livinguard

Livinguard technology against microorganism and its application for face masks

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Background

- Livinguard's technology originates from the development of antimicrobial properties in the area of textiles, especially for professional and military garments, in order to provide anti-odour properties
- From this starting point, the technology has been continuously developed further and applied on different other surfaces for a range of applications

Principle of the Livinguard technology

- The basic principle is the action of polycationic surface to inactivate microorganisms
    - This principle has been described in literature since almost two decades. However, practical application is still very limited
    - The Livinguard technology comprises (1) methods to bind a range of cationic compounds to textiles and other surfaces, (2) optimized chemistries for inactivating bacteria and viruses; (3) methods to apply this technology to a range of surfaces, and (4) and methods to combine this with other properties, such as water repellency, hydrophilicity etc.
    - Livinguard technology is protected by a range of patents

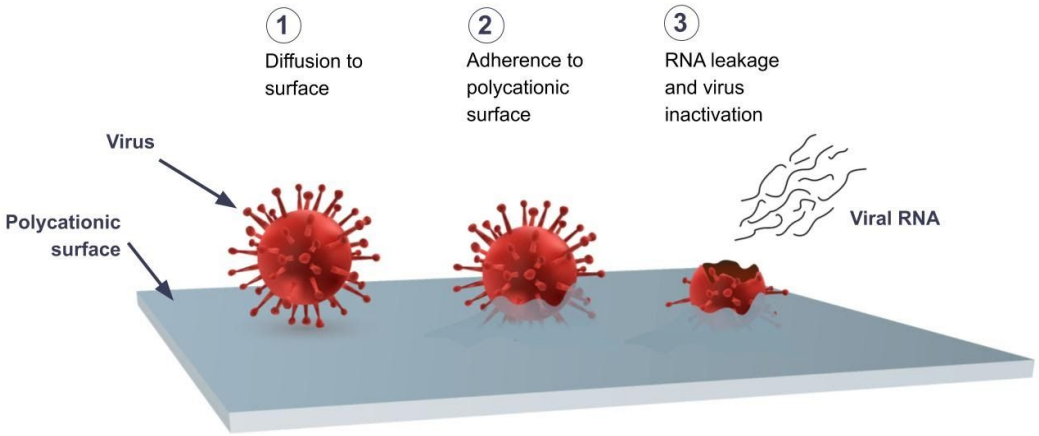
Antimicrobial activity

- Since about 2 decades, scientific papers have been published which describe the inactivation of bacteria, viruses and several types of fungi (e.g. yeasts) by polycationic surfaces[1]. It has been proven that cationic surface inactivation can take place without leaching[2]
- Investigations of surfaces treated with Livinguard technology have been performed internally and by external partners, showing effective inactivation of a broad range of organisms. This includes both gram-positive and gram-negative bacteria, several viruses and fungi. Typical inactivation rates are higher than 5 Log in one hour for E. coli (Gram- bacteria), S. aureus (Gram+ bacteria), and Candida albicans (yeast, fungus) and higher than 4 Log for the MS2 virus at a contact time of 8 hours.
- According to scientific literature[3], the inactivation mechanism of viruses is most probably based on distortion of the protein capsid by adsorption of negatively charged proteins to

the positively charged surface, finally leading to release of non-infectious RNA, as schematically shown in Figure 1

- Furthermore, it has been shown that after multiple rinses or washes, the fabric remains antimicrobial

Figure 1: Assumed mechanisms of virus inactivation by cationic surfaces



Implication for facemasks

- Facemasks accumulate particles and aerosols which can contain coronaviruses
- A risk of conventional masks is the fact that they can spread aerosols during extended use: Due to the high relative humidity of air being breathed out, humidity accumulates in the mask material. This leads to an increased resistance and at extended use, spreading of aerosols can occur exposing both the user (when breathing in) and the environment (when breathing out)
- The Livinguard facemask has a sandwich construction consisting of 3 layers: The inner layer is a N95 filter, while both outer layers are fabrics treated with our patented polycationic technology
- The fabric layers in combination with the filter material make sure that the abundance of aerosol droplets is retained by the mask
- No penetration of bacteria aerosol penetration was observed in mask fabric up to 30 times washing
- Face mask fabric was observed resistant to penetration of virus as measured by using Phi-X174 bacteriophage (ISO 16604:2004) up to 40 washes
- During use, electrostatic interactions will take place between the virus and the surface, leading to inactivation of viruses
- Previous investigations have shown that the antibacterial activity of Livinguard textiles is maintained after multiple rinsing with water or washing with non-ionic laundry detergents. This is also expected for the antiviral activity. Experiments are ongoing to prove this

- Due to the antiviral properties of the textile surface the risk of recontamination when handling a mask is strongly reduced

<u>References:</u>

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3) B. Hsu, S.Y. Wong, P.T. Hammond, J. Chn, A.M. Klibanov, Mechanism of inactivation of influenza viruses by immobilized hydrophobic polycations, *Proc. Natl. Acad. Sci.* (2011) 108 (1), 61-66