KNI101

Ceramic-Ag nanocomposite coatings produced by magnetron sputtering: effect of Ag nanoparticles on functional properties

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The propose of this work is the development of Ag/a:C and Ag-Au/a:C coatings for biomedical devices, to provide them with antimicrobial characteristics. Silver was selected due to the well-known antibacterial properties, while gold was included to assess its capacity to accelerate the silver ion release forming a galvanic couple between Au and Ag. Thus, the metallic (Ag) and bimetallic clusters (Ag/Au) were produced by three different configurations: i) unbalanced magnetron sputtering (conventional sputtering), (ii) plasma gas condensation process and by (iii) a combination between both previous approaches.
Coatings with Ag/Au bimetallic clusters were characterized by transmission electrons microscopy (TEM) in order to study the arrangement (alloy, core-shell and galvanic couple) of these particles in the carbon matrix. Inductively coupled plasma optical emission spectroscopy (ICP-OES) was used to quantify the Ag ions released through artificial urine from the different coatings deposited on thermoplastic polyurethane (TPU) tape (one of the materials used in the ureteral stent manufacture). Then, the antibacterial and cytotoxicity properties of Ag and Ag-Au/a:C coatings were evaluated.
TEM shows that a biphasic structure was not detected, thus not allowing to anticipate the establishment of a galvanic couple. The ICP-OES results demonstrate that the silver ionization is mainly function of the amount of silver incorporated in the a:C matrix, and the bimetallic alloy clusters has a detrimental effect on the silver ions release. The antibacterial activity was regulated by the silver ionization mechanisms, since the coatings with higher Ag release had a higher antibacterial activity.

Keywords
sputtering
plasma gas condensation process
antibacterial