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.
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.

### Results

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.