Table 33. Anti-microbial nanocoatings-Nanomaterials used, principles, properties and applications

<table>
<thead>
<tr>
<th>Category</th>
<th>Nanomaterials used</th>
<th>Principle</th>
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</tr>
</thead>
</table>
| Nanomaterials used | • Zinc Oxide nanoparticles.  
• Titanium Dioxide nanoparticles.  
• Silicon Dioxide nanoparticles.  
• Nanosilver.  
• Chitosan.  
• Copper oxide nanoparticles.  
• Nanocellulose. | • Zinc Oxide (ZnO), Titanium Dioxide (TiO2), Silicon Dioxide (SiO2) and silver are anti-microbial at the nanoscale. | • Particles are dispersed at the surface and also throughout the coating. Additionally, a higher concentration of anti-microbial particles can be created at the surface.  
• Anti-microbial properties on the surface coating are permanent and remain effective even if the coating is cleaned.  
• Low friction coating properties unaffected by the anti-microbial nanoparticles.  
• Tenacious bonding to surfaces: do not require an intermediate layer and can uniformly treat all exposed surfaces, without altering the device’s original mechanical or physical properties.  
• Nanoparticles are stabilized with additives and integrated homogeneously into the polymer matrix. Anti-microbial activity does not decrease with time because the solid nanoparticles are not volatile, like many commonly used biocide additives.  
• Silver Ions have a high affinity for negatively charged side groups on bacterial molecules, which bind to the bacterial DNA. This hinders bacterial replication and simultaneously deactivates the metabolic enzymes of the cell. The result is that reproduction of the microorganism is stopped or the microorganism is killed. | • Germs, bacteria or fungal spores brought into contact with surfaces coated with nanoparticles, are very quickly eliminated. As the particles interfere with various stages of cell metabolism, it can destroy a wide range of germs and make it difficult for microbes to develop resistance.  
• Improvement in the level of hygiene in medical and nursing facilities of all kinds, and also protection against the formation of mould and mildew in bathrooms, toilets, wash areas and kitchens and food processing facilities.  
• Long lasting anti-microbial effect, constant release of the active substance, effectiveness against bacteria and other micro-organisms, no chemical impurities, produced according to the requirements, easy processing, no changes to the characteristics of the equipped material, and no later discolouration of the equipped material. | • Strong reduction of the visibility of fingerprints  
• Prevention of the blue tarnishing of the stainless surface (corrosion/oxidation by salts and organic acids from finger sweat)  
• Prevention of unsightly smears. Fingerprints are optically less noticed and don’t leave any traces of oxidation (tarnishing of the metal). The effect is based upon the reduction of the optical contrast caused by a fingerprint. The user is able to enjoy an appropriately clear image even after longer and intensive periods of use. |