Design of Copper-based Coatings for Bactericidal Applications

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Abstract

The spreading of nosocomial infections (NIs) in a medical environment is a major issue that Health Organizations have to tackle worldwide. Three germs are responsible for more than 50% of all NIs: *Escherischia coli* (urinary tract infections), *Staphylococcus aureus* (respiratory infections, infection of surgery site) and *Pseudomonas aeruginosa* (respiratory infections, urinary tract infections). These germs have developed strong resistances towards antibiotherapies and NIs induce each year a dramatic over cost in all countries. In order to save patient lives and to reduce the burden of the induced costs, many prevention protocols have been developed. However, one other way to avoid the formation of bacteria colonies in a hospital environment is to design active surfaces able to impede the growth and/or to kill pathogenic cells. During the past decades, silver nanoparticles have been used in many commercial bioactive devices or coatings but their bactericidal property are also shared by copper materials. [1] Thus, bioactive thin films containing Cu NPs should be of great interest for surface treatments and anti-biofilm purposes with low copper loading in the 1% mass loading range. Moreover, the control of the stability of the coating as well as the possible release of metal ions have to be considered in order to design a smart bactericidal surface. [2] To fulfill these requirements we have developed a multi-step approach starting from the study of individual copper NPs towards their assembly onto a multilayer structure (Figure 1). First, we evaluated different types of organic molecules, exhibiting either weak (amines) or strong (phosphonic acids) affinity for the NPs' surface and we highlighted the discrepancies between the ligands for the NPs' functionalization. [3] We also focused on the role of complex macromolecules such as polymers, dendrons or dendrimers which have proved to strongly adhere to several surfaces and allowed to form a polymeric matrix embedding the NPs. [4] Finally, we were able to attach the copper particles to a silanized surface and to build up a complex structure by means of either a direct *in situ* synthesis or using a standard coating procedures. Now, the activity of the resulting materials is tested against different types of bacteria, such as *P. aeruginosa*, *E. coli* or *S. aureus*, and the first results will be compared to the ones obtained with conventional antibiotics.

References

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