Design and Development of silver-doped DLC nanocoatings with improved operational stability

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Introduction:

Reduction in microbial contamination of inanimate surfaces is of the utmost importance to many industries, especially in healthcare activities. Consequently, there is a growing interest in the design and development of bioactive and biofunctionalized surfaces which can either prevent bacterial contamination altogether or resist microbial adhesion. In this regard, functional Diamond-like Carbon (DLC) thin films are interesting candidates to act as antibacterial surfaces in any healthcare environment [1]. DLC coatings have excellent mechanical properties and exhibit high chemical inertness and innocuous towards human. Also, due to their low friction coefficient and roughness, DLC films can reduce the adhesion of bacteria to surfaces [2, 3]. Moreover, because of their amorphous structure, surface properties can be tailored by the incorporation of other elements and they may be deposited on most type of substrates [4]. Hence, by adding specific microbicidal materials, such as silver, a highly effective broad spectrum antimicrobial [1], to the DLC matrix, the resulting coating can act with a dual functionality of antimicrobial properties in addition to anti-adhesive properties.

Materials and Methods:

In this work, the DLC deposition was achieved by using a hybrid, radio frequency, inductively coupled plasma reactor coupled to a low-frequency sputtering setup. The innovation of this technique is to combine plasma enhanced chemical vapor deposition (PECVD) and physical vapor deposition (PVD) simultaneously, in order to deposit silver-doped DLC coatings in a one-step process. The DLC film properties were modulated and optimized by controlling the energy of the plasma species,

mainly through the power of the RF source, the total gases pressure as well as the substrate temperature and bias voltage during the deposition. By changing the deposition parameters and by modifying the interface of the coating and the substrate, it was possible to optimize the physico-chemical and mechanical properties of the coatings. Furthermore, different concentrations of silver were incorporated into DLC matrix to induce the bacteria inactivation on the surface.
This presentation will describe the optimization process of the deposition, with an added focus on the adhesion, stability as well as the biological characterization of the deposited coatings.

Results:

The hardness of thin DLC coatings was determined by AFM-nanoindentation. The results revealed that as the negative bias voltage increases from -45V to -110 V, the hardness show a significant increase from 1.2±0.3 GPa to 17.2±0.5 GPa which can be corresponds to the transition from polymer-like to diamond-like carbon.

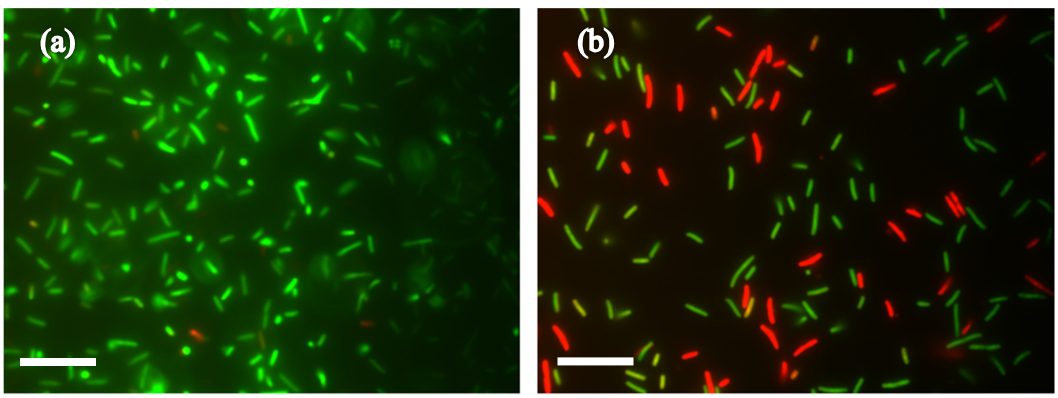

Figure 1. Representative fluorescent optical micrographs showing the distribution of Live (green)/Dead (red)-stained cells on (a) DLC coated samples (b) Ag-DLC coated samples (Scale bars, 5 µm).

Preliminary results have indicated that the addition of ~ 2.5 at.% of silver resulted in a reduction in bacterial activity on the surfaces of Ag-DLC coated samples as compare to pure DLC coated samples, after 3 hours of incubation time (Figure 1).

References:

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