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Improvement of DLC antibacterial activity by addition of TiO_2 nanoparticles

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Abstract – The antibacterial property of Diamond-like carbon (DLC) films containing TiO_2 nanoparticles was investigated. The films were growth on 316L stainless steel substrates from a dispersion of TiO_2 in hexane using plasma enhanced chemical vapor deposition (PECVD). The composition, bonding structure, surface energy, stress and surface roughness of these films were also evaluated. As TiO_2 content increased, there was an increasing in I_D/I_G ratio, hydrogen content and roughness; the films become more hydrophilic, with higher surface free energy and the interfacial energy of bacteria adhesion decreased. Experimental results show TiO_2 increased DLC bactericidal activity.

Diamond-like Carbon (DLC) films have been the focus of extensive research in recent years due to its potential application as surface coatings on biomedical devices [1,2]. Titanium dioxide (TiO_2) in the anatase crystalline form is a strong bactericidal agent when exposed to near UV-light [3]. In this work we investigate the bactericidal activity of DLC films containing TiO_2 nanoparticles. The films were growth on 316L stainless steel substrates from a dispersion of TiO_2 in hexane using PECVD. The characterization was performed with Raman scattering spectroscopy, atomic force microscopy, perfilometry and wetting contact angle. The antibacterial tests were performed against *Escherichia coli* (*E. coli)* and the results were compared to the bacterial adhesion force to the studied surfaces. The presence of TiO_2 in DLC bulk was confirmed by Raman spectroscopy (Fig. 1). As TiO_2 content increased, there was an increasing in I_D/I_G ratio, hydrogen content and roughness; the films become more hydrophilic, with higher surface free energy and the interfacial energy of bacteria adhesion decreased. Experimental results show TiO_2 increased DLC bactericidal activity (Fig. 2). Pure DLC films were thermodynamically unfavorable to bacterial adhesion. However, the chemical interaction between *E. coli* and the studied films increased for the films with higher TiO_2 concentration. As TiO_2 bactericidal activity starts its action by the oxidative damage to the bacteria wall, a decreasing in the interfacial energy of bacteria adhesion cause an increasing in the chemical interaction between *E. coli* and the films, which is an additional factor for the increasing bactericidal activity. From these results, DLC with TiO_2 nanoparticles can be useful to produce coatings with antibacterial properties.

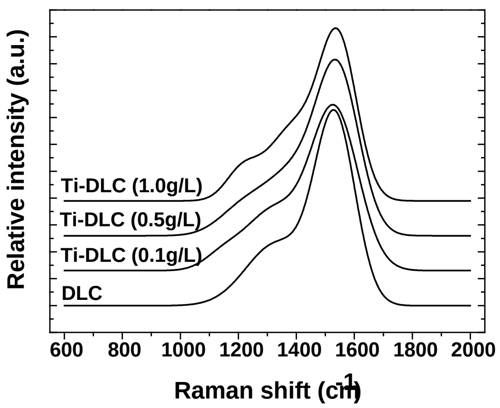

Figure 1: Raman spectra according to TiO_2 concentration in DLC films.

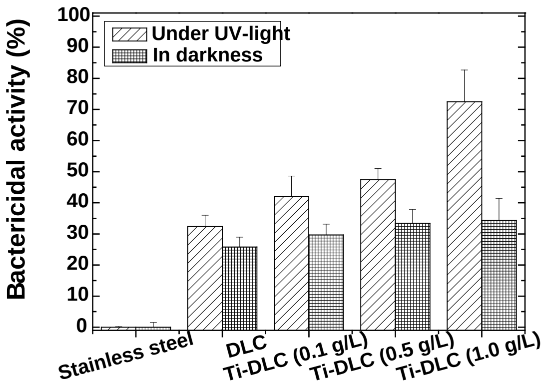

Figure 2: Bactericidal activity of the samples.

References

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