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Dynamic fatigue tests performed on Ag-ZrCN coatings for orthopedic prostheses

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With the increase of elderly population and health problems that are arising nowadays, knee and hip joint prosthesis are being widely used worldwide. However, it is estimated that 20% of hip replacement surgeries simply fails after 5 years, due to wear fatigue and subsequent replacement due to infection. Several studies have been performed describing the use of silver as an anti-microbial agent for biomedical application.s However, these studies consider solely silver antimicrobial action, disregarding other important factors, such as silver cytotoxicity and materials' mechanical properties. Hence, this highlights the importance of gathering all the materials properties, from mechanical and physical to biological properties, in order to develop a multifunctional material that is able to last long in patient and is the less harmful possible. This work reports the development of anti-microbial multifunctional coatings based on Ag-Zr(C,N). Samples were prepared by DC reactive magnetron sputtering using two targets, Zr and Zr+Ag, in an Ar + C_2H_2 + N_2 atmosphere. Silver pellets were placed in the erosion area of a Zr target in order to obtain a silver content up to 10 at. %. The mechanical characterization (hardness, Young´s modulus, residual stress) was carried out by using depth sensing nanoindentation and the deflection technique. The adhesion/cohesion of the films to the substrate was assessed by scratch-testing experiments. Fatigue tests are carried out by nanoindentation, following a variation of the ISO 7206 standard, being the failure mechanism observed by SEM. For the assessment of anti-microbial activity, adhesion and biofilm formation was studied on samples' surface, using *Staphylococcus epidermidis*. The total amount of biomass was determined using the crystal violet staining method.

Keywords
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