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Effects of silver segregation on sputter deposited antibacterial silver-containing diamond-like carbon films

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Abstract: Silver-containing diamond-like carbon (DLC) films for antibacterial applications were prepared on 316L stainless steel and slide glass substrates by magnetron sputtering at different silver target current. Scanning electron microscopy and atomic force microscopy analyses show that the film surface becomes rough due to the formation of nanoparticles/clusters and even a surface layer with the increase of silver target current. The Ag content was measured as 0, 2.1, 6.1 and 14.3 at.%, respectively by energy dispersive X-ray analysis. X-ray diffraction and X-ray photoelectron spectroscopy reveal the dominant metallic nature of silver for the Ag-containing films. Silver segregation from the carbon matrix to film surface is confirmed by the above analyses. Microhardness indentation, contact angle measurement and potentiodynamic polarization test in a Ca-free Hank's balanced salt solution indicate that the addition of silver has decreased hardness, elastic modulus, H/E and H^3/E^2 ratios, wettability, surface energy and corrosion resistance of the DLC films, respectively. The antibacterial tests by agar disk diffusion assay and agar plate counting method against Escherichia coli demonstrate long-lasting and reusable antibacterial activity of the Ag-containing films. The study shows that silver segregation plays a crucial role in microstructure, mechanical, chemical and biological properties of the antibacterial Ag-containing DLC films.

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