# EPD AND CHARACTERISATION OF GRAPHITE OXIDE/HYDROXYAPATITE/SODIUM ALGINATE COATINGS INCORPORATED WITH $Si_3N_4$ or CuO NANOPARTICLES ON TITANIUM BIOMATERIALS

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Titanium biomaterials are commonly used for bone implants, particularly in orthopaedic and dental applications. Nevertheless, they are considered as biologically inert, which causes problems with permanent bone fixation. Another major complication with the use of titanium implants is the easy formation of biofilm on their surfaces. Thus, coatings with dual osteoinductive and antimicrobial properties are developed. Alginate, which is a natural acidic polysaccharide derived from brown sea algae, is a promising polymer for hosting both bioactive and antimicrobial particles. It has been extensively investigated and used for many biomedical applications, especially tissue engineering, due to its high biocompatibility, biodegradability, low toxicity, relatively low cost, and cross-linking capability. The aim of the present work is the development of the EPD of multicomponent sodium alginate-based coatings incorporated with graphite oxide flakes (GtO), bioactive nanocrystalline hydroxyapatite (HA) and CuO or $Si_3N_4$ NPs on commercially pure titanium (CP-Ti1) and Ti-13Nb-13Zr alloy substrates. The microstructure, surface topography and properties, adhesion strength, electrochemical corrosion resistance, bioactivity and antibacterial properties of the coated materials were investigated. The suspension for the deposition of multicomponent coatings as well as EPD voltage and time were developed and optimised. Both coatings were anodically deposited from a water-ethanol colloidal solution containing SA and different contents of GtO, HA, $Si_3N_4$ or CuO particles. We discuss the zeta potential, mechanism and kinetics of EPD as well as the influence of the EPD parameters on the coating homogeneity. The morphology and surface topography of the coatings can be varied by altering the HA, $Si_3N_4$ and CuO content in the suspensions. The GtO flakes were oriented parallel to the coating surface, the HA formed agglomerates and the $Si_3N_4$ or CuO NPs were present in the form of agglomerates or separate particles. It was found that coatings revealed high adhesion to the Ti-13Nb-13Zr alloy substrates. All coatings revealed a hydrophilic character and showed a high ability to protect the alloy substrates against corrosion in Ringer's solution at normal body temperature. A HA layer was formed as a result of soaking the coated samples in SBF for 3 weeks. All coatings showed similar behaviour against *S. aureus*. However, coatings with CuO considerably reduced the viability of *E. coli* bacteria. The introduction of HA improved the initial cell viability of the pure sodium alginate coatings. The addition of GtO did not induce any cytotoxic effects. The coatings containing CuO and $Si_3N_4$ reduced the cell viability after 72 h of incubation, but this effect was much higher for the CuO-containing coatings.

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