Tailored Organic-Inorganic Nanocomposite Coatings for Biomedical Applications

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This communication shows a review of the main results of a collaborative work of interdisciplinary nature. The research is focused on the preparation of new sol-gel thin films for improving corrosion resistance and biocompatibility of Ti6Al4V alloys. With this aim, different strategies are being applied. For example, mixtures of two organopolysiloxane precursors are being used for the preparation of sol-gel matrix of coatings: tetramethylortosilicate as inorganic precursor of the network, and γ-methacryloxypropyltrimethoxysilane or γ-glycidoxypropyltrimethoxysilane as inorganic precursors. The resulting sol-gel coatings are modified with zirconium tetrabutoxide or titanium isopropoxide as precursors of ZrO_2 and TiO_2 micro- and nano-particles for improving their active corrosion protection or self-healing properties. Another important part of the study is consisting in using triethylphosphite and dimethylsilylphosphite to introduce phosphorus into organic–inorganic hybrid silica network for improving the bioactivity and biocompatibility of the sol-gel coatings. The incorporation effect of the different dopant additives on the physicochemical properties is studied with different characterization techniques. Thermal stability of the hybrids is been examined by using thermogravimetric analysis (TG/DTG). Attenuated total reflectance Fourier Transformer Infrared Spectroscopy (FTIR-ATR) is been applied for studying the functional groups within the matrix of the prepared sol-gel coatings. Scanning Electron Microscopy (SEM) coupled with an Energy Dispersive X-ray (EDX) areapplied to study the surface morphology and composition of coated samples. Normal human osteoblast (NHOst) response in terms of osteoblast viability and adhesion tests of coatings to the Ti6Al4V alloys routinely used in medical implants are used in the study. Fibrinogen has been chosen as a model for the for protein adsorption studies on the coated surfaces. Corrosion resistance of the prepared coatings during immersion tests in simulated body fluids (SBF) is been studied by applying. For this purpose global Electrochemical Impedance Spectroscopy (EIS) at macroscopic scale and local impedance spectroscopy (LEIS) at sub-millimeter and sub-microscopic scales are been applied. TG/DTG results are indicating that the addition of the dopants used for these studies do not have a negative influence on the coating stability. Addition of phosphorous precursors to TMOS-MAPTMS hybrids dramatically increased the rate of intermolecular condensation and cross-linking improving the barrier properties of coatings. The study is showing that some of these sol-gel coatings display excellent bioactivity when soaked in the (SBF) and good corrosion protection behaviour and can be potentially applicable for the manufacture of new implant materials for biomedical uses.