1

Killing bacteria gently

What influence do manufacturing conditions exert on the properties of novel plasma polymer coatings containing silver nanoparticles? Empa researchers have looked into this question and can now create tailor-made coatings that leverage the properties of silver ions, which kill bacteria while at the same time are gentle to human tissue.

TEXT: Beatrice Huber

2

1
Silver ions are quite efficient at killing bacteria and thus are very interesting for wound dressings. Too much silver, however, can damage human cells. (Photo: iStock)

2
Empa researchers are developing novel nanostructured polymers with embedded silver nanoparticles. These coatings are intended to use silver ions exactly within a therapeutic range. For their fabrication, radio frequency (RF) plasma reactors are employed. (Photos: Empa)

Silver ions are small miracle weapons in the battle against bacteria. They're very adept at killing these microorganisms and are effective against hundreds of bacterial strains. This makes silver extremely popular as an additive on wound dressings or implants. "The more the better", however, doesn't hold true here because high concentrations of silver ions can damage cells and tissue. Therefore the search is on for surface coatings with integrated silver which deliver a therapeutically useful range of silver ions.

Empa researchers led by Enrico Körner and Dirk Hegemann, working within the scope of the EU project EMBEK1 (development and analysis of polymer-based multifunctional bactericidal materials), have developed novel nanostructured polymer coatings. "We're investigating the impact of manufacturing conditions on the film structure and how this in turn affects the release of silver ions," explains Körner, "because this release is what ultimately determines the coating's antibacterial effectiveness."

Firmly embedded silver nanoparticles

The coatings are fabricated within RF plasma reactors. Inside them, the polymer coatings are deposited on top of a substrate. The gases ethylene (C_2H_4) and carbon dioxide (CO_2) serve as raw materials. The required electrical energy is supplied by electrodes whereby the process remains near room temperature. In order to embed silver nanoparticles firmly in the plasma layer, one of the electrodes is made of pure silver.

The Empa team varied individual process parameters such as the ratio of the two gases and the power supplied to the electrodes. They discovered that increasing the ratio of CO_2 to C_2H_4 leads to smaller silver particles, that more silver gets embedded, and that it gets distributed more homogenously. And while increasing the input power promotes the integration of nanoparticles, doing so allows them to grow larger. Finally, through kinetic experiments the researchers investigated which layers release how many silver ions, and they evaluated the results in the context of antibacterial and cell tests carried out in parallel. "We have determined a range for the silver nanocomposite coatings within which they exhibited antibacterial properties and yet were found to be cytocompatible, that is, gentle on cells," summarises Körner.

But the work is going even further. The results can now be used to transfer the deposition process from the laboratory scale to Empa's in-house pilot plant, the first step towards industrial production. In addition, the researchers are attempting to create gradients in the coatings to enable a more controlled release of silver ions over time. //

Literature: "Formation and distribution of silver nanoparticles in a functional plasma polymer matrix and related Ag+ release properties", E. Körner, M. Aguirre, A. Ritter, G. Fortunato, J. Rühe and D. Hegemann, Plasma Processes and Polymers, online on 22 June 2010.