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Antibacterial coating on polymer for space application

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HIGHLIGHTS

► A silver nanocluster silica composite coating was deposited on a polymeric film.
► A co-sputtering technique was used for the coating deposition.
► The coating induced an antibacterial effect on the polymer film.
► The coating improved the nano-hardness and the resistance to tensile and perforation.

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ABSTRACT

The microbiological contamination on board of spacecraft and orbital stations is a relevant problem in prolonged space exploration. For this purpose, an antibacterial silver nanocluster silica composite coating was deposited on a commercial polymer Combitherm®, suitable for aerospace application, using the radio frequency (RF) co-sputtering technique. The presence of metallic silver nanoclusters and silica was confirmed by energy dispersion spectrometry (EDS), x-ray photoelectron spectroscopy (XPS) and localized surface plasmon resonance (LSPR) detected through UV–visible absorption spectrophotometry (UV–Vis). The atomic force microscope (AFM) evidenced the coating morphology. The slight hydrophobicity of both coated and uncoated samples was revealed through the contact angle measurement. The antimicrobial behavior was verified through evaluation of the inhibition halo against several bacterial and fungal species. The coating enhanced the Combitherm® nano-hardness and its resistance to tensile and perforation tests; the coating wear resistance was measured by abrasion test against Kevlar. A folding procedure on the coated Combitherm® and storage in air for three months was also carried out without deterioration of the measured properties. The coating deposition did not influence the air permeability of Combitherm®.

1. Introduction

The problem of microbiological contamination on board of spacecraft and orbital stations arises from the necessity to prolong space explorations ensuring crewmembers' health, safety and well-being, together with the integrity of the spatial structures for the whole duration of the mission [1,2]. The interior of a space structure can be easily colonized by microorganisms due to the presence of humans and conditions such as humidity and temperature create a suitable environment for the growth of bacteria and fungi [3,4], able to induce adverse effects as infections, allergies, degradation of air and water [1,2]. It was observed that the largest quantity of bacteria and fungi is concentrated on the surfaces of the space structure, in potable water and air [5,6].

In addition, the increased application of polymers in space and aviations focused the attention of the researchers toward the materials deterioration and degradation. Recently, an inflatable habitat structure was developed and introduced by United States National Aeronautics and Space Administration (NASA, Johnson Space Center) with the function of a high volume module [7]. The inflatable module is composed mainly by a series of polymeric layers, packaged around a central metallic core. This peculiar structure allows the reduction of the initial volume during the

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