Applied Research Activities

Impact of photo-hydrophilic and photo-catalytic effects on the antimicrobial properties of TiO_2 deposited by a HiPIMS/PbII combination process

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Objective:

In addition to the technological challenges of process development for a combination process of HiPIMS and PIII, the scientific objective of the study was to quantify the amounts of photoinduced hydrophilicity and photocatalysis on the initial microbial adhesion and biofilm formation and the correlation of the antimicrobial effects with results from physicochemical and electrochemical investigations.

Results:

We could show that the photoinduced hydrophilicity is metastable state, which is dependent to the availability of water. Once activated by light exposure the photoinduced hydrophilicity can be conserved for weeks by storing the coatings under high humidity or in water. Interestingly the water contact angle of this metastable state can be adjusted in a defined manner by changing the humidity in the storing atmosphere. We further were able to demonstrate that the photocatalytic effect does not decay immediately after the end of light exposure, but show a relaxation behaviour for a certain time. Thus, the efficacy of the coatings reduced by less than 5 % during interval irradiation at 50 % power compared to the 100 % exposed coatings. Overall, we could quantify a reduction of initial adhesion due to photoinduced hydrophilicity of 36 % and in combination with photocatalysis of 88 % compared to the dark reference. Biofilm formation was inhibited by photocatalysis by three orders of magnitude, whereby the hydrophilization showed a significant smaller impact compared to the initial adhesion.

Conclusion:

We developed a combination process of HiPIMS and PII for the deposition of photocatalytically active TiO_2 coatings containing doped elements. As expected, the coatings show both a photoinduced hydrophilicity and photocatalysis. Furthermore, we developed an appropriate test strategy to discriminate between the mentioned photoinduced effects. The finding that its permanent irradiation is not essential to have an excellent antibacterial effect, combined with the developed coating process, makes this type of coatings highly interesting both for surfaces in water-bearing systems and for biomedical applications.