Type of coating determines release

Nanoparticles in functional clothing

They make clothing water and dirt-repellent, they block UV radiation, and they reduce odours: nanomaterials have popular functional properties. It is, however, largely unknown whether they pose health risks on account of their miniscule size. In a research project on nanosilver, the BfR determined whether the tiny particles are released from textiles and can therefore pose a health risk.

Nanomaterial

is a natural material occurring in certain processes or an artificially produced material that contains particles in unbound state, in aggregate form or as an agglomerate, and in which the majority of particles have one or more outer dimensions in the range of below 100 nanometres. In nanosize, a substance can possess properties different from those that it would possess if the particles were larger.

In clothing the use of silver nanoparticles is particularly common. Silver has antibacterial properties and is supposed to reduce odour formation due to sweating. When nanosilver is used in items of clothing, the question of primary relevance is whether it is released into the sweat and therefore potentially comes into contact with the skin. Alongside the question as to whether and in what amount silver is released from textiles in general, the other issue researchers are looking into is the role played by the technology used to apply or incorporate the nanosilver on or into textiles. What was also unclear to date is the extent to which the surface coating of the nanoparticles influences the release mechanism.

Artificial sweat simulates release

In a research project, the BfR tested nine textile samples that were finished with nanosilver. The "control group" consisted of a piece of textile finished with conventional silver (in this case, silver salt with a particle diameter greater than 100 nanometres). Two of the textiles were so-called compos-

ites in which nanosilver is integrated in the fibre. In the other tested textiles, the fibre surface was coated with silver nanoparticles and in one case with conventional silver (textile coating). In order to simulate the release of silver due to sweating, the textiles were incubated in a simulated sweat solution for 24 hours. For evaluation purposes, the entire silver content in the sweat solutions was first determined by means of mass spectrometry. The samples in which silver was present were then differentiated by centrifuging and using a special method to measure individual particles of dissolved and particulate silver. In the final step, the particle sizes of the determined particulate silver were measured in order to identify nanoscale silver.

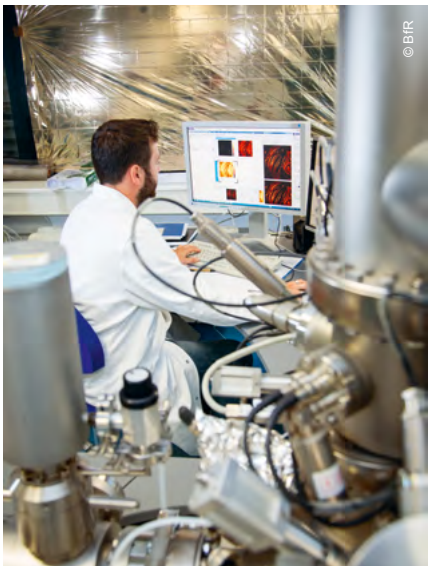
Silver released from clothing

The tests performed by the BfR showed that silver migrated from each textile sample into the simulated sweat solution – with levels of between 7 and 75 percent of the silver originally contained in the textile depending on the tested textile. It was found that coated textiles released more silver than the composites. The BfR determined the highest share of released silver in the textile coated with conventional silver. The technology used for finishing therefore plays a greater role in the release of silver than the actual amount of silver contained in the textiles. Moreover, the release rate of silver from nanosilver appears to be not higher than from conventional silver. The released silver was mainly in dissolved form in the sweat solution. Only a small amount of silver was particulate silver, but this particulate silver was in the nanosize range. Further investigations are necessary to establish whether these particles are individual nanoparticles or whether the silver is bound to larger particles. Based on current scientific knowledge, it is assumed that nanoparticles behave differently in the body than larger particles. Surprisingly, BfR researchers also detected particulate silver of nanosize in the simulated sweat of the textiles coated with conventional silver. In other words, the occurrence of silver particles does not appear to depend on whether the silver was applied to the textiles in nano form or in conventional form. In a parallel study, the BfR research group found that the consistency of the nanoparticles – in the form of a special coating, for example – also influences their solubility in the sweat solution.

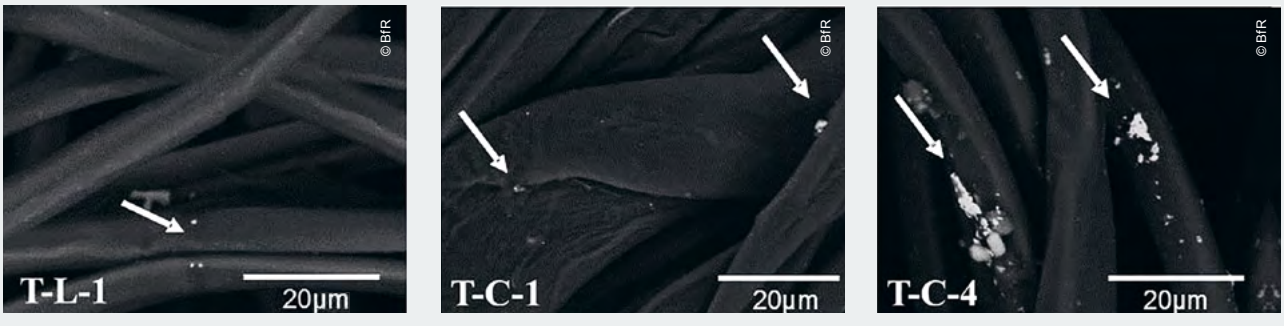
Type of coating is relevant

It can be concluded that silver is released from textiles, and to a minor degree even in particulate form. The chosen form of textile functionalisation as well as the texture of the nanoparticles are key criteria for the release characteristics. Insights like these are particularly important with regard to the safe use of nanomaterials in everyday products, as human exposure to these kinds of substances should be minimised wherever possible. Moreover, they provide some indication as to the application form in which nanomaterials can be used safely in consumer products. ◘

More information:
Wagener et al. 2016. Textile Functionalization and Its Effects on the Release of Silver Nanoparticles into Artificial Sweat. Environ Sci Technol 50: 11, 5927–5934.



Silver can be detected on coated textile fibres using time-of-flight mass spectrometry.



Scanning electron microscope image of textile fibres
Left: nanocomposite in which hardly any silver particles can be found on the fibre surface.
Centre and right: textiles with silver coating; here, the textile surface is covered with silver more densely.