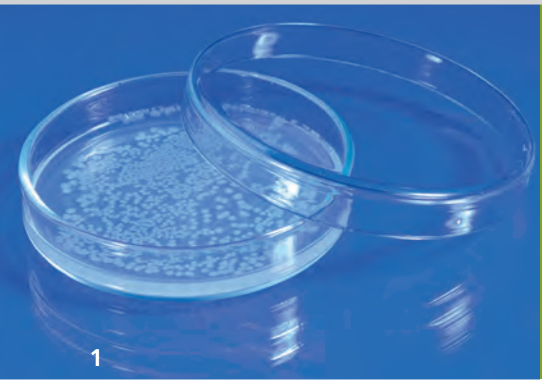
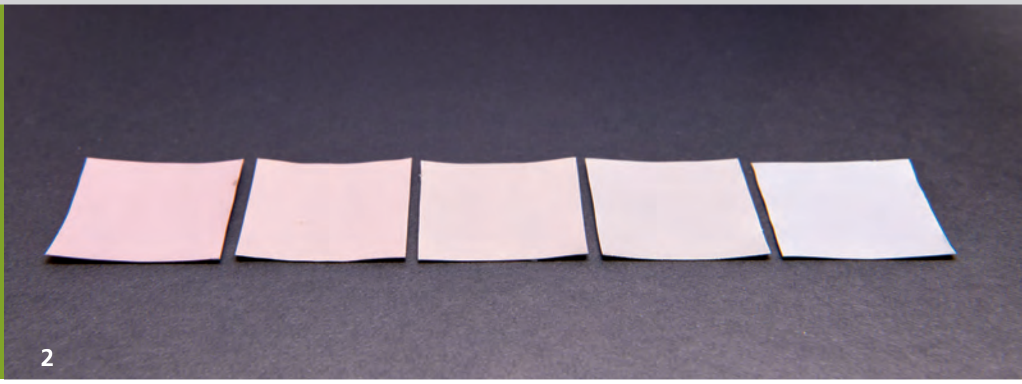
FEP

FRAUNHOFER INSTITUTE FOR ORGANIC ELECTRONICS, ELECTRON BEAM AND PLASMA TECHNOLOGY FEP

1 *Escherichia coli (E. coli)*
2 *Coated samples*

SILVER AND COPPER

TOGETHER EFFECTIVE AGAINST BACTERIA

Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP

Winterbergstr. 28
01277 Dresden, Germany

Contact persons

Ines Schedwill
Phone +49 351 2586-592
ines.schedwill@fep.fraunhofer.de

Dr. Gaby Gotzmann
Phone +49 351 2586-353
gaby.gotzmann@fep.fraunhofer.de

www.fep.fraunhofer.de

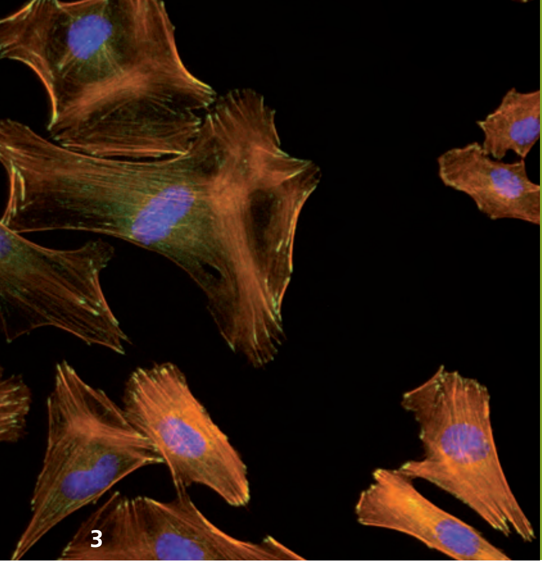
We focus on quality and the ISO 9001.

Due to its antimicrobial properties, silver is employed as a traditional and established treatment agent. It is currently used for numerous medical applications, both intracorporeal and extracorporeal.

Many applications are the result of historical experience or empirical tests, without full understanding of the mechanism and kinetics of the biological process. This can give rise to overdosing, with side-effects extending to clinical complications or non-discernible effects.

