Polyelectrolyte multilayers with metal/metal oxide nanoparticles as antimicrobial solution for biomedical applications

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INTRODUCTION: The growing concern over implant-associated infections motivates the investigation of antibacterial coatings that can locally prevent microbial adhesion and proliferation [1]. Among different coatings, polyelectrolyte multilayer (PEM) films are attracting particular attention because of their ability to coat substrates of various size, composition, and topology, along with their promising biocompatibility [2]. Their antimicrobial properties can be enhanced by incorporating antimicrobial agents with low potential to cause antimicrobial resistance, such as metal/metal oxide nanoparticles [3]. In this study, the build-up of poly-L-lysine (PLL) and poly-L-glutamic acid (PGA) multilayers with embedded silver (AgNPs) or copper oxide nanoparticles (CuONPs) was investigated and the physico-chemical and biological properties of the two types of coatings were compared.

EXPERIMENTAL: The build-up of PEM with embedded NPs was analysed with quartz-crystal microbalance with dissipation monitoring (QCM-D) and atomic force microscopy (AFM). The elemental content and distribution of Ag and Cu within the PEM was determined by energy dispersive spectroscopy (EDS), while their total amount and release was determined by inductively coupled plasma mass spectrometry (ICP-MS). PEMs were tested for biocompatibility using the human osteoblastic cell line MG-63 by MTT test. The formation of *S. aureus* and *P. aeruginosa* biofilms was also tested on these samples.

RESULTS AND DISCUSSION: The NPs were embedded within PLL/PGA multilayer as an anionic component in the 3rd and 8th bilayer. QCM-D measurements indicated that the NP coverage was as a submonolayer with a rather low amount of adsorbed nanomaterial. SEM and EDS analysis confirmed this revealing individual or aggregated NPs distributed over the coated surface. The viability of MG-63 cells on all investigated PEM was greater than 70 %, which is the threshold value for non-cytotoxic materials. In addition, the absence of cytotoxic effect was confirmed by SEM images of the cells, which showed that the cells had a classical elongated shape with cytoplasmic extensions. In contrast, PEM containing AgNPs or CuONPs reduced the formation of biofilms of *S. aureus* and *P. aeruginosa*, with CuONPs embedded PEMs being more efficient.

CONCLUSIONS: The results obtained confirm the high potential of PEMs with metal/metal oxide NPs as antibacterial coatings for medical devices, but also for other applications.

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