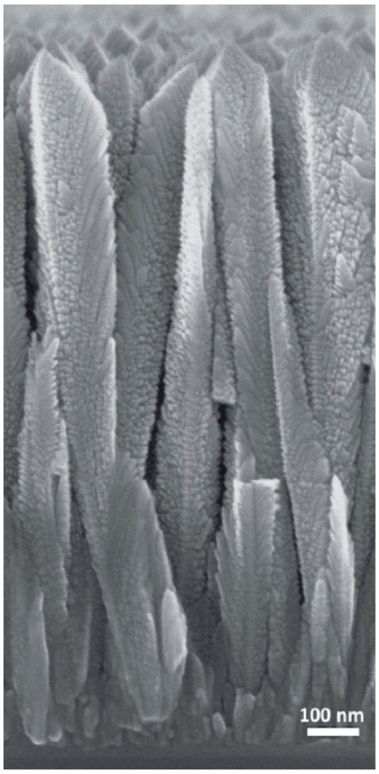

Figure 2:
Cross section of an anatase TiO_2 coating seen with a scanning electron microscope. The coating thickness is about 1 µm.

Contact:

Tribology Centre
Kongsvang Allé 29
DK-8000 Aarhus C

Phone: +45 72 20 15 99
Mail: tribo@teknologisk.dk
www.dti.dk/tribo

QUALITY SYSTEM CERTIFICATION DNV ISO 9001

DANISH TECHNOLOGICAL INSTITUTE

Properties

Deposition temperature	50 - 600 °C
Hardness	2,5 GPa for anatase TiO_2 up to 15-20 GPa for rutile TiO_2
Thickness	From 50 nm up to 3 µm
Crystal structure	Amorphous, anatase, rutile or mixtures hereof
Chemical stability	Stable under acid as well as alkaline conditions, especially when deposited at elevated temperatures
Application temperature	Depending on deposition parameters but thermally stable up to at least 600 °C
Photocatalytic activity	Depends of e.g. coating thickness as seen on the figure below
Antibacterial properties	99% reduction of bacterial activity (E. Coli) observed for anatase TiO_2 coatings on steel
Colour	Transparent. Depending on coating thickness interference colours appear

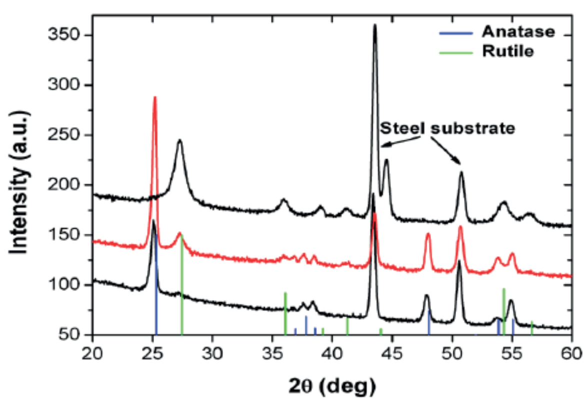

Figure 3:
X-ray diffractograms from 1 µm TiO2 coatings deposited on stainless steel substrate. The diffractograms reveal coatings consisting of the crystal phases anatase (bottom), anatase + rutile mixture (middle) and rutile (top), respectively.

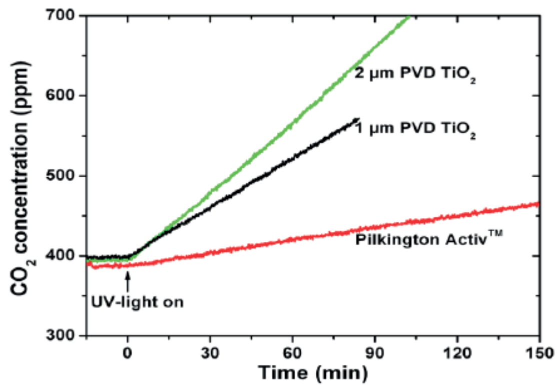

Figure 4:
Photocatalytic activity can be measured by photocatalytic conversion of acetone to water and CO_2. By measuring the increase in CO_2 concentration, it is possible to evaluate the efficiency of degrading acetone and thereby the photocatalytic activity. The figure illustrates that 2 µm PVD TiO_2 is more active than 1 µm PVD TiO2, which is more active than Pilkington ActivTM.

Contact:

Tribology Centre
Kongsvang Allé 29
DK-8000 Aarhus C

Phone: +45 72 20 15 99
Mail: tribo@teknologisk.dk
www.dti.dk/tribo

QUALITY SYSTEM CERTIFICATION DNV ISO 9001

DANISH TECHNOLOGICAL INSTITUTE