Plasma deposited nanocomposite coatings for biomedical applications: silver and hydroxyapatite containing thin films

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Nanocomposite materials are characterized by unique properties, different from separate phases and represent new challenges of great technological and economical impact.

Nanocomposite coatings find applications in biomedical field showing favourable effects in biomedical applications to manufacture materials for tissue engineering, drug delivery devices or as a strategy to improve mechanical properties or chemical inertness of materials. In this work two kind of nanocomposite coatings deposited by means of plasma assisted technology will be presented like silver containing and hydroxyapatite (HA) containing plasma deposited nanocomposite coatings. The former aimed to produce antibacterial surfaces and the latter intended for application in bone and cartilage generation on properly designed scaffolds. Bacteria responsible for nosocomial infections are often multi-resistant to antibiotics and represent a special therapeutic challenge. Antibacterial surfaces are of fundamental importance for many health and consumer products (e.g. catheters) [1,3]. In this study plasma deposition of nano-composite coatings (*i.e.* dispersions of silver clusters embedded into an organic matrix) are presented as silver delivery systems. The aim of this work is to improve the performance and reliability of existing products and to extend the use of silver to new value-added products, by applying PE-CVD of silver containing nano-composite coatings directly on biomaterial surfaces. The coatings were deposited in RF (13.56 MHz) Glow Discharges fed by a mixture of Diethyleneglycol di-methyl ether (DEGDME) and Ar. A simultaneous sputtering process occurred when a silver coated sputter target was used, to obtain a dispersion of silver clusters into an organic matrix [2]. A similar strategy was applied to produce HA containing coatings replacing the Ag target with one of HA. XPS characterization demonstrates that the higher the amount of silver embedded, the higher the crosslinking of organic matrix: the retention of the monomer structure is lost due to experimental conditions used during glow discharge. Water contact angle (WCA) measured on such surfaces increases as a function of surface roughness. A deep FT-IR characterization of coatings deposited in this work shows characteristic vibrations of structural groups placed tightly on surfaces of small silver inclusions. Such kind of absorption peaks is not present on coatings that do not include Ag. The enhancement of such absorptions greatly depends on the morphology, dimension and density of metal clusters. It can be used to estimate ageing of coatings and possible amount of released silver. Investigation of the influence of Ag-nanocomposite coatings, containing the highest amount of Ag, on bacterial (*S. epidermidis*, ATCC 35984, slime-positive) adhesion, under static and flow conditions, shows that these coatings not only significantly reduce bacterial adhesion, in comparison to the native PET, but cause bacterial death as well. HA-nanocomposite coatings with variable HA content have been deposited from allyl alchool vapours (fixed flow rate 0.1 sccm) in Ar carrier (20sccm). A HA-sputter coated cathode has been used, RF power (10–100 W) and pressure (10–50 mTorr) have been changed. The HA content in the coatings increases as the input power increases and a clear evidence of the characteristic feature of HA in the FT-IR spectra has been shown. By comparing the behaviour of Saos-2 osteoblasts grown on plasma deposited coatings it has been shown that nano-composite coatings containing HA are much more effective in promoting cell spreading with respect organic coatings with similar chemical composition but non containing HA and coatings of only HA sputtered on glass substrates. **References:** [1] Elliot, T. S. J., *et al.* Journal of Hospital Infection 30, 181, 1995. [2] Sardella E., *et al.* Plasma Processes and Polym. 3, 456, 2006 and references therein. [3] Silver S., FEMS Microbiol Rev 27, 341, 2003 **Acknowledgements:** M. Katsikogianni, Y.F. Missirlis are gratefully acknowledged for their contribution and MIUR-FIRB RBNE01458S_006 and INTERREG (No. I 2101003) Italy-Greece projects for funding.