Nanosilver: A new name -- well-known effects

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Nanosilver is not a new discovery by nanotechnologists -- it has been used in various products for over a hundred years, as is shown by a new Empa study. The antimicrobial effects of minute silver particles, which were then known as "colloidal silver," were known from the earliest days of its use.

Numerous nanomaterials are currently at the focus of public attention. In particular silver nanoparticles are being investigated in detail, both by scientists as well as by the regulatory authorities. The assumption behind this interest is that they are dealing with a completely new substance. However, Empa researchers Bernd Nowack and Harald Krug, together with Murray Heights of the company HeiQ have shown in a paper recently published in the journal *Environmental Science & Technology* that nanosilver is by no means the discovery of the 21st century. Silver particles with diameters of seven to nine nm were mentioned as early as 1889. They were used in medications or as biocides to prevent the growth of bacteria on surfaces, for example in antibacterial water filters or in algaecides for swimming pools.

The nanoparticles were known as "colloidal silver" in those days, but what was meant was the same then as now – extremely small particles of silver. The only new aspect is the use today of the prefix "nano". "However," according to Bernd Nowack, "nano does not mean something new, and nor does it mean something that is harmful." When "colloidal silver" became available on the market in large quantities in the 1920s it was the topic of numerous studies and subject to appropriate

regulation by the authorities. Even in those days the significance of the discovery of nanoparticles and how they worked was realized. "That is not to say that the possible side-effects of nanoparticles on humans and the environment should be played down or ignored," adds Nowack. It is important to characterize in exact detail the material properties of nanosilver and not just to believe unquestioningly the doubts and reservations surrounding the product.

The term nanoparticle is understood to refer to particles whose dimensions are less than 100 nm. Because of their minute size nanoparticles have different properties than those of larger particles of the same material. For example, for a given volume nanoparticles have a much greater surface area, so they are frequently much more reactive than the bulk material. In addition, even in small quantities nanosilver produces more silver ions than solid silver. These silver ions are toxic to bacteria. Whether or not nanosilver represents a risk to humans and the environment is currently the subject of a great deal of investigation.

Currently there are hundreds of products in circulation which contain silver nanoparticles. Examples include cosmetics, food packaging materials, disinfectants, cleaning agents and – not least – antibacterial socks and underwear. Every year some 320 tonnes of nanosilver are used worldwide, some of which is released into wastewater, thus finding its way into natural water recirculation systems. What effects solar particles have on rivers, soil and the organisms that live in them has not yet been clarified in detail.

A commentary by Bernd Nowack in the scientific journal *Science* discusses the implications of the newest studies on nanosilver in sewage treatment plants. More than 90% remains bound in the sewage sludge in the form of silver sulfide, a substance which is extremely insoluble and orders of magnitude less poisonous than free silver ions. It apparently does not matter what the original form of the silver in the wastewater

was, whether as metallic nanoparticles, as silver ions in solution or as precipitated insoluble silver salts.

"As far as the environmental effects are concerned, it seems that nanosilver in consumer goods is no different than other forms of silver and represents only a minor problem for eco-systems," says Nowack. What is still to be clarified, however, is in what form the unbound silver is present in the treated water released from sewage works, and what happens to the silver sulfide in natural waters. Is this stable and unreactive or is it transformed into other forms of silver?

More information: 120 Years of Nanosilver History: Implications for Policy Makers, Bernd Nowack, Harald F. Krug, Murray Height, *Environ Sci Technol*, 2011, DOI:10.1021/es103316q

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