Microstructured PVDF surfaces and their inhibitory effect on the microbial attachment of nosocomial biofilm-forming microorganisms

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Abstract

Bacterial resistance to conventional antibiotics combined with the increasing awareness of the essential role of biofilms in nosocomial infections caused by medical devices has led to a growing interest in new antimicrobial strategies. Since the formation of bacterial resistances represents a permanent risk in the drug treatment of biofilms, the optimisation of surface properties to avoid microbial attachment is gaining further attention. Due to microbial attachment being mainly determined by the surface properties of the respective substrate material, the medically established polymer PVDF was provided with different microstructures in the size s of 1 µm ≤ s ≤ 200 µm in order to influence the wettability. These structures were applied to injection moulding tools by high and ultra precision milling, electrical discharge machining as well as laser machining. The injection moulded, microstructured PVDF samples showed pyramidal, cup-shaped, channel-shaped and random structures in the micrometer range and led to contact angles ϴ in the range of 50° ≤ ϴ ≤ 110°. These samples were then tested for their influence on bacterial attachment by typical representatives of nosocomial biofilm formers Pseudomonas aeruginosa and Staphylococcus aureus. The microbial growth and the formed biofilms were analysed after 24 h and 72 h via crystal violet staining and fluorescence microscopy. In comparison to unstructured surfaces, a significant reduction of bacterial attachment was found, which correlated with the respective contact angle and surface roughness, the microgeometry of the structures and the cell morphology of the tested microorganisms. The results offer great potential for the reduction of biofilm formation on medical devices. This technology can also be used in the water treatment sector, such as pipe linings, filter surfaces and sensor housings. The economic large-scale implementation of these microstructures requires further research.