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Influence of surface material and reprocessing on the durability of antimicrobial surfaces

Abstract: The risk of infection from contaminated surfaces has already been shown in several publications. Due to the increased demand for optimized infection control measures during the Corona pandemic, antimicrobial surface technologies have gained more an interest. Apart from many proofs of efficacy, there are only a few studies dealing with the durability of these surface coatings with regard to the material and the reprocessing measures. This work did therefore examine the impact of different materials and surface textures, as well as different detergents and disinfectants, on the durability of antimicrobial surface technologies. Differently structured materials (glass, wood, plastics, metal) and wallpaper bonded to plasterboard were coated with an TiO₂Ag based antimicrobial coating (HECOSOL GmbH, Bamberg). These test samples are then used to perform abrasion tests with various cleaning and disinfecting agents and cloth systems (microfiber cloth, cotton cloth, foam cloth). The majority of the test samples in our experimental setup showed at least significant activity. According to our results, both the selection of cleaning and disinfection methods including wiping systems and the surface material have a major impact on the durability of antimicrobial coatings. In order to be able to come to conclusions about the long-term activity of these surface technologies, the effectiveness should be tested not only during the development phase, but also in the finished product and again after several reprocessing cycles in use.

Keywords: antimicrobial surface, durability, coating, reprocessing

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1 Introduction

Infection through contaminated surfaces is not an abstract risk, but has already been demonstrated by several publications. [1–3] The Corona pandemic has focused the public's attention even more strongly on infection control. Accordingly, the reprocessing of surfaces should also play a role in optimal hygiene management. Antimicrobial surfaces could act as an additional factor in improving the hygiene concept. These surfaces have been shown to reduce microbiological contamination on surfaces in the long term. [4] How the material and structure of a surface affects the durability of an antimicrobial coating is essential for potential clinical applications. This influences the extent to which products and devices can be efficiently antimicrobially coated and addresses which decisions have to be taken already during the development process of such products regarding the selection of materials. However, there have been few studies to date on how surface properties and preparation affect the durability of these coatings. Therefore, this work did test the impact of different materials and surface textures as well as different cleaning and disinfection agents on the durability of antimicrobial surface technologies.

2 Material and Methods

Test samples made of different materials (glass, plastic) were subsequently coated with a TiO₂Ag-based antimicrobial coating (HECOSOL GmbH, Bamberg) using an electrospray process. The overall resistance of the coating was tested on these test samples by means of abrasion tests using an Elcometer (Elcometer Instruments GmbH, Aalen) and subsequent effectiveness testing according to the standard ISO 22196. (Fig.1)

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Figure 1: Elcometer 1720 abrasion test device

In a second step, different materials (wood, glass, metal) and wallpaper bonded to plasterboard were coated with the antimicrobial agent and abrasion tests were carried out using various cleaning and disinfecting agents and cloth systems (microfiber cloth, cotton cloth, foam cloth). (Fig. 2)

Figure 2: Different surface specimen after reprocessing (A: wood, B: plastic, C: wallpaper)

The remaining antimicrobial efficacy of these test samples was also determined afterwards by microbiological tests. For this purpose, 50µl of a bacterial suspension (*Staphylococcus aureus*, ATCC 6538) at a concentration of 1×10^6 CFU/ml was applied to previously reprocessed test surfaces. After drying and a defined exposure time (75 minutes), samples were taken by swabbing and the bacterial growth was documented.

3 Results

The antimicrobial efficacy was demonstrated for all subsequently coated test samples by standard antimicrobial test procedure (ISO 22196). (Fig.3)

Figure 3: antimicrobial activity tested with ISO 22196 after several disinfection cycles depending on different surface materials

However, it was found that the durability is strongly dependent on the underlying surface material. While strong antimicrobial efficacy could still be demonstrated on glass surfaces even after several hundred abrasion cycles, this was no longer present on plastic surfaces after just a few cycles.

The abrasion tests with various cleaning agents, disinfectants and wipe systems also showed an impact of the material and the preparation on the antimicrobial efficacy. With a few exceptions, the test samples in our experimental setup showed slight efficacy. The antibacterial activity was classified according to Table 1. Depending on the germ reduction or germ coverage, the following antibacterial activity was observed. (Tab. 1)

Table 1: Evaluation of germ reduction activity

A	
antibacterial activity	germ reduction
no	>1500 CFU
weak	>500 CFU to ≤ 1500 CFU
significant	>5 CFU to ≤ 500 CFU
strong	< 5 CFU

B	
antibacterial activity	germ plate coverage
no	≥ 25%
weak	< 25% to ≥ 15%
significant	< 15% to ≥ 5%
strong	< 5%

In our experimental setup only 5 of the 47 tested samples showed a remaining strong efficacy. In 5 other test samples, antimicrobial activity was no longer detectable. (Fig. 4)

Figure 4: antimicrobial activity on different surface materials after reprocessing

On the other hand, the majority of the test samples showed at least significant antimicrobial activity (31 out of 47 samples). Here, a germ reduction of at least 85% of the overgrown area or less than 500 CFU per plate could be detected.

4 Conclusion

Our results suggest that the underlying surface material has a strong impact on the durability of the antimicrobial surface technology. Likewise, the selection of cleaning and disinfection measures and wipe systems appears to influence the durability of the coatings on different surfaces. It could be shown, that even after reprocessing of the surfaces the majority of the wallpaper specimen still showed at least a significant

antimicrobial activity. However, it must be pointed out that the test design was not feasible according to the standard procedure (like ISO 22196). For many samples the spacing of the areas to be tested was very small. Likewise, the great heterogeneity of the test materials must be considered. In order to be able to exclude potential antimicrobial effects of the pure material itself, simultaneous testing of all materials should be carried out with an untreated control. Moreover, to come to conclusions regarding the long-term activity of these surface technologies, the effectiveness should be tested not only during the development phase, but also in the finished product and again after several reprocessing cycles in use.

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