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Oxygen plasma etching of hard Ag/a-C:H nanocomposite coatings

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Nanocomposite metal/plasma polymer films have been in the center of attention for several decades. In recent years, Ag/hydrocarbon plasma polymer films attracted considerable interest because of their antibacterial properties. In general, precise control of chemical composition and surface texture is required for the adjustment of bactericidal efficacy whereas mechanical robustness of such coatings is demanded to enhance the durability of their performance.
In this work, Ag/a-C:H nanocomposites were prepared by simultaneous deposition of Ag nanoparticles (NPs) and plasma polymerization of n-hexane. The Ag NPs were fabricated by a gas aggregation cluster source (GAS) and their beams were directed onto Ti and VT6 alloy substrates located on a separate electrode. The electrode was RF driven to sustain plasma in the mixture of Ar and n-hexane (10:1) at pressure of 5.5 Pa. The discharge power was chosen to ensure the negative self-bias of 300 V and to enable the deposition of hard a-C:H matrix. This setup allowed independent control of the amount of the embedded Ag NPs and the properties of the embedding matrix. Subsequently, the samples were exposed to the action of the O_2 plasma at pressure of 2.5 Pa, power of 40 W and self-bias of -160 V, and the preferential etching of the organic phase was observed. Such anisotropic etching resulted in an exposure of higher amount of the NPs initially buried beneath the surface. It was also confirmed that an increase of the Ag content resulted in the enhancement of the antibacterial properties of the films. However, the excessive NPs concentration of > 6 % led to rapid worsening of the mechanical properties of the coatings. The optimal concentration of 3% of as-deposited Ag NPs was found to retain both the antibacterial effect and the mechanical stability.
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