Titanium and its alloys are widely used implant materials in medical applications. Despite numerous beneficial properties, these materials exhibit poor osteoconductive properties, which are essential for preventing implant loosening and achieving long-term stability. In addition, an unfavorable phenomenon that hinders osseointegration process is the formation of a biofilm on the implant surface. Biofilm, which is an architectural colony of microorganisms, cause microbial and chronic infections. These failures are mostly solved by the administration of systemic antibiotics to the patient. However, such procedure leads to microbial flora depletion and bacterial biofilms resistance against human immune system, as well as against antibiotics. This has led to the necessity of innovative prevention and treatment strategies. Due to these limitations, the modification of titanium biomaterials surfaces by deposition of bioactive coatings with antibacterial activity, including electrophoretic deposition method, is being intensively investigated.

The project is aimed at investigating the suspension's stability, EPD kinetics and mechanisms of electrophoretic co-deposition of organic and inorganic particles with different size and morphology to obtain multicomponent biodegradable coatings with a balance of bioactive and antibacterial properties on titanium biomaterials, commercially pure titanium CP Ti1 and near-β Ti-13Nb-13Zr titanium alloy. Two types of composite coatings will be developed in the proposed project:

Type I: fluoride-containing sol-gel glass and mesoporous sol-gel glass, SGG/zein and MSGG/zein coatings, respectively,

Type II: nanocrystalline antibacterial agent (nc-aa)/graphene oxide (GO)/hydroxyapatite (HA)/polymer coatings, including nc-aa/GO/HA/chitosan coatings and nc-aa/GO/HA/alginate coatings, where aa is an antibacterial agent, Si_3N_4 or CuO.

An important aspect of the project will be to design EPD parameters to ensure high coatings quality, homogeneity and tailored microstructure. Detailed characterisation of the coatings will be performed to obtain a fundamental understanding of the EPD parameters – micro/nanostructure – property relationships. The scientific scope of proposed research realized by an interdisciplinary team with vast experience will enable a comprehensive analysis of the influence of EPD suspensions chemical composition and deposition parameters on the coating microstructure, tribological and micro-mechanical properties, as well as bioactivity, antibacterial activity and resistance to electrochemical corrosion. In particular, an advanced investigation of kinetics and mechanisms of the EPD route, a complementary characterisation and correlation of the micro/nanostructure and surface topography with different properties will contribute to the development of multicomponent biodegradable coatings with a balance of bioactive and antibacterial properties, as well as good adhesion to the titanium biomaterial substrates. It is expected that the proposed multicomponent biodegradable coatings will be a versatile solution and will lead to a significant improvement in the bioactivity as well as ensure prolonged antibacterial properties of titanium biomaterials. This will result in development of orthopedic and dental implants with superior performance and extended durability, which is of great importance and has an immeasurable economic and societal impact on the quality of life of patients, in terms of minimalizing the risk of complications after implantation and limiting the use of antibiotics.