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Physical-chemical characterization of ZrN/Ag thin films deposited by reactive magnetron sputtering for biomedical applications

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Titanium implants are broadly used clinically, but implant associated infection remains one of the most dangerous complications and is usually difficult to treat, sometimes requiring implant removal and repeated surgeries. Among the materials used to solve this problem (as biomedical coatings), zirconium nitride occupies a prominent place due to its excellent biocompatibility in addition to other properties such as high hardness and high resistance against corrosion and abrasion. Furthermore, metallic silver in the form of silver nanoparticles has made a remarkable comeback as a potential antimicrobial agent, as several pathogenic bacteria have developed resistance against various antibiotics. In this work, ZrN and Ag were co-deposited in titanium substrate by reactive magnetron sputtering for future applications in biomedical area. The physical-chemical characterization was realized using Rutherford Backscattering Spectrometry, that proved the ZrN films are stoichiometric (which possess the best tribological properties). In addition, it was observed the presence of silver and it was confirmed the good quality of films (which do not have significant amounts of oxygen). Through the Glow Discharge Optical Emission Spectroscopy analysis, it was observed that silver is in the substrate surface, as expected. The actual formation of ZrN was proven by Raman Spectroscopy. The ZrN hardness was measured by nanoindentation, which appointed hardness of 15 GPa, like found in the literature. Microbiological tests were realized in Petry dishes with nutrient agar to evaluate the inhibitory activity against Escherichia coli by halo formation around the samples. It was observed the formation of a discrete white inhibition halo in the samples containing silver, indicating that there was bactericidal activity. This phenomenon did not occur in samples containing only ZrN film, or in the titanium substrate without treatment. Other biological tests were made with different bacteria, proving the efficacy of the treatment.

Keywords
Reactive magnetron sputtering
Antimicrobial action
Zirconium nitride