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Photocatalytic activity of TiO_2 layers produced with plasma electrolytic oxidation

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Abstract

The photocatalytic activity of titanium dioxide (TiO_2) results from its crystalline phase's anatase and rutile. In this regard, plasma electrolytic oxidation (PEO) is a promising process for producing highly porous surfaces with a high proportion of crystalline phases into the oxide layer on pure titanium. PEO-coatings were produced under different conditions in various electrolytes in order to identify the crystalline fractions of the surfaces and to examine the associated photocatalytic activity. The composition of the PEO electrolyte was varied to optimize the polymorphic composition of the TiO_2 comparable to the photocatalytic active TiO_2 material AEROXIDE® P25. X-ray powder diffraction (XRD) was selected to identify the produced crystal structures of anatase and rutile on the surface material depending on the electrolytic system. In order to establish the expected band gap of the TiO_2 on the surfaces, the samples were subjected to a diffuse reflectance measurement, which detected direct transitions for all samples using the TAUC and DASF methods. The acceptance of the photocatalytic reaction by the crystalline PEO-samples was further confirmed by the degradation of two typical dyes (methylene blue MB, rhodamine B RB) under UV-light irradiation. Both a high proportion of anatase and the presence of rutile on the PEO-layers had a targeted effect on the catalytic efficiency. However, the average crystallite sizes also played an important role in the samples produced in an optimum range of 30 - 40 nm. Both effects support the photocatalytic properties of PEO-surfaces.