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

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The research for new biomaterials has been widely performed in order to solve problems such as infections that can occur in implants. This work brings the use of thin film coatings of zirconium nitride with silver nanoparticles as a solution to this problem. Zirconium nitride has several properties that give it an ideal character for use in bioapplications, such as high hardness, excellent chemical resistance, high resistance to corrosion and biocompatibility. In addition, metallic silver in the form of nanoparticles is effective against a broad spectrum of bacterial and fungal species, including strains that are resistant to antibiotics. Silver nanoparticles are considered to be even more active due to their high surface area to volume ratio. In order to combine the ZrN and Ag properties, these were co-deposited by magnetron sputtering on titanium and AISI 304 steel substrates. The physical-chemical characterization proved that ZrN thin films are stoichiometric (condition in which they exhibit the best tribological properties) through RBS analysis. The existence of Ag on the surface was also demonstrated by the GD-OES technique, and the effective formation of ZrN was observed through Raman spectroscopy. Hardness measurements were obtained through nanoindentation and the result obtained (15 GPa) is in accordance with the literature. For the biological characterization, two tests were performed. The first consisted of a visual analysis through Petri dishes with nutrient agar to attest the bactericidal activity against Escherichia coli through the formation of halos around the samples. The second test, a quantitative approach, had the objective of evaluating the percentage reduction of microorganisms' adhesion to the samples with surface treatment. The test was done with the bacteria Listeria and Salmonella. It was observed that there was a maximum percentage reduction of microorganisms' adhesion of 53.33%.

Keywords
Reactive magnetron sputtering
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