NEW ANTI-MICROBIAL COATINGS FOR BIOMATERIALS

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In all developed countries, the numbers of patients requiring implant operations are strongly increasing, e. g. for the UK, the amount of total knee and hip replacements increased from 2005 to 2006 by 6%, respectively 3%, to ca. 60'000 finished episodes for each. These medical devices are prone to infection, which still represents one of the most serious and devastating complications, forcing patients back to surgery for repair or replacement. Even though operations' conditions are excellent in developed countries, the infection rate due to bacterial adhesion and biofilm formation is still relatively high, e. g. 1-7% (hip/knee), and increasing resistance of bacteria point to higher infection percentages in the future. The cost of such interventions arise to ca. 50'000,- € per episode with a high risk of a recidivism. In this context the development of new bioactive surfaces, able to reduce the high vulnerability of the interstitial milieu between implant and tissues, represents at the same time a solution to a medical problem of large impact, improvement of quality of life to patients, and an opportunity for the production of new marketable technologies.

Silver compounds are known to possess antimicrobial properties. However, they were set aside and almost forgotten when antibiotics were discovered and developed for the treatment of all kinds of bacterial infections. However, today, the wide use of antibiotics leads more and more to bacterial resistance, rendering the combat against infections increasingly difficult. Resistance to β-lactam antibiotics is a major problem in hospitals with methicillin-resistant of *Staphylococcus (S.) aureus* (MRSA) and *Staphylococcus (S.) epidermidis* (MRSE) infections being predominant in systemic and implant-associated infections respectively. Coagulase-negative staphylococci (e.g. *S. epidermidis,* Fig. 1) are the most common organisms introduced during implantation, since they directly adhere to foreign body materials, while *S. aureus* is a typical organism, which colonizes implants after implantation; it adheres to foreign surfaces covered with host proteins. Once such an infection, and thus the biofilm have formed, it is impossible to treat with antibiotics. Implant exchange or even amputations are then the only solution to prevent a chronic infection.

Since several years, our research group is gaining in expertise in the field of coordination polymer compounds, mainly with Ag^+ [1-4] with the aim of understanding fundamental aspects of polymorphism on one hand, but also for their application as anti-microbial compounds on the other. Having control over the polymorph formation, its solubility and light stability, we were able to deposit Ag-coordination polymer networks on surfaces such as gold alloy, steel, titanium, as well as the model substrate Au(111). Different linking methods were tested, and the so-coated surfaces exposed to bacteria in different essays. The results show that our Ag-compounds show an improved antimicrobial activity. We have developed ways to coat metal substrates with one specific Ag-coordination network, A (Fig. 2), which revealed to possess the best light stability among the so far studied compounds in this context, which are all based on L1 (Fig. 2).

The surface coating was analyzed by microscopic methods (AFM and/or SEM), powder x-ray analysis, and XPS in order to a) confirm the adhesion of the compound to the surface, b) analyse the chemical nature of the depot, and c) determine the surface topology obtained by the different coatings. First *in vitro* tests for solubility and antimicrobial properties with *S. sanguinis* [5] and *S. epidermidis, S. aureus* have turned out to be very promising for further investigations and use as antimicrobial compound.

References:

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Figures:

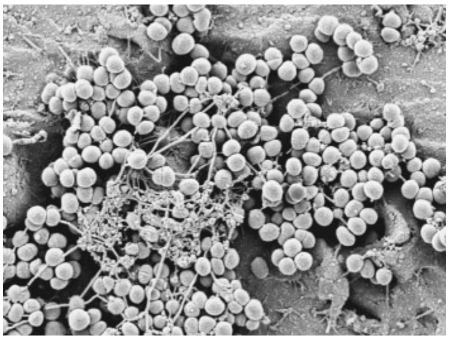

Figure 1: Scanning electron micrograph of an S. epidermidis biofilm formed on a foreign material

Figure 2: Structure of the deposited Ag-coordination compound A (below) and XPS analysis of a coated Au-surface (right)