The objective of the project work at Fraunhofer FEP was to study mixed copper-silver layers on textile materials and polymer surfaces used in medical technology for their antibacterial effectiveness and cell tolerance. By varying the layer composition it was attempted to maximize the antibacterial effect and limit cytotoxic side-effects. Also, the aim was to minimize the use of noble metals and so keep the costs low. For this reason the surfaces were coated using sputter methods.

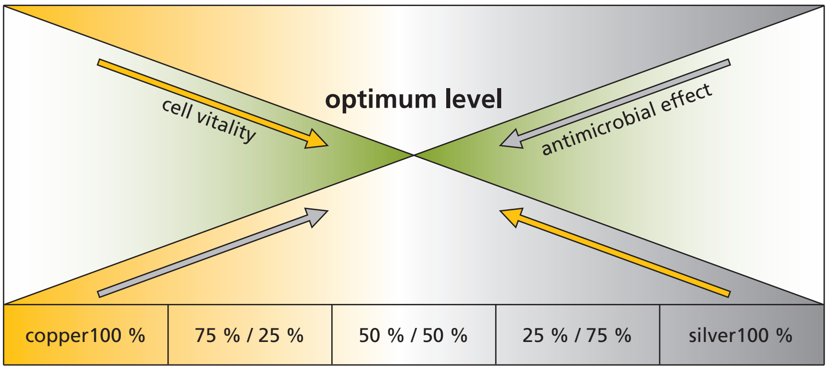
The layers were characterised using surface analysis methods. Their antibacterial effect was studied in a model using the bacterium *Escherichia coli* K12. The evaluation of cytotoxicological parameters was carried out using fibroblasts and keratinocytes.



Results

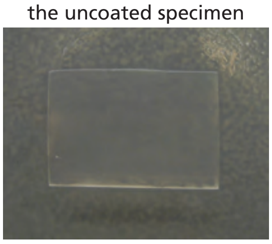
Five different layer combinations were applied by DC magnetron sputtering to fabrics and polymer surfaces. SEM and EDX analysis of all the layers showed there was a homogeneous distribution of silver and copper clusters at the nanometer level. In order to determine the antimicrobial properties, the kinetics of propagation of *E. coli* in contact with the layers were analysed. Studies of the depth effect using nutrient agar showed the development of an inhibition zone. This indicated there is an effective region in the immediate vicinity of the coating and this is, for example, of major importance for wound care. The analytical characterization of the surfaces showed that the roughness and the hydrophobic properties of the layers antagonize bacterial adhesion. Microbiological and cell studies showed that there were no toxic side-effects for a system comprising **50% copper and 50% silver**. There was simultaneously an **optimum duration of the antimicrobial effect**.

Optimization of the effects of copper and silver

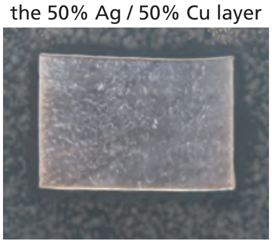


Agar diffusion test

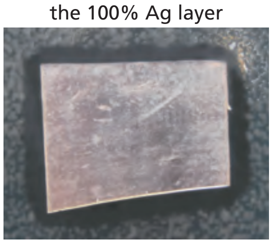
no inhibition zone around the uncoated specimen



inhibition zone around the 50% Ag / 50% Cu layer



inhibition zone around the 100% Ag layer



3 *Cell test with fibroblasts*

4 *Medical textiles*

Our offer

These results open up a wide range of applications in the life sciences and medical technology. The customization of the technology with regards to layer adhesion, layer thickness, and effectiveness will be undertaken individually for every specific substrates. Further enhancement of the antimicrobial effect via activation of the copper fraction is conceivable, whereby the copper is converted to the bivalent state, which implies even greater biocidal effectiveness. This is a very promising way of carrying out further optimization for future fields of application.

Gefördert aus Mitteln der Europäischen Union
Europa fördert Sachsen. EFRE Europäischer Fonds für regionale Entwicklung

The project work was funded by the European Union and the Free State of Saxony.

Funding reference: 13840/2